7 2
NCS 82

SECOND NATIONAL CONFERENCE ON SANITATION

CALCUTTA

4—6 November, 1982

TECHNICAL PAPERS

LIBRARY
International Reference Centre
for Community Water Supply

Sponsored by :

Department of Health,
Department of Environment,
Department of Education,
GOVERNMENT OF WEST BENGAL

Co-Sponsors and Collaborators

Calcutta Metropolitan Development Authority
Institution of Engineers (India), West Bengal State Centre

United Bank of India
Development Consultant Private Limited, Calcutta
M. N. Dastur & Co., Calcutta
Sulav International, Patna
Ghosh Bose Associates, Calcutta
& etc.

SECOND NATIONAL CONFERENCE

ON

SANITATION

CALCUTTA

November 4 - 6, 1982

LIBRARY KD 5823
International Reference Centre
for Community Water Supply

TECHNICAL PAPERS

Sponsored by

Department of Health,

Department of Environment,

Department of Education,

GOVERNMENT OF WEST BENGAL

LIBRARY, INTERNATIONAL REFERENCE
CENTRE FOR COMMUNITY WATER SUPPLY
AND SANITATION (IRC)
P.O. Box 93190, 2509 AD The Hague
Tel. (070) 814911 ext. 141/142
RN: 06523 ISN 3291
LO: 72 NC 90




CONTENTS

		Page
1.	"Prospective of Sanitation in the Decade (1981-90) by Er. S.R. Mendiratta ..	1.
2.	"Environmental Management in 80's by Er. A.C. Chaturbedi ..	197
3.	"Land Treatment System for Surat City" by Prof. M.B. Gohil ..	203
4.	"Evaluation of Performance of Sewage Farms - A Case Study of Tirupati Municipal Sewage Farm" by Prof. B. Kotaiah ..	6
5.	"Collection and Transportation of Night Soil for Sewerless Sanitation System" by Prof. N.C. Shah ..	143
6.	"Status of Low Cost Sanitation in Gujarat" by Er. Y.N. Nanjundiah & Er.B.J.Vasavada ..	164
7.	"Water and Waste Water Recycling for Small Communities" by Dr. K. Raghavan Nambiar ..	125
8.	"Decade Programme for Drinking Water Supply & Sanitation in Tamilnadu" by Er. R. Krishnaswamy & Er. S.A.Jagadeesan ..	71
9.	"Existing Sanitation Status - Problems and Prospects - Refuse Sanitation" by Er. S. Shankarappa ..	181
10.	"Basic Functions for Solid Wastes Management" by Prof. M.M. Tamakuwala ..	119
11.	"Institutional, Financial, Sociological and Legal aspects of Low Cost Sanitation - Latrine Construction Programme" by Er. B.J. Vasavada ..	109
12.	"Role of Communication and Health Education in Water Supply & Sanitation Programme" by Mr. A.C. Johri & Dr. A. Rahaman ..	159
13.	"Environmental Sanitation - Present Status of Metropolitan Cities of Gujarat State" by Er. C.C. Shah & Er. G.A. Gosla ..	212
14.	"Low Cost Sanitation by Anaerobic (Upflow) Filter System" by Prof. V. Raman, Mrs. S.A.Patkie, & Mr. A.N. Khan ..	207
15.	"Choice of Appropriate Technology for Sanitation in Developing Countries" by Dr. R. Guruswamy ..	83
16.	"Rural Sanitation Project - A Case Study" by Dr. R. Guruswamy, Mr. R. Desigavinayagam Pillai, and Er. S. Sundaramoorthy ..	101
17.	"Low Cost Sanitation Programme in Tamil Nadu" by Er. G. Mathew & Er. T.Ramachandran ..	92

		Page
18.	"Constraints in Adoption of Low Cost Sanitation Technology" by Dr. R.N. Shelat & Prof. M.B. Gohil ..	43
19.	"Economic Analysis of Water Supply & Sanitation Development" by Prof. D.T. Shete ..	50
20.	"Economic Contribution of Water Supply & Sanitation to National Development by Prof. D.T. Shete ..	57
21.	"Gaming Simulation of Water Supply & Sanitation" by Prof. D.T. Shete ..	65
22.	"Appropriate Pollution and Water Technologies for Rural Population" by Dr. D.S. Bhargava ..	80
23.	"Low Cost Sanitary Latrines on the Basis of Gandhian Philosophy" by Mr. Ishwarbhai Patel ..	16
24.	"Potential of Water Hyachinth in Waste Water Treatment" by Dr. M. Narayan Rao ..	134
25.	"Sanitation for the Poor - Five Developing Regions in Search of Appropriate Technology" by Er. P.K. Saha ..	47
26.	"Bombay -II Sewerage Project" by Er. A.N. Sabnis ..	29
27.	"Quality Control of Bombay Water Supply" by Er. V.M. Shidhyay & Er. N.W.Mirchandani ..	149
28.	"Bio-Monitoring Tests for Determinigg Industrial Effluent Toxicity of Water" by Prof. J.J. Ghosh and Mr. A. Manna ..	179
29.	"Aerated Lagoons at MECON-SAIL Township Ranchi" by Er. M. Vevekanandan & Er. D.N. Bhattacharya ..	215

(NOTE: This book does not contain any page bearing number 191).

PROSPECTIVE OF SANITATION IN THE DECADE (1981-90)

S.R. MENDIRATTA*

INTRODUCTION

Sanitation is a way of life. It is the quality of living that finds expression in clear homes, clean neighbourhoods and in a clean community. There is no better sign of civilization and culture. A good and well maintained drain reflects the culture as much as a beautiful statu.. Environmental Sanitation is the control of all the factor's in human being's physical environment which exercise an adverse effect on his physical and mental development, health and survival. Human excreta are the principal vehicle for the transmission and spread of a wide range of communicable diseases. A large number of diseases are spread directly through man's contanct with human excrement, indirectly via water food and soil or via carriers like flies, mosquitess and cockroaches. It is estimated that 1760 million manhours are lost every year due to people made unfit by communicable diseases and our nation is loosing about Rs. 4500 million per year on account of treatment, purchase of medicine and loss of production. Invariably it is the poor who suffer the most from the absence of sanitation, because they lack not only the means to provide for such facilities but also information on how to minimize the ill effects of the insanitary conditions in which they live. As a result, the weakening effects of insanitary living conditions lower the productivity of the very people who can least afford it.

2. MAGNITUDE OF THE PROBLEM:

As per the data collected by the W.H.D. in 1977 only 32% of the population in developing countries have adequate sanitation services; that is, about 630 million out of 1700 million people. The level of coverage in India in urban sanitation as on 1.4.80 is 27% that is, about 39 million out of 144 million people are provided with sanitation facilities in urban areas. Even in urban towns where the urban sewerage facilities exist now only a part of sewerage is treated and the balance is partially treated and led on to land for agricultural purposes or discharged into water courses. The rural sanitation has been the most neglected so far. The level of coverage in India in rural sanitation as on 1.4.80 is 2% that is, about 10 million people out of 516 million people are provided with sanitation facilities in rural areas.

In Rajasthan Sewerage system have been extended mainly to two urban towns (Jaipur and Jodhpur) covering about 20% of the population in these two cities or about 5% of total urban population, much below All-India average (of 27%). The bulk of the urban population in the state rely on conservancy system or have no sanitary facilities at all. Sanitary conditions, particularly in congested urban areas, are severe and are steadily deteriorating. In rural areas of the state no sanitary facilities have been provided as far and people use open fields for defecation.

---

*Executive Engineer, I.D.A. Monitoring, PHED, JAIPUR.

3. SERVICE LEVEL GOALS

The United Nations General Assembly launched the International Drinking Water Supply and Sanitation Decade (1981-90) at a special meeting on 10th November,1980. The following targets of coverage have been fixed for the Decade in our country.

i) Urban Water Supply	100% of the population to be covered by March 1991.
ii) Rural Water Supply	-do-
iii) Urban Sanitation	100% population to be covered in respect of class I cities and 50% in respect of class II and other towns. Overall coverage in each State should be 80% of the urban population by means of sewerage or simple sanitary methods of disposal.
iv) Rural Sanitation	25% of the population to be covered with sanitary toilets.

During the decade, it is proposed to cover all the class I cities (population more than one lac) with sewerage and sewage treatment plant facilities. Even this task appears to be gigantic one since it requires a lot of funds. It is, therefore, necessary to think in terms of providing low cost sanitation facilities such as water-seal toilets followed by septic tank/seak pits to certain percentage of population living in the sub-urban and fringe areas of all the class I cities for the time being. The total estimated requirement of funds for the country for Decade Programme is Rs.2590 crores and Rs. 1584 crores for urban sanitation and rural sanitation respectively.

For Rajasthan the requirement of funds for decade is Rs. 192 crores and Rs. 42 crores for Urban Sanitation and Rural Sanitation respectively. It is proposed to cover 3.31 million population of all the class I towns with sewerage system and sewage treatment plants. It is also proposed to cover 3.84 million population in the remaining towns by providing low cost sanitation facilities such as water seal latrines and public latrines.

To explore the possibility of evelving a safe and suitable low cost sanitation system for our urban areas particularly those with a population less than 1 lac the Government of India had requested the U.N.D.P. to assist in the preparation of feasibility studies for providing low cost pourflush latrines. The U.N.D.P. agreed to do so and, in the first phase of project, 7 states (Assam, Bihar, Gujarat, Maharashtra, Rajasthan, Tamil Nadu and Utter Pradesh) were included covering of 110 towns in these states. The feasibility studies in respect of phase I of the project have since been prepared. For Rajasthan to cover 3.8 lac population * crores. Extrapolation of this amount to all the class II and III towns in the state gives an overall investment need of Rs. 27 crores (1980 prices). Allowing for inflation and the increase in population during the implementation period, the requirements upto 1990 may be about Rs. 40 crores. A provision of Rs. 14.40 crores have been made for urban sewerage and Rs. 2.00 crores for conversion of dry latrines into water seal latrines in 15 towns during the VIth plan period.

* of 15 towns the requirement of fund is estimated to Rs. 3.8

In rural areas it has been proposed to provide low cost water seal latrines to 8.33 million population during the decade (1981-90). The estimated cost is Rs. 42 crores. During the VIth plan period no provision has been made for rural sanitation and it is proposed to carryout this work during the VIIth plan period.

4. THE CONSTRAINTS

The primary constraints to the successful provision of sanitation facilities in developing countries are the lack of funds, the lack of trained personnel, and the lack of knowledge about acceptable alternative technologies. The per capita cost for sewerage alone range from Rs. 300 to Rs. 1000, which is totally beyond the ability of the beneficiaries to pay.

In industrialized countries, the standard solution for the sanitary disposal of human excreta is water borne sewerage. Water borne sewerage is designed to satisfy convenvience and local environmental, rather than health, requirements. It is not designed to maximize health benefits and is far from an optimal environmental solution (as developed countries today are discovering). There is a need to reopen the question of appropriate sanitation technologies for developing countries.

A major effort is needed to identify and develop alternative sanitation technologies appropriate to local conditions in developing countries and designed to improve health rather than raise standard of user convenience. The solutions must be acceptable to the user and reflect community preferences if they are to find acceptance.

5. SANITATION TECHNOLOGIES

The water supply service levels influence, often very strongly, the choice of sanitation technology and the options for sullage disposal. There are basically three levels of water supply service in urban are as :

i) Public Standpipes
ii) Yard taps
iii) Multiple taps in house connections

The table I given below shows the typical water consumption figures and the options available for sanitation and sullage disposal for each level of service.

TABLE- I

WATER SUPPLY SERVICE LEVELS VIS-A-VIS OPTIONS FOR EXCRETA AND SULLAGE DISPOSAL IN URBAN AREAS

Sl. No.	Water Supply Service Level	Typical Water Consumption in litres per capita per day.	Options for excreta disposal	Options for Sullage disposal
1.	2.	3.	4.	5.
1.	Standpipes	20 to 40	i) Pit latrines ii) Pourflush toilets iii) Vault toilets	Soakage Pits.

Table- I(Contd.)

1.	2.	3.	4.	5.
2.	Yard taps	50 to 100	i) Pit latrines	i) Soakage pits.
			ii) Pourflush toilets	ii) Storm water drains.
			iii) Vault toilets	iii) Sewerage Pourflush toilets
			iv) Sewered pour flush toilets	iv) Septic tanks
			v) Septic tanks	
3.	Multiple tap inhouse connections.	>100	i) Sewered pour flush toilets	i) Sewered pour flush toilets
			ii) Septic tank	ii) Septic tank
			iii) Conventional sewerage	iii) Conventional Sewerage.

NOTE: i) The options listed in the above table are not in any order of preference.

ii) Pour-flush toilets and valut toilets are feasible for standpipes only if sufficient water is carried home for flushing.

In rural areas where the water supply is existing the alternatives mentioned at S.No. 1 in Table I can be adopted for excreta and sullage disposal. In the villages where no water supply is existing the pit latrines and the compost latrines are most suitable. The compost latrines can be used under the most difficult soil and ground water conditions. Where the soil and ground water conditions are all right the pit latrine is an excellent solution to the problems of excreta disposal. The bucket latrine system can be used as a short term measure and in long term they should be replaced by some other sanitation facility.

6. TECHNOLOGY SELECTION:

After making the tentative selection of the most appropriate technology from the Table I it should be examined from the following angles and the final decision should be taken :

i) Is the technology socially acceptable ? Can it be maintained by the user or by the municipality ? Are municipal support services required ? Can they be made available ?

ii) Is the technology politically acceptable ?

iii) Are the beneficiaries willing to pay the full cost of the proposed facility ? If not, are user subsides (Grant or loan) available ?

iv) Is it consistent with current housing and water development plants ?

v) Are the necessary raw materials are locally available ? Can selfhelp labour be used ? Are training programmes required ?

vi) Can the existing system, if any, be upgraded in any better way than providing for new system ?

vii) What is the potential for reuse ? If low, would the adoption of a technology with higher reuse potential be economically justifiable ?

viii) If the selected technology can not deal with sullage what facilities for sullage are required ? Is the amount of sullage water so low or could be reduced, so as to perclude the need for sullage disposal facilities ?

CONCLUSION:

In order that the huge investments that are made on sanitation programme become more effective it is necessary to creata awaraness, interest and motivate people to accept use and maintain the facilities provided for. The health education programme in samller communities is very essential for acceptance and proper use of sanitation facilities. Several health benefits can only be expected to occur if latrines are properly used and maintained. Unless the people come to have some new understandings of the health hazards associated with the improper excreta disposals and measures that can be taken to avoid them, the purpose of providing sanitation facilities will not be achieved.

EVALUATION OF PERFORMANCE OF SEWAGE FARMS A CASE STUDY OF TIRUPATI MUNICIPAL SEWAGE FARM

B. Kotaiah*

INTRODUCTION.

Sewage-farming is widely practiced as a low-cost method of community wastewater disposal by many municipalities in India. There are more than 132 organised sewage farms in India and many more are in planning stage (Sastry, 1975). Although such sewage farms are in operation for many years, there is not much documented evidence how ad equate a sewage farm is as a treatment system for the removal of nutrients, organic matter, suspended solids, and a variety of micro-organisms including pathogenic types as well as viruses, by physical, chemical and biological retention mechanisms.

Inaddequate removal of pollutants by soil and plant system may release the pollutants into the surface and groundwaters and contribute to enrichment and subsequent eutrophication. Thus in the absence of the comprehensive data on the capacity of the sewage farms to fix and store wastewater constituents for use by plants and microorganisms, it becomes necessary to evaluate or assess the sewage farms for their effectiveness as a treatment system. A short term investigation (March 1981 to August 1982) has been undertaken by the author on municipal sewage farm of Tirupati. The major objectives of the present investigations are (1) to compute the reduction of various wastewater constituents upon disposal by soil and plant system, (ii) to ascertain the change of physicochemical characteristics of the sewage farm soils due to the longterm disposal of wastewater and change of ground water quality in the nearby wells of the sewage farm against the background levels, and (iii) to understand the crop production capabilities of the sewage farm and also other nuisance factors that exist in the sewage farm.

SITE DESCRIPTION AND OPERATING CONDITIONS

Tirupati municipal sewage farm, 6.67 hectares in area, has been in continuous operation since 1958. An underdrainage system which collects the water that percolates through the soil is installed at a depth of 1.5 m below the soil surface. The water collected in all the drainage pipes is discharged into a collection channel of 1.2 m wide and 1.5 m depth. There are 22 plots in the sewage farm of each having a size of 115m x 20m to 150m x 20m. The farm is leased to local farmers who irrigate all the year-round and raise various crops using surface flooding. The schedule of application of wastewater is one day application and six days resting. The topography of the area has a 0.01% uniform slope towards the collection channel. The soils profile is dominated by granular-blocky structure for the top one meter depth, followed by prismatic-blocky structure for the subsequent depths. The groundwater flow is from North-West to South-East (Reddy, 1982). The depth of the ground water table is approximately 7.8m below the soil surface. The evapotranspiration at the site is approximately 1.0 m/year which is twice the mean annual rainfall in Tirupati region. The wind direction is West to East for the majority of the days in a year. Site location and layout of the sewage farm are presented in fig. 1 and 2.

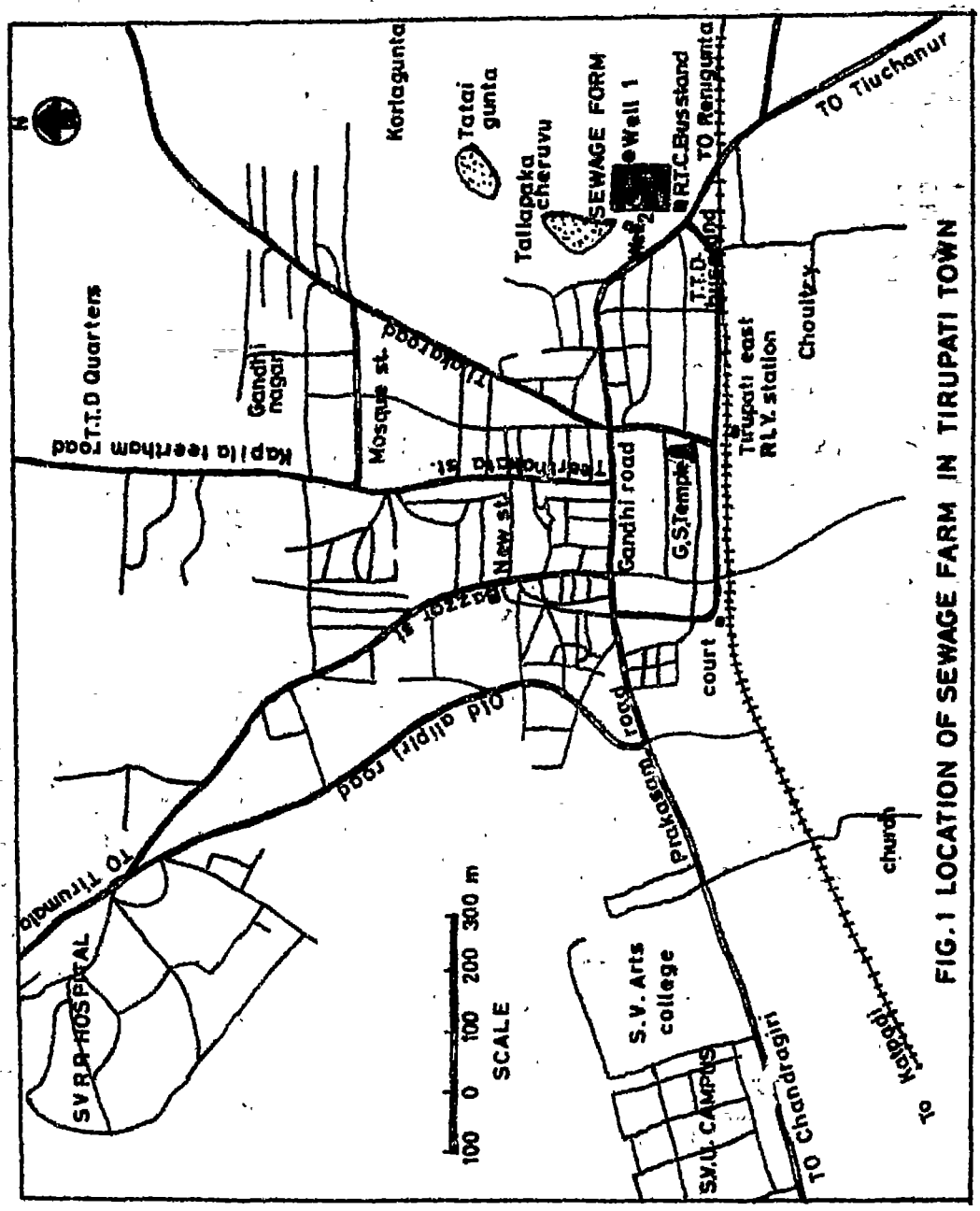


FIG.1 LOCATION OF SEWAGE FARM IN TIRUPATI TOWN

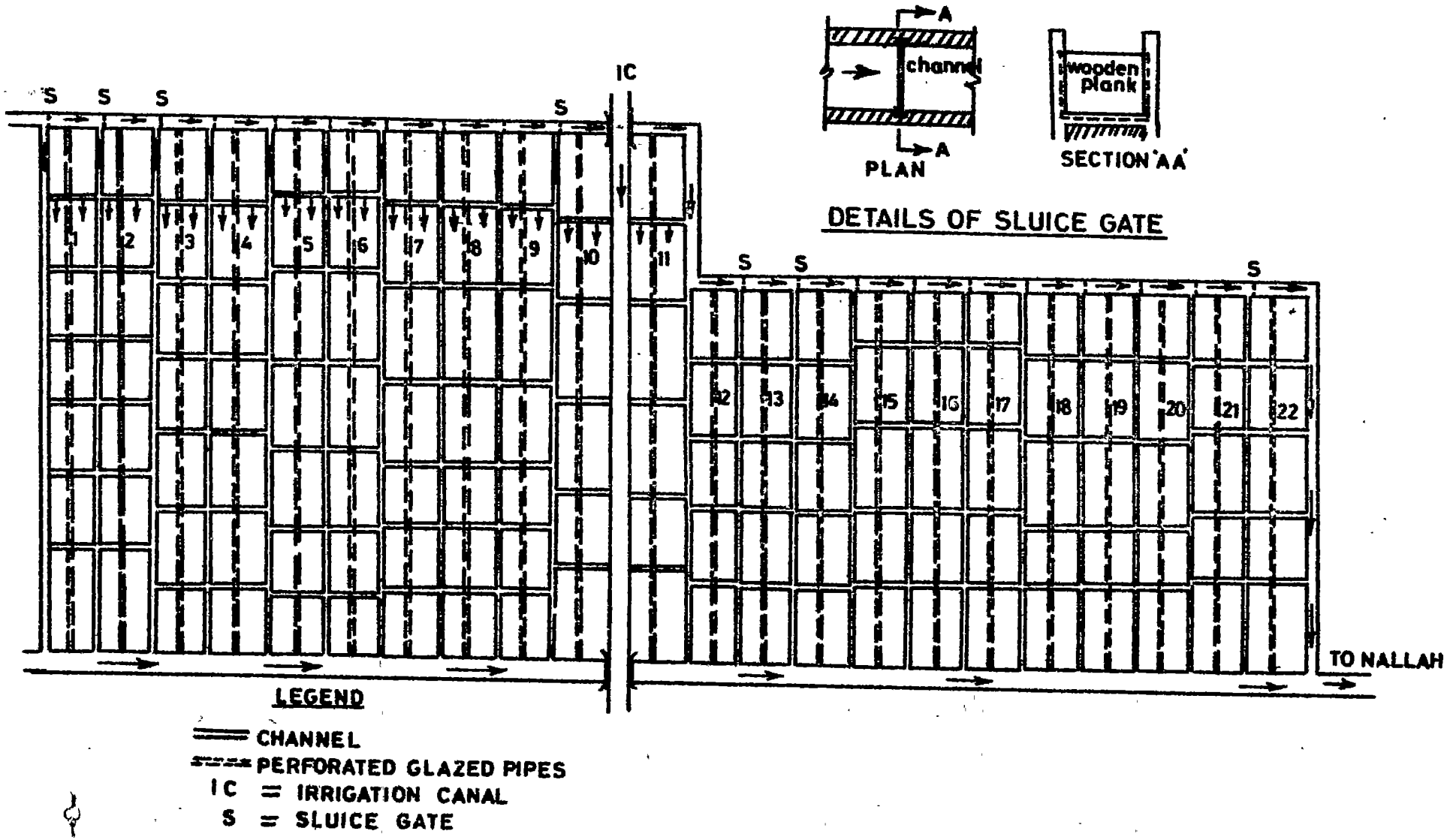


FIG. 2 LAYOUT OF SEWAGE FARM

SAMPLING AND ANALYSIS

Quantity of wastewater entering and leaving the sewage farm was estimated by float method for a period of one month at hourly intervals.

Composite samples of waste water from influent channel and collecting channel were collected biweekly for analysis for a period of three months. The parameters analyzed were pH, EC, SS, BOD, and various forms of nitrogen and phosphate. The analytical methods were based on standard methods (1965).

Soil samples at each plot and background soil samples (outside sewage farm) at six locations were collected upto a depth of 45 cms randomly and analyzed for pH, bulk density, EC, organic matter, nitrogen, phosphate, SAR, CEC and permeability according to the procedures given in Analytical Agricultural Chemistry (Chopra and Kanwar, 1976), Soil Chemical Analysis (Jackson, 1967), Diagnosis and Improvement of Saline Alkaline Soil (U.S. Salinity Laboratory Staff,1954).

Ground water from two wells of 18m, and 30m distance from the sewage farm and selected wells of Tirupati town were collected and analysed for pH, EC, TS, DO, alkalinity, hardness, chloride, sulphate, phosphate and nitrate according to the standard methods (1965).

All results were statistically analysed for mean and standard deviation.

RESULTS AND DISCUSSION

The average quantity of wastewater entering and leaving the sewage farm is 2200000 and 44000 litre/day respectively. This indicates that only 2% of the water is leaving sewage farm into the drainage channel and remaining 98% of water is percolating into the ground water table. The The rate of application of wastewater is calculated based on the availability of land for application and quantity of wasterwater entering into the field to be 20 cm/week with an operation schedule of 1 day application and 6 days resting.

The physical and chemical characteristics of influent and percolated water are presented in table 1. Based upon the influent wastewater characteristics, the approximate loadings of BOD, suspended solids, nitrogen and phosphate are 17,600, 15,400, 3.520 and 1,120 Kg/hectare. year respectively. These loadings are very much higher for all types of soils as recommended by some researchers (Loehr et al., 1979).

A comparison of the chemical characteristics of influent and percolated water indicates that there is a reduction of 78, 85, 58, and 68% of BOD, suspended solids, total nitrogen, and phosphate respectively. There is an increase of 1250% of nitrate-nitrogen in the percolated water indicating that the nitrogen content of the influent is nitrified during its percolation through the soil system. The slight decrease of pH in the percolated water may be attributed to the carbon dioxide and organic acids which are produced by biological processes.

Table- I

Physical and chemical characteristics of influent and percolated water

Sl.No.	Characteristic	Influent			Percolated water		
		Range	Average	S.D.	Range	Average	S.D.
1.	pH	7.0-7.2	7.1	0.2	6.8-7.0	6.9	0.68
2.	EC (μmhoc/cm)	1660-2140	1950	21	1720-2420	1986	46
3.	Suspended solids	140-186	160	22	26-48	28	32
4.	BODs at 20°C	148-235	182	41	30-68	40	20
5.	Total nitrogen	16-38	28	26	6.8-13.2	11.8	17
	Organic nitrogen	4.6-8.1	6.2	5.6	3.2-4.8	3.4	2.4
	Ammonia nitrogen	11.2-26.2	18.6	9.8	1.8-5.8	3.2	6.8
	Nitrate-nitrogen	0.6-1.2	0.8	2.2	10.2-14.2	10.86	12
6.	Total phosphate	10.6-15.8	14.3	14.8	3.7-5.8	4.6	7.5
	Organic phosphate	2.6-4.4	2.9	4.2	1.8-2.2	2.0	3.1
	Inorganic phosphate	8.4-13.2	11.8	8.8	3.6-4.2	3.18	2.8

All values are in mg/1 except where noted.

TABLE- II

Physical and chemical characteristics of sewage farm soils and background soils

S.No.	Characteristic	Soils of sewage farm			Background soils		
		Range	Average	S.D.	Range	Average	S.D.
1.	pH	6.8-7.0	6.85	0.16	7.4-7.8	7.62	1.8
2.	Bulk density (gcm^3)	1.24-1.32	1.28	5.6	1.53-1.68	1.59	3.8
3.	EC (μmhoc/cm)	2650-3120	2950	13.8	1250-1480	1380	8.9
4.	Organic matter (%)	3.48-8.6	6.8	18.2	1.86-2.0	1.90	2.6
5.	Nitrogen (%)	1.12-1.23	1.18	6.0	0.21-0.36	0.29	6.2
6.	Phosphate (%)	0.15-0.17	0.16	2.6	0.084-0.087	0.086	6.1
7.	CEC (meg/100g)	38-56.8	49.6	17.8	16.2-24.6	18.4	10.6
8.	Sodium adsorption ratio	10.8-12.2	11.8	2.2	1.40-3.2	1.50	4.25
9.	Permeability (cm/sec)	$7.5-9.5\times10^{-2}$	$8\times1\times10^{-2}$	6.4	$3.1-3.2\times10^{-1}$	3.18×10^{-1}	1.8

The physical and chemical characteristics of sewage farm soils and background soils (outside sewage farm) are presented in table II. The results indicate that due to the long term sewage farming, the physical and chemical characteristics of soil are changed compared with the background soils. The electrical conductivity, organic matter, nitrogen, phosphate, cation exchange capacity and sodium adsorption ratio are increased from 1.380 to 2.950 millimhos/cm, 1.98 to 6.8%, 0.29 to 1.18%, 0.086 to 0.16%, 18.4 to 49.6 meq/100g, and 1.5 to 11.8 respectively. The average pH of the soil, bulk density, and permeability are decreased from 7.75 to 6.85, 1.59 to 1.28 g/c.c., 0.318 to 0.081 cm/sec respectively. The physical and chemical changes in the sewage farm soil can be related to the capacity of the soil to filter, adsorb or precipitate the various pollutants from the wastewater.

Ground water quality of the nearby wells of the sewage farm located at 18m up and 30m down the groundwater flow gradient in the area of the sewage farm, and ground water quality of Tirupati town are shown in table III.

The results indicate that ground water pollution has occurred due to the extensive longterm sewage farming. The levels of electrical conductivity, total solids, alkalinity, hardness, chloride, sulphate, phosphate, and nitrate-nitrogen in the two wells of nearby sewage farm are very much higher than those of background levels of well waters in Tirupati. Extensive algal growth also has been found by visual observation indicating that the well waters are bacteriologically impure. Low content of dissolved oxygen in the two wells indicates that the wells are contaminated with organic carbon, utilizing the dissolved oxygen of the well waters for its decomposition by biological process.

Oral discussions with farmers of the sewage farm indicate that crop productivities such as Rice, millets, sugarcane, cooton, groundnut, banana, tomato, etc., grown in the sewage farm did not give grainyields, although they grow tall with very dark green, soft and sappy leaves. A survey of literature suggests that the excessive application of nitrogen, phosphorus and salts are the major factors which affect productivity in this context. Excessive nitrogen than the crop requirement (350 Kg/hectare year) may (1) delay the maturation by encouraging the excessive vegetative growth, (2) lower the crop yield, (3) decrease the resistance to the disease of grains, (4) decrease the sugar content of sugarcane, and (5) decrease the vitamin C in tomatoes (Buckman and Brady, 1961; Day, 1973, Baier and Fryer, 1973). Excessive phosphorus (> 40 Kg/hectate,year) may be toxic to plants by inducing deficiencies of Cu, Zn, Fe, or Mn which are supposed to play a vital role in higher yield of grains (Hinesly, et al. 1974). Excessive salts in the soils have been correlated with yield reductions mainly in arid areas (Loehr, et al., 1979). Short term matured leafy crops which are used for both human and animal consumption are growing better and the same are growing for many years successfully with profits (oral discussions with farmers, June,1982). These crops include: (I) Chiri Koora (Amaranthus polygamous), (2) Perugutotakura (Ameranthus Gangeticus), (3) Chukkakura (Rumex visicarius), (4) Menthol (Menthaviridis), (5) Cabbage (Brassica oleracea), (6) Gogu or Deccan hemp (Hibiscus canna bumus), (7) Avise (Sesbania grandi flora). These crops are highly tolerant for excess nutrients (Rao, 1982). Odours, Mosquito breeding are the potential problems at the sewage farm by visual observa-

Table- III

Comparison of ground water quality of nearby wells of sewage farm with ground water quality of Tirupati town

S.No.	Characteristic	Nearby wells of sewage farm		Ground water quality of Tirupati Town		
		18m distance average value	30m distance average value	Range	Average	S.D.
1.	pH	7.2	7.2	7.0-7.3	7.12	2.8
2.	EC (μ mhcs/cm)	1340	1980	280-1160	708	49
3.	Total solids	1100	1344	130-610	506	28
4.	Dissolved oxygen	3.8	3.4	5.8-7.2	6.6	4.8
5.	Total Alkalinity(as $CaCO_3$	350	375	110-160	138	8
6.	Hardness (as $CaCO_3$)	410	460	140-188	160	11
7.	Chloride (as Cl)	157	390	38-88	75	8.6
8.	Sulphate (as SO_4)	98	134	35-80	60	14
9.	Phosphate (as PO_4)	1.20	1.98	0.16-0.28	0.24	4.8
10.	Nitrate-nitrogen (as NO_3-N)	6.85	8.64	0.8-3.8	1.18	8.2

All values are in mg/1 except where noted

is metereologically sound at its inception, recent residential building activities around the sewage farm may pose some environmental health hazards for the residents in the proximity of the farm.

CONCLUSIONS

(1) The underground drainage system for collecting the percolated water was not working satisfactorily, since the effluent collected was only 2%.

(2) The reductions of influent of BOD, suspended solids, total nitrogen and phosphate were 78%, 85%, 58% and 68% respectively.

(3) The twelvefold increase of nitrate-nitrogen in the drained effluent indicates that the nitrogen has been converted into nitrate by nitrification process.

(4) The physical and chemical changes in the sewage farm soil can be related to the capacity of the soil to filter, adsorb or precipitate the various pollutants from the influent.

(5) The results of groundwater quality in the vicinity of the sewage farm indicate the ground water aquifer was contaminated due to the extensive sewage farming.

(6) Forage crops yielded better profits than grain crops due to excessive application of nitrogen, phosphorus and salts.

(7) The study indicates that the sewage farm was excessively over loaded with reference to wastewater constituents than the ability of the soil to fix and store wastewater constituents for use by plants and micro-organisms.

ACKNOWLEDGEMENTS

The author wishes to thank final year B. Tech.(Civil) students and Mr. N. Bhaskar, Lab. Assistant for their help in carrying out the present investigation. The author is also indebted to Prof. C. Venkatramaiah, Head of Civil Engg. for providing necessary facilities and correcting the manuscript.

REFERENCES

American Public Health Association, 1965. Standard Methods for the examination of water and wastewater, 12th Ed.

Baier, D.C. and W.D. Fryer, 1973. Undesirable plot responses with sewage irrigation. Journal of the Irrigation and Drainage Division, ASCE, 99: 131-141.

Buckman, H.O. and N.C. Brady, 1961. The nature and properties of soils. The Macmillan Company, New York.

Chopra, S.L. and J.S. Kanwar. Analytical Agricultural Chemistry. Kalyani Publshers, Ludhiana, India.

Hinesly, T.D. et al., 1974. Agricultural benefits and environmental changes resulting from the use of digested sludge on field crops. Univeristy of Illinois, Urbana.

Jackson, M.L. 1967. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Kipps, M.S. 1970 Production of field crops. McGraw-Hill Book Co., New York.

Loehr, R.C. et al., 1979. Land application of wastes, vol. I and II. Van Nostrand Reinhold Company, New York.

Rao, K.R. 1982. Information on forage crops. Deptt. of Botany, S.V. University, Tirupati.

Reddy, T.V.K. 1982. Hydrogeology of Tirupati-Renigunta area Chittoor District, Andhra Pradesh. Thesis submitted to S.V. University, Tirupati for the award of Ph.D. degree.

Sastry, C.A. 1975. Design of sewage farms and desirable mangement practices with respect to sewage farming in course mannual of refresher course on waste recycling utilization for agriculture, conducted at College of Engineering, Guindy, Madras, pp. XI-2.

U.S. Salinity Laboratory Staff 1954. Diagnosis and Improvement of saline and alkaline soils, Agriculture Hand Book No. 60, USDA.

LOW COST SANITARY- LATRINES ON THE BASIS OF GANDHIAN PHILESOPHY

ISHWARBHAI PATEL*

Cleanliness is next to Godliness : was the principle in which Mahatma Gandhi believed and practiced himself. He advocated and improvised various methods of cleaning latrines. In South Africa, at Johannesburg he used to clean the latrines, of his residence. When a plague broke out in Johannesburg in the locality of the Coolies, he personally attended the cleaning work of their latrines, and thus gave proper importance and dignity to the 'Safai Work' which was regarded in those days as the most filthy and shameful.

When Gandhiji came to India from South Africa and stayed at Shantiniketan, he gave special attention to Safai work and latrine-cleaning activities, in 1901, when All India Congress Session was held in Calcutta at the Rippon College, Lokamanya Tilak joined him as a Safai Volunteer and gave priority to the work of cleaning latrines. As a result a new outlook towards maintaining sanitation personally was developed and a new tradition and prestige not attached amongst Gandhian followers, for carrying on with this Safai work personally. Gandhiji used to say that latrines should be as clean as our kitchens. Every person should know the right method of cleaning the latrines so that he realizes its importance and also the hardships, when a badly constructed latrine or badly used latrines is to be cleaned by him. There are some people in the Society who have a habit to make things dirty by their careless behaviour and then expect others to clean them. When a person does Safai work personally, he can readily understand to what a great extent the persons engaged in Scavenger work are put to difficulties. The unbearable and inhuman workings conditions of the Scavengers have been vividly described, by the 'Scavenger Conditions Enquiry Committee' appointed by the Government of India, under the Chairmanship of Prof. N.R. Malmani.

The persons doing the Scavenger work are called 'Bhangis', who are the lowest among the low. It is a sad hard reality of life that our Bhangi brothers and sisters are despised and discriminated against, even by the other groups of the Scheduled Castes. At various places, they are denied social rights enjoyed by other Harijans. This is a peculiar situation, which exists in India, where this occupation of Safai (Street cleaning & Latrine cleaning) is confined to a particular caste, under the name of tradition or convention or convention or caste-system. Nowhere in the world, this profession of 'Safai' is confined to a particular caste as in India and that the job of a scavenger is considered as the meanest. In very pathetic words Mahatma Gandhi Said "We have reduced them to the level of the beast. They earn a few coppers but only at the expense of their human dignity". In Western Countries a lot of development has taken place towards the improvement of the Modern Science in health, hygiene and sanitation, and the common man shares its advantages, because scagenging work is not considered as a hereditary profession of any one community. This idea was taken up by Gandhiji and his followers who did Safai-work personally and who tried to re-arrange this work in India on Scientific principles. They chalked

---

*Principal, Safai Vidyalaya - Sanitation Institute

out programmes for 'Bhangi-Mukti' and 'Bhangi-Kasta Mukti', - a liberation of Bhangi as an unit in the caste-system and liberation of the drudgery and menial work associated with Bhangi progression. For the implementation of these programme, it is necessary that at least the custom of carrying faces as head-load be completely stopped and the age-old service latrines be converted into clean water borne latrines and scavenging be not considered a heriditary profession of any one community. Gandhiji and his co-workers and followers, by their personal participation of the latrine -cleaning work tried to remove the stigma attached to this work, and tried to set-up Safai work on scientific principles. Attention was, therefore, paid towards the construction of Sweeperless, latrines, like septic tank, Agua-privy, Hand Flush etc. It is heartening to know that Gujrat, Kerala and Bihar have decided that new latrines should be Sweeperless, State Governments and Municipal Committees encourage people to convert dry-type latrines into Sweeperless ones by giving them loans and grants. Gandhiji, on 13th April, 1921, addressing the 4th Harijan Conference said the following in a tone full of pain and grief. "I do not desire re-birth, but if I do get re-birth. I wish to be born in the family of the untouchable, so that I can share their hardships and remaining amongst them can struggle to eliminate their sufferings.". This shows how deeply Gandhiji was moved and how much he felt for sufferings of the low-cast Scavengers, who were branded as untouchables by the So-called traditional hindu society.

To abolish this age-old evil of untouchability, from the Society, in addition to the legal support received under Article-17 of the Constitution, this problem needs a little re-thinking on humanitarian ground and on adopting scientific methods of constructing latrines and insisting on disposing of the human waste systematically. Gandhiji used to say that any effort done, and labour put to remove the obstacles harmful to the health and hygiene of the people is a FORM of 'Yagna' or sacrifice. Moreover he believed that there is no waste in the domain of the nature. The waste at one place, can prove to be a valuable material at some other place. Hence Gandhiji advocated the persons in his Ashram and to the people in the Villages to cover up the human-waste, after defecation with sand or earth which will eliminate the filth and the danger of contamination by the flies, thus slowly converting the waste into a valuable organic manure.

The Slogan "Tatti Par Mitti Lagao",'spread the earth on the defecated human waste' was being practiced in all the institutions or organisations, where Mahatma Gandhi used to live or visit, and thus positively contribute to the latrine-safai work. His idea was to change the traditional bias to latrine-cleaning or Safai work and develop a prestige and importance to this useful work, Later on, when Gandhian ideas were studied carefully and a scientific background provided, utilisation of the human waste, along with animal waste or agricultural waste yielded worndorful results as in the working of the Bio-mass digestions. These devices of utilizing the waste material have become very useful as sources of renewable energy in the form of fuel (Methane gas) as well as a rich organic manure inform of the digested slurry. This, what was formerly regarded as a foul-smelling, filthy, waste material is now-a-days an important contributor to rural economic and rural sanitation.

Environmental Sanitation and the present progress :-

The immediate convern of any programme of environmental sanitation in India, has therefore, to be replacement of these primitive latrines, which need cleaning by the Scavengers.

The construction of water-borne latrines will also help us to remove forever, the age-old sinful custom of carrying the night-soil as a heal-load by the Scavengers. Moreover, it is also necessary that public opinion be created and a new tradition established in which Scavenging be not comsidered a hereditary profession of any community.

Health impact of improper sanitation and absence of safe drinking water :-

Even in urban areas, in different states of our Country, about 1/3 of the houses have Basket-privies, 1/3 houses have water borne latrines and septic tank connections, while the remaining 1/3 houses have practically no arrangements, for their latrines. In rural areas, however, the arrangements for latrines is negligible. Lacking sanitary privies, people are in the habit of simply relieving themselves in open field or any ground available to them, unware that these practices are unhealthy and create breeding places for bacteria which cause diseases like diarrhea, typhoid, polio, malaria, hookworms and Ascariasis (round works) etc.

According to the World Health Organisation (WHo) approximately 80% of all sickness and disease can be attributed to inadequate water or sanitation facilities. For example -

* Diarrhea directly kills six million children in developing countries every year, and contributes to the death of 18 million people.

* Trachoma effects some 500 million people, at any given time, often causing blindness.

* Parasitic work infections (Hookworms and round works) infect nearly one half of the entire population of developing countries.

* Malaria yearly kills nearly twelve million people a year; the loss in production and income losses due to s sickness is enormous. In India, alone, water - borne diseases claim 73 million work-days ever year. The cost in terms of medical treatment and loss of production has been estimated at around Rs. 6,000 million per year. It is estimated that about 50% of the hospital beds in developing Countries is due to water-borne, water-based and Fecal disposal diseases.

Excreta disposal in a correct and hygienic manner is necessary, as exposed excreta spreads disease in two ways :-

i) Bacteria in excreta causes diseases transmitted through hands, water, and through insects (flies, cock-roaches and mosquitoes).

ii) Agents of many potentially serious infections, which the body has eliminated in the excreta, are eventually returned to it through the mouth, while taking foods and drinks contaminated with pathogenic bacteria

DIAGRAM-No-1

(OVER GROUND)

GOPURI LATRINE

DIAGRAM NO. 1

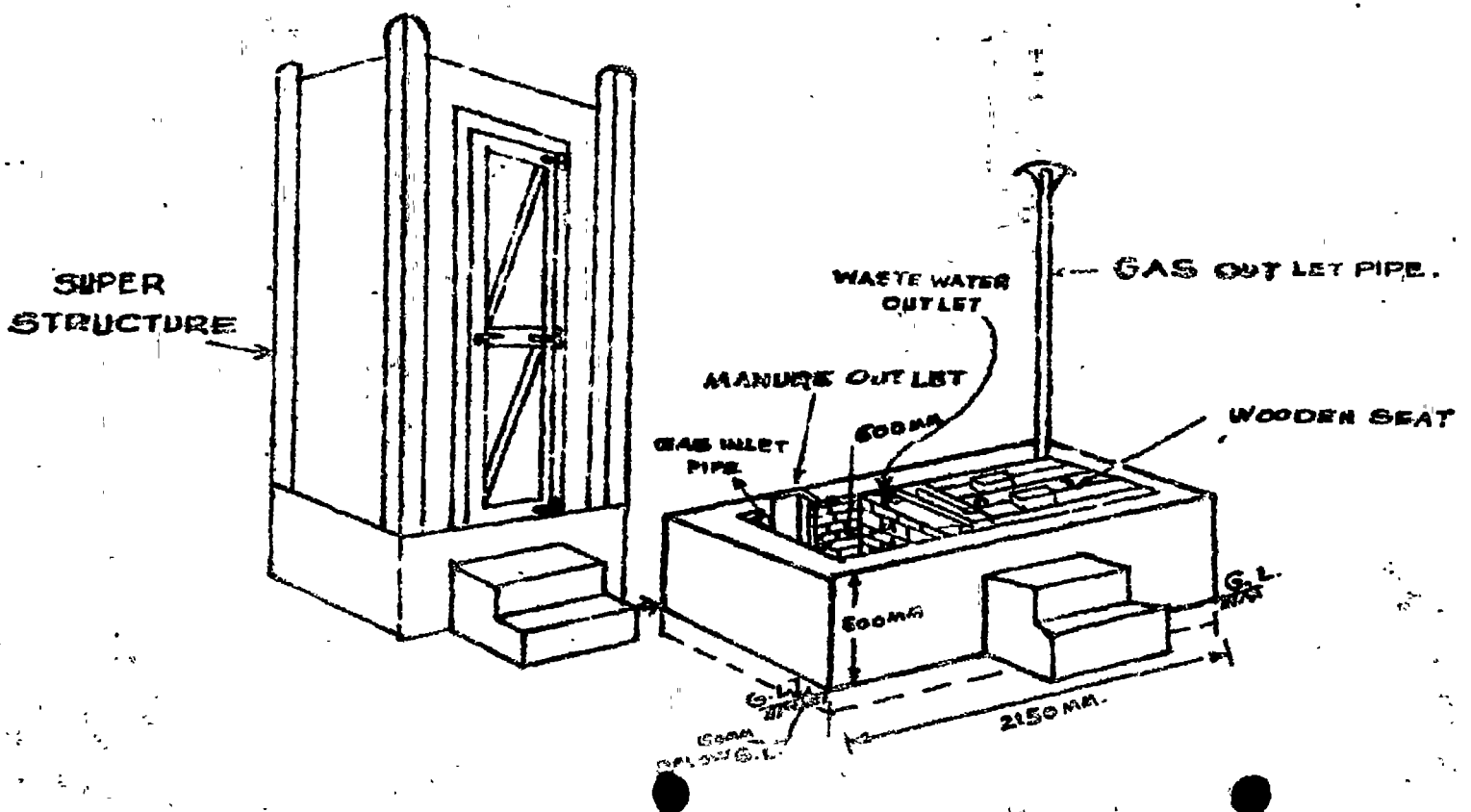
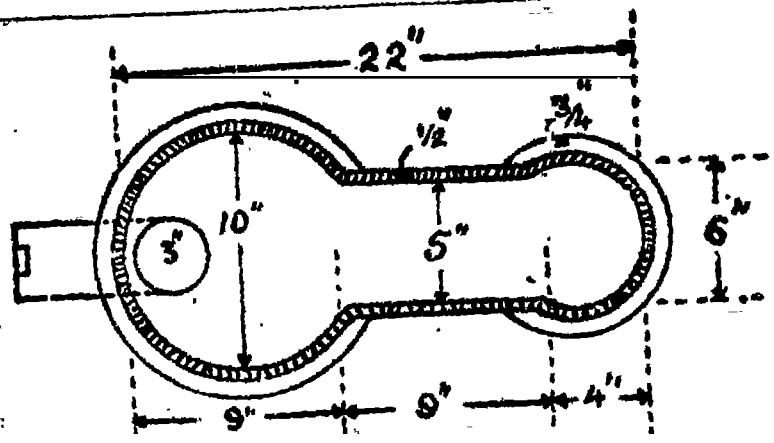
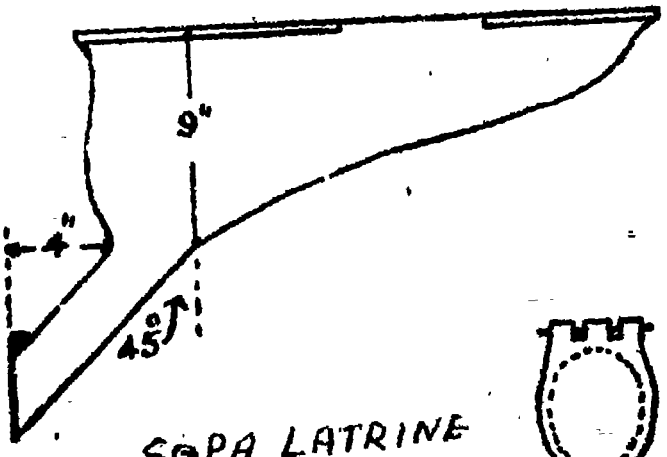


DIAGRAM-2





SOPA LATRINE
Flap Trap Pan

DIAGRAM-2

Hence, construction of hygeinic latrines, though absolutely essential, will not completely solve the problem of sanitation; what is needed is health and sanitation education to the masses, who will then realize the importance of the maintainance of health and sanitation conditions in the family and in the Society. This view-point was very sincerely and strictly observed in all the institution and Ashrams organised by Mahatma Gandhi. He gave priority to this latrine-cleaning work and introduced trench-latrines in Ashrams, which were then popularly known as Kisan-latrins as they would yield a very useful organic manure formed by covering the night-soil by earth or paddy husks.

Types of improved latrines :-

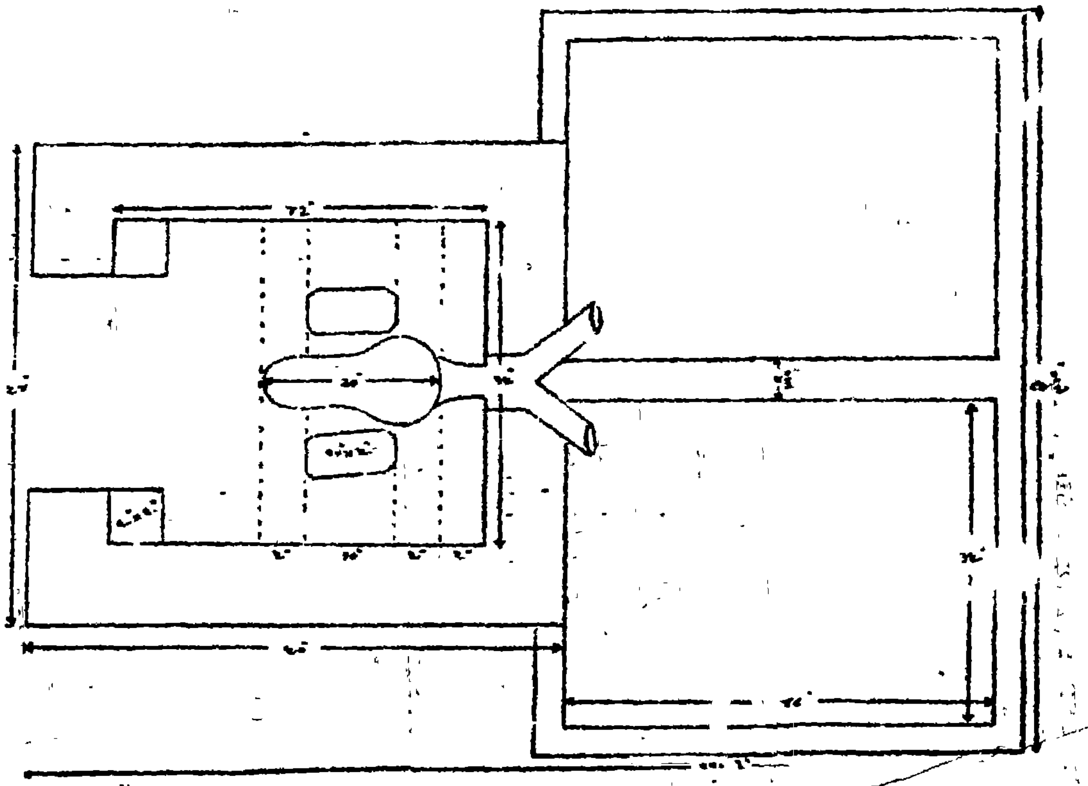
The credit of improving latrines on scientific lines goes to Shri Appasaheb Patwardhan, who devised the 'Gopuri Latrine' which is excellent for preparing manure and is very convenient for rural areas. Such latrines were started in Gopuri Ashram in the District Ratnagiri of Maharashtra as thus got the name. Shri Krishnadas Shash, who was working as the Public Health Adviser, Maharashtra State, made many scientific improvements in it and got the Stage Government's approval, so that it could be adopted throughout the State.

The Gopuri-latrine, also known as a double-value latrine in Vietnam has two under-ground trenches. The gutter in the middle is for the flow of water and urine. One tank has a folding cover of a wooden plank and the other remains closed, but has an arrangement of an inlet as well as an outlet pipe for passage of air and an opening for the removal of the manure. One trench could be used for about 3 months after which it is closed and the other trench is brought into use. The persons using the latrine cover up the refuge with earth, dust or paddy - husks. By the time the second trench is over, the first trench is ready with the manure and can be taken out. Thus the Gopuri latrine, is convenient for a rural family where sanitary aspects as well as low-cost of materials of construction have been carefully looked after. The agriculture department of the State of Maharashtra gave a good stimulus for its use in rural area.

In places where the above arrangement is not convenient, a simple septic 'SOPASANDAS' method was started. Initially a special type of clay-pan was prepared which was then glass-glazed and given a slope of 45^0 and the length of 22". A method of the flap-trap was used instead of the water-seal arrangement.

Two pits were constructed in the rear having the size of 4 ft. length, 3 ft. breadth and 3 ft. depth; and a brick-wall around these pits was constructed; so that when one pit was full, the other could be put to use and the manure ready in the first pit could be made available. Shri Appa Saheb in 1948 onwards popularized this type of latrines in the villages and Gandhian institutions in the State of Maharashtra. This design later on, got modified by introducing the water-seal instead of the flap-trap and was found very servisable in the rural area of Maharashtra and in Bihar and this design is popularly known as a simple sanitary latrine or 'SULABH SWATCHH SHOUCHALAYA'. Dr. Kessel prepared it an sevagram and later on Appa Saheb modified it and used it extensively in rural area.

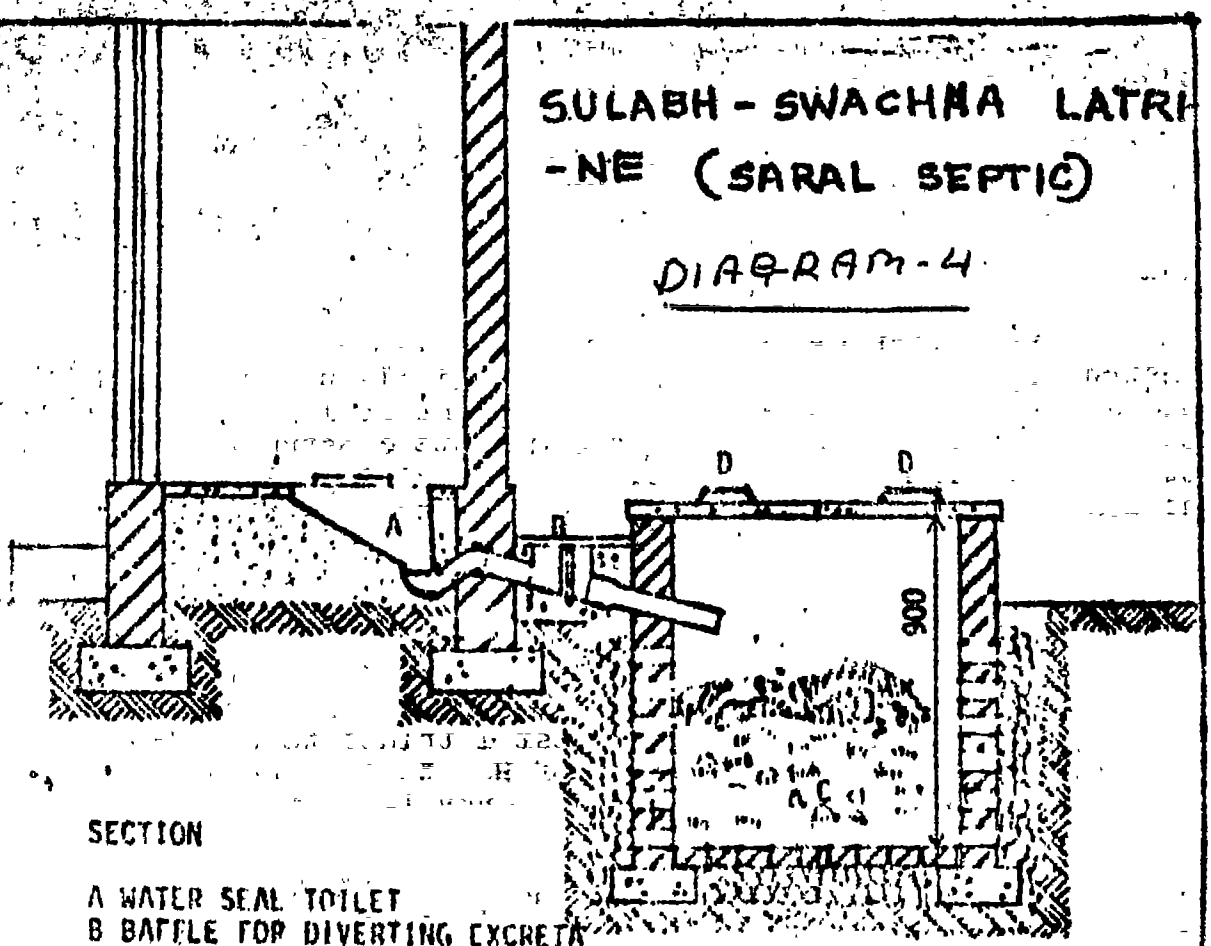
DIAGRAM - 3



सोपा संडास
प्रकार २.
डबल खड्डा.

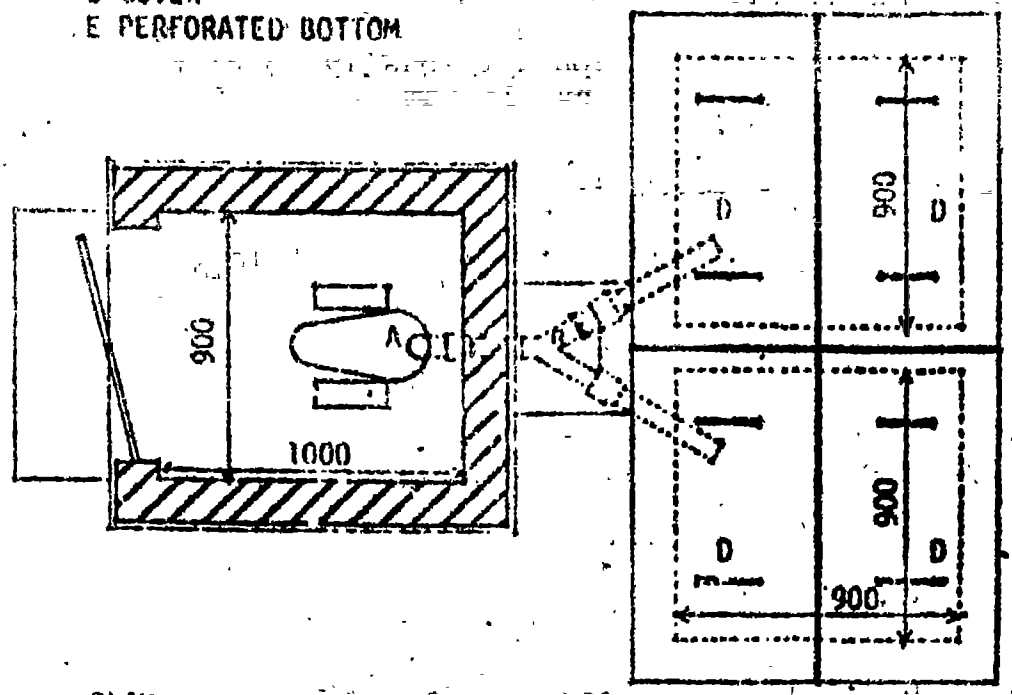
SULABH - SWACHHA LATRI -NE (SARAL SEPTIC)

DIAGRAM-4



SECTION

A WATER SEAL TOILET
B BAFFLE FOR DIVERTING EXCRETA
C ORGANIC MATTER
D COVER
E PERFORATED BOTTOM



PLAN

~~Fig. 2~~ THE POUR-FLUSH DOUBLE VAULT COMPOSTING TOILET

The Maharashtra Smarak Nidhi also encouraged the Nanigaon latrine, by giving a grant to the family who builds this type of latrine, which was evolved by Shri Narvekar and named it after the village, where it was designed and evolved. It is a variety of Agua-privy latrine and its action is similar to that of Agua Privy.

Bio-gas Plants :-

Gram-Lakmi institution which specialized in the construction of 'Gobar-gas Plants' or animal-dung gas plants, successfully experimented the use of night-soil in addition to cow-dung; and mini-gas plants came into construction attached to the house-latrines. Again Shri Appa Saheb took the lead to popularise this Project of latrines attached : bio-gas plants, in towns and in rural area. Safai Vidyalaya, at the Harijan Ahshram, Ahmedabad started Courses of training and actual demonstrations in the use of Bio-gas plants. As a result out of 12,000 Gobar-gas plants in Gujrat today, more than 6000 have been connected to the latrines. An intensive programme is also organised by the Safai Vidyalaya which gave training and instructions in low-cost latrines to the Sanatory Inspectors, Supervisors, Chairman of Health Committees and to the Social workers in the field of rural-health and sanitation work.

In Gujrat, during 1964 to 1982, 1,60,000 basket type latrines or service latrines were converted into water-borne latrines of the type, which was evolved by the planning Research Action Institute, Lucknow at the suggestions of the Health Department and was consequently named P.R.A.I. latrines. Basket type latrines could be easily converted into P.R.A.I. type by the necessary alterations costing only Rs. 650/- per latrine.

Cost of the P.R.A.I. Type latrine :-

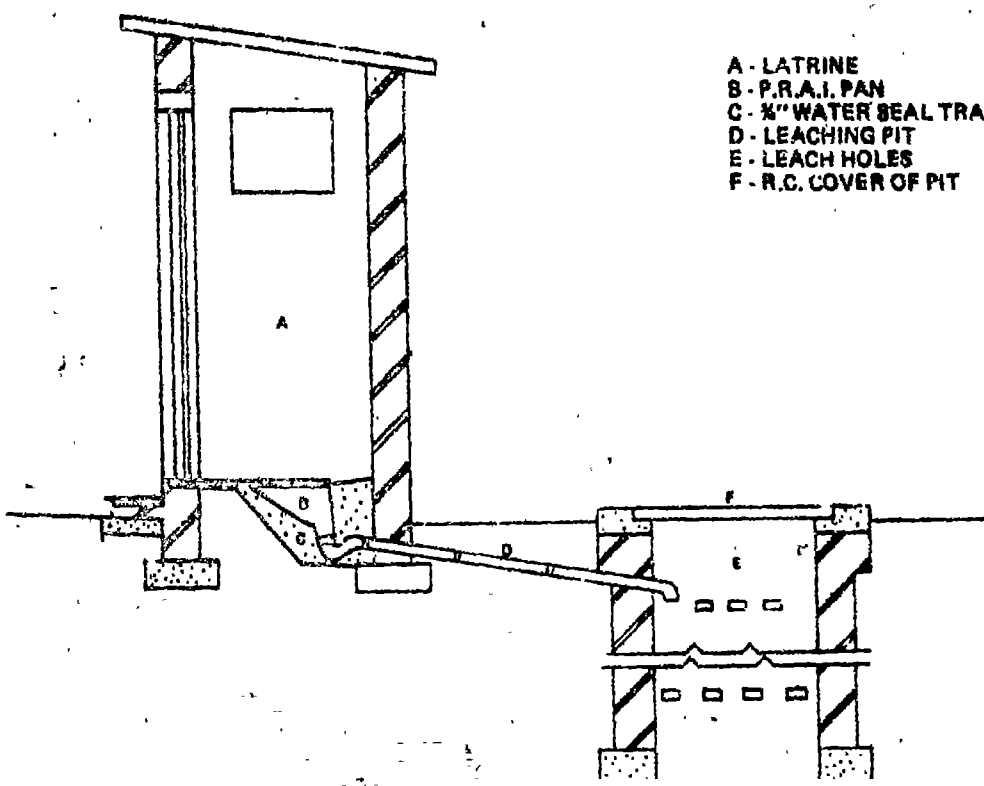
The estimated cost of the P.R.A.I. type latrine is worked out at Rs. 650/- for the various items shown as under -

1.	P.R.A.I. Pan and Trap	...	Rs. 95/-
2.	4" Stone ware Pipes	...	Rs. 20/-
3.	Bricks - 750	...	Rs. 185/-
4.	Cement 2½ bags	...	Rs. 90/-
5.	Sand, Stone etc.	...	Rs. 35/-
6.	Reinforcement iron bars for slab cover	...	Rs. 25/-
7.	Excavation charges	...	Rs. 50/-
8.	Mesonary charges - Labour charges, Fitting Charges etc.,		Rs. 150/-
		Total :	Rs. 650/-

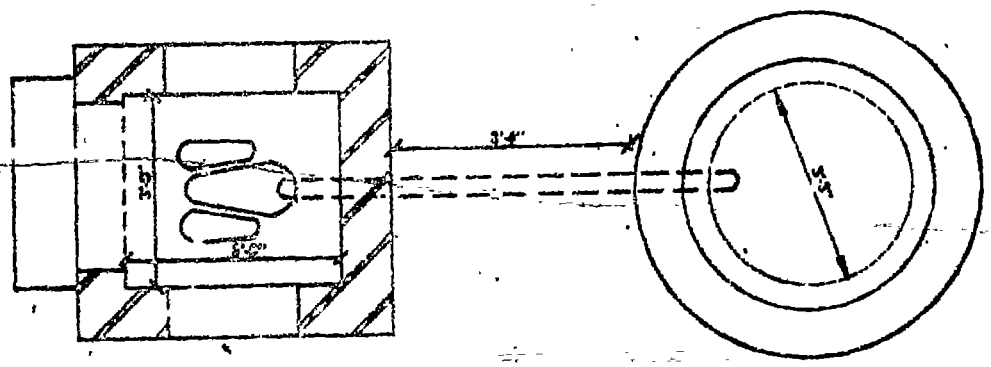
The Service type latrines can also be conveniently transformed into Septic-tank latrines. Dr. G.S.N. Murti in 1968 designed a pottery Septic tank and introduced large earthen containers for this purpose.

DIAGRAM-5

A - LATRINE
B - P.R.A.I. PAN
C - ¾" WATER SEAL TRAP
D - LEACHING PIT
E - LEACH HOLES
F - R.C. COVER OF PIT



SECTIONAL ELEVATION

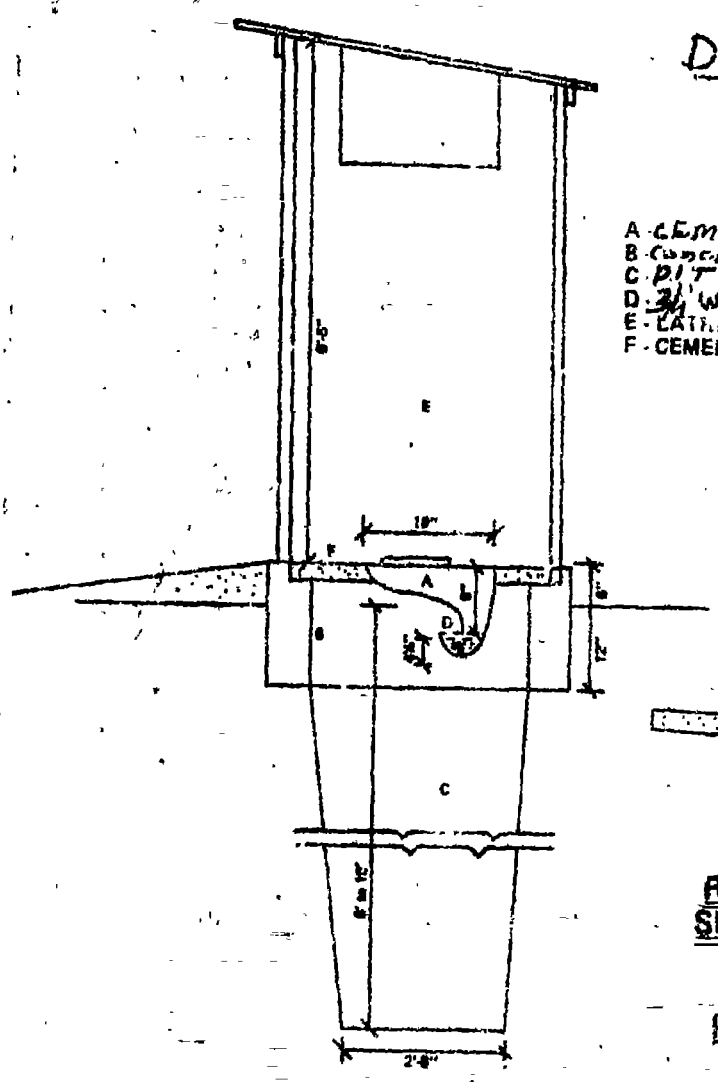


PLAN

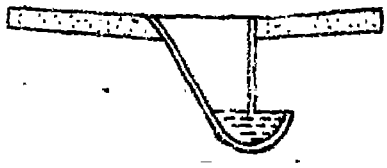
P.R.A.I. TYPE LATRINE

DIAGRAM-6

A - CEMENT PAN WITH ¾" WATER SEAL
B - Concrete ABOVE PIT
C - PIT
D - ¾" Water Seal IN THE TUB
E - LATRINE
F - CEMENT CONC. SLAB



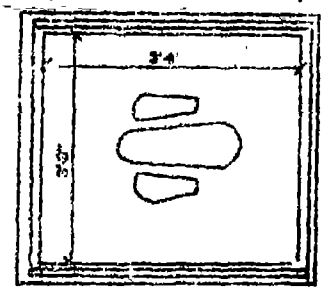
SECTIONAL ELEVATION



REVERSED WATER-SEAL PAN WITH THE SLAB

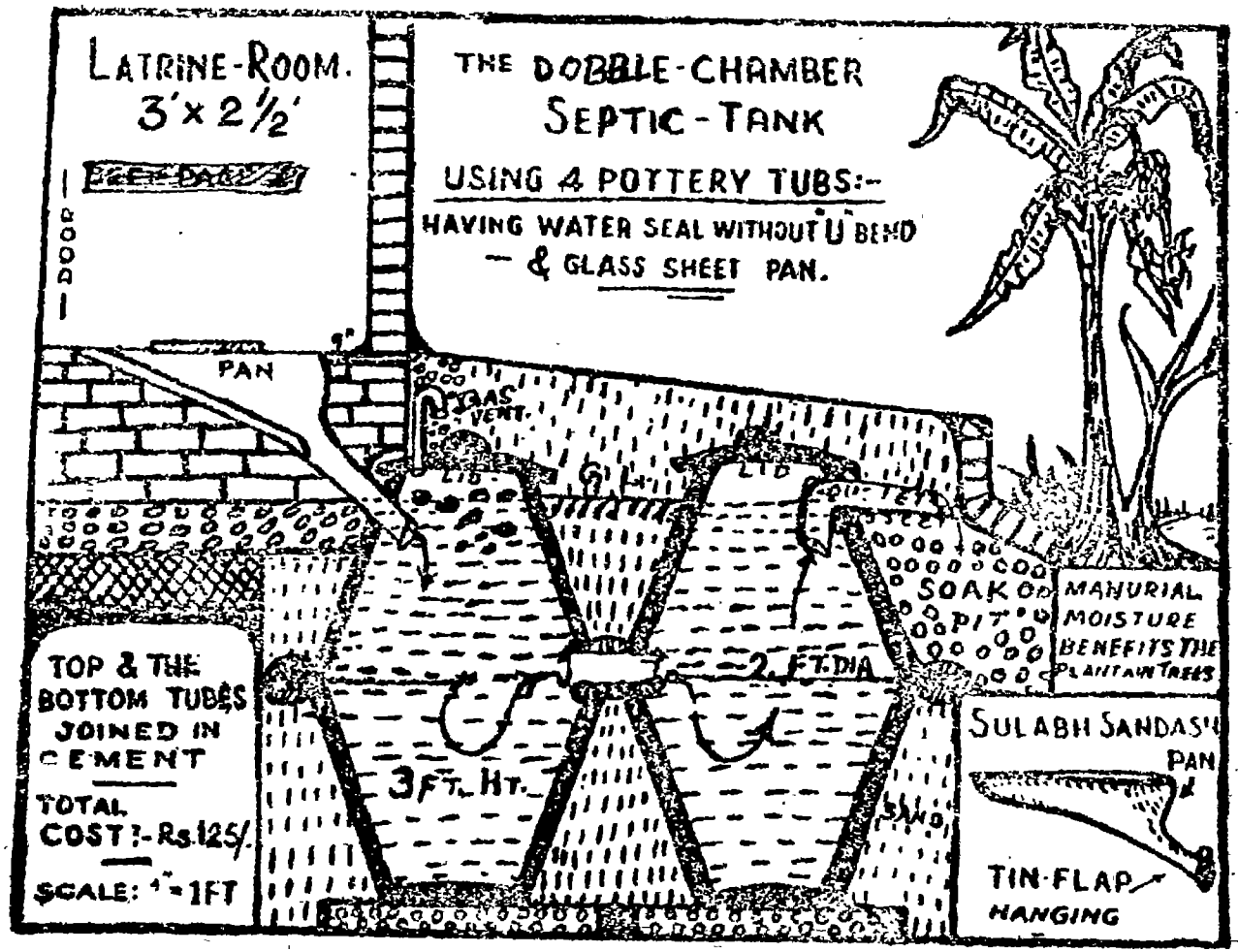
RASULIYA MODEL

PLAN



HAND-FLUSH LATRINE

DIAGRAM - 7


LATRINE-ROOM.
3'x 2½'
DOOR
THE DOBBLE-CHAMBER
SEPTIC-TANK
USING 4 POTTERY TUBS:-
HAVING WATER SEAL WITHOUT 'U' BEND
— & GLASS SHEET PAN.
PAN
GAS VENT.
LID
LID
SOAK PIT
MANURIAL MOISTURE BENEFITS THE PLANTAIN TREES
TOP & THE BOTTOM TUBES JOINED IN CEMENT
TOTAL COST:- Rs.125/-
SCALE: 1" = 1FT
3 FT. HT.
2 FT. DIA
SULABH SANDAS'
PAN
TIN-FLAP HANGING

The National Government at the Centre, decided to commemorate the Gandhi Centenary year in 1964 and decided to take-up the programme of converting basket-latrines into water-borne latrines and thus help in abolishing completely the inhumane tradition of carrying night-soil as head-load, This will also contribute towards the liberation of the drudgery and menial work associated with Bhangi profession, which in reality is a service to the Society.

As a results of many experiments, the Safai Vidyalaya Ahmedabad, developed a design of a pan, which can be flushed with only 2 litres of water. Such deep slope pans were made available, being prepared by a commercial firm, A mould for the construction of such a pan is obtained from the Safai Vidyalaya as well as the Lucknow Research Centre for preparing this type of pan, mostly used in P.R.A.I. latrines.

Hand-flush Latrine :-

A low-cost latrine, occupying minimum of space and which could be located in the verandah of the house, has been evolved, which is simple in construction and serves the sanitary needs of the rural people. It keeps away flies, insects and filth and the scavenger is not required for cleaning it. It also yields manure, sufficient for the kitchen gardens.

A pit of 2'-6" x 2'-9" x 8'-0" should be made and kept 25' to 30' away from the wall. It should also not be at a low-level, to avoid rain-water flowing into it. The top three layers be built by 9" thick bricks and a slab with a water-seal cement pan be placed over it. The roof covering can be built from materials locally available. To slab and the pan can also be made from the cement mixture with the help of the mould standardised by the SAFAI VIDYALAYA or by Mitra Mandap, Village : Rasulia, P.O. Hoshangabad (M.P.) Thus the hand-flush latrine can be constructed at a very small cost and greatly improves the sanitary condition of the village. In a way, it is a boon to the old and the Sick people of the village.

It will be observed that Gandhiji gave special importance to this problem of Safai and creating latrine-facilities for maintaining sanitation, necessary for the health and happiness of the Society, and a new tradition of the recognition of dignity of human labour and respect for the human values was established. The institutions organised on Gandhian philosophy and way of living have taken up this problem on scientific lines by imparting sanitary education or health education to the rural people and by implementing programmes for converting all basket-latrines into cheap, convenient and Scavenger free latrines, which is a tribute to the human aspect of Gandhian work, and is a real tribute to Mahatma Gandhi, the father of our nation, whose philosophy cenred round his ceaseless activities for the poor, needy and down-trodden sections of our Society.

BOMBAY-II SEWERAGE PROJECT

A.N. SABNIS*

The Municipal Corporation of Greater Bombay have started implementing this project since 1979. I.D.A.I. Sewerage Project which we started implementing in 1975-76, has almost been completed.

The broad outline of First World Bank Aided Project, known as I.D.A.I. Project, can be summarised as under :

1. Augmenting Bombay's Water Supply by 100 mgd.

2. Complete treatment to the entire quantity of 420 million gallons of water.

3. Extending sewerage facilities to the developed localities including construction of seven new pumping stations in the sewerage system.

4. Appointing Engineering Consultants for -

   a) Further studies on Ocenography,
   b) Assessing possibility of application of sewage on land.
   c) Preparing of development plan for treatment and disposal of sewage for Greater Bombay Area. For this Project, the World Bank had given a credit of 55 million U.S. Dollars to the Municipal Corporation of Greater Bombay.

Likewise, the scope of work included in Bombay II Project can be summarised as under :

1) Further augmentation of Bombay's water Supply, by 100 mgd. including complete treatment.
2) Improving existing transmission and distribution systems.
3) Extending sewerage facilities to the remaining areas of suburbs and extended suburbs.
4) Treatment and disposal of the entire quantity of sewage generated within the limits of Municipal Corporation of Greater Bombay. This also is a World Bank Aided Project for which the Bank has agreed to give a credit of 196 million U.S. Dollars.

It will thus be seen that the Project, which is already completed and the one which is now being implemented is an integrated Water Supply and Sewerage Project.

During present discussions, I will however, restrict myself to the sewerage component of the Project only.

While discussing the Bombay's Sewerage Project it would not be out of place to spend some time to know the historical background of the sewerage system so far as it relates to Bombay.

---

*Dy. Chief Engineer, Municipal Corporation of Greater Bombay.

Initially in Bombay the residential, commercial and industrial Development was mostly concentrated in areas South of Worli. To cater for the then population and the needs during the period, following sewerage works were undertaken for execution in 1880-1900 and were completed.

1. Branch sewers in areas South of Worli.
2. Trunk Sewer leading to Love-Grove (Worli).
3) Pumping Station at Love-Grove (Worli).
4. Screening and Degritting facilities.
5. 6'-0" dia. outfalls for a length of 2000 ft.

for discharge of sewage into Arabian Sea.

Areas north of Worli started developing further and arrangements for sewage collection and treatment were required to be done. These works were completed during 1900-1935. The list of works undertaken and completed is as follows :-

1. Branch sewers in areas North of Worli.
2. Trunk sewers leading to Dadar.
3. Pumping station at Dadar.
4. Secondary Sewage Treatment Plant at Dadar.
5. Discharge of sewage effluent into a storm water drain leading to Cleevland Bunder.

Further areas North of Dadar got developed thereafter and hence following works were undertaken for execution.

1. Branch sewers in areas North of Dadar.
2. Trunk sewers leading to Dharavi.
3. Pumping Stations at Mahim, Matunga and Dharavi.
4. Secondary Sewage Treatment Plant at Dharavi.
5. Discharge of effluent into Mahim Creek.

These works were completed during 1935-1950 period.

On completion of these works, almost 90 to 95% of the proper city area was provided with sewerage facilities.

In the year 1950, suburban areas presently under H,K,L,M, & N Wards were merged with the Bombay Municipal Corporation limits. At the time of merger, some areas of H and L wards were partially sewered but areas of K,M and N Wards were not sewered at all.

In the year 1957, extended suburbs, presently under P,R & T Wards were further merged with the Municipal Corporation of Greater Bombay. None of the areas in these Wards had any sewerage facility.

Thus by 1960, the B.M.C. had a stupendous task of providing all civic amenities to a large population of about 42 lacs.

With sewerage always getting a last priority then in the budgetory provisions, very little could be done in this respect, during 19.0-1970. A short resume of the words done during 1950-1970 can be given as under :

1. Branch sewers in some areas of Khar, Santacruz, Andheri, Malad, Kandivali, Chembur, Ghatkopar and Mulund.
2. Trunk sewers leading to Khar, Versova, Malad, Ghatkopar Pumping Stations,
3. Pumping Stations at Khar, Versova, Ghatkopar, Malad and Deonar.
4. Primary Treatment Plants at Khar, Ghatkopar and Versova (Now not functioning).
5. Discharge of sewage effluent into big nallahs or branches of creeks which ultimately lead to Thana Creek or Arabian Sea.

But these sewarage Works which were being undertaken were not keeping pace with the increase in population and consequent increase in supply of water. It would be interesting to note the figures of increase in population in Bombay during the last 8 decades and the position of water supply during that period.

T A B L E NO. 1

Figures of Population in Bombay during 1900-1980.

Year	Population in lacs	Increase in 10 years.
1900	9	-
1910	11	2
1920	13	2
1930	14	1
1940	20	6
1950	30	10
1960	42	12
1970	58	16)
1975	70	12) 24 lacs
1980	82	12) in 10 years.

To cope up with the increase in population, schemes for augmenting the Water Supply were taken yp by tapping different sources step by step.

The details of this augumentation are listed in the following table :

T A B L E No. 2

Augmentation of Bombay's Water Supply during 1860 - 1980.

Year	Source	Water Supply in million gallor/day	Cumulative figures in million gal/day	Method of Supply.
1860	Vihar	12	-	Gravity
1879) 1887)	Tulsi	4	16	Gravity
1892) 1915) 1926)	Tansa	94	110	Gravity
1957	Vaitarana	102	212	Gravity
1967	Ulhas	20	232	Pumping
1972	Upper Vaitarna	118	350	Gravity
1981	Bhatsai	110	450	Pumping

With the increase in population and consequent increase in demand of water, the schemes undertaken for augumentating the Water Supply, were found to be adequate to cater for the domestic and industrial needs of the City of Bombay.

It would be evident from the table below that efforts were being made by the B.M.C. to maintain the "per capita supply" over a long period.

TABLE No. 3

Per Capita Supply of Water in different years

Year	Population in lacs	Total Water Supply in mgd.	Per Capita Supply in gallons/day	REMARKS
1900	9	16	18	Only Vihar & Tulsi supply was available.
1930	14	110	80	Tansa Scheme was completed.
1940	20	110	55	-
1950	30	110	35	-
1960	42	212	50	Vaitarna scheme was completed.
1975	70	350	50	Ulhas & Upper Vaitarna scheme were completed.
1980	80	450	55	Bhatsai I scheme

These figures do not take into account

a) Emroute Suplly

b) Losses in transmission and distribution

c) Quota's given in Industries.

It will be seen from the above table that as the population went on increasing we were effectively trying to meet the water demand of the City of Bombay. But very little could be achieved in respect of sewage collection, treatment and disposal. We had to tackle these problems on a very large scale.

Following actions were taken by the B.M.C. to solve these problems.

1) In the year 1962 a high level committee was appointed to suggest measures to augment the water supply and sewerage facilities.

2) In the year 1969 the World Bank was approached for financial assistance.

3) In the year 1970 M/s. Binnie and Partners, consulting engineers from U.K. were appointed to prepare a feasibility report for appraisal of the World Bank.

Experts from each discipline from the consulting engineers firm, worked in Bombay along with the staff of Bombay Municipal Corporation for one year and prepared in 1971, a feasibility report which is known as Development Plan I for Bombay's Water Supply and Sewerage Project.

Broad outline of the Sewerage Projects Works recommended by the Consultants for being undertaken phase-wise for execution is as under :

1. Providing sewerage facilities in the remaining developed areas of Bomay.

2. Replacement of old ejector stations by new pumping stations and construction of additional pumping stations in the newly laid sewerage system.

3. Construction of 12'-0" dia. outfall at Worli for a length of 4 miles in the sea for disposing of 175 mgd. of screened and degritted raw sewage.

4. Constuction of 12'-0" dia. outfall at Bandra (Mahim Creek), for a length of 4 miles in the sea for disposing of 325 mgd. of screened and degritted raw sewage.

As per this recommended Development Plan, the sewage generated in Marve and Chembur Zone was also intended to be conveyed at Mahim for disposal through outfall.

After review of the proposals made in D.P.I. by B.M.C. it was though advisable to consider the reuse of sewage to some extent for irrigation in the areas around Bombay, instead of dumping the entire sewage into creek or Arabian Sea. This view was also in conformity with G.O.I's policyfor reuse of sewage for irrigation purposes and the same was accepted by the World Bank also. The Consultants were, therefore, asked to go into further details and modify the proposals keeping in view of the new approach.

The Consultants M/s. Binnie and Partners thereafter submitted a supplementary report in the year 1972.

Recommendations of the consultants as per their supplementary report Development Plan II submitted in 1972, were as under :

1. Existing small drainage districts were regrouped and rearranged into 5 drainage Zones viz. :

a) Malbar Zone	Comprising areas of	Colaba Nariman Points etc.
b) Worli Zone	-do-	South & North of Worli.
c) Mahim Zone	-do-	Bandra, Khar, Santacruz, Kurla, Dharavi.
d) Marve Zone	-do-	Andheri to Dahisa
e) Chembur Zone	-do-	Chembur to Mulund.

2. Extension of sewerage facilities in the developed areas (same as in Development Plan I)

3. Replacement of old ejector stations by new pumping stations and construction of additional pumping stations in the newly laid sewerage system.

4. Construction of submarine outfall at Worli, 3 meter dia. and 7 K.M. long for carrying 160 mgd. of sewage flow by providing only preliminary treatment.

5. Construction of submarine outfall at Bandra (Mahim Creek) 2.75 meter dia. and 7.5 K.M. length for carrying 135 mgd. of sewage flow by providing only preliminary treatment.

6. Construction of conventional activated sludge treatment Plants at

a. Marve with capacity of		84 mgd.
b. Chembur	-do-	70 mgd.
c. Bhandup	-do-	34 mgd.

7. Disposal of raw sludge flom these treatments plants to be done through deep tunnels and outfall at Mahim.

The estimated cost of Sewerage Project Works mentioned above at 1971 prices as estimated by consultants was Rs. 273 crores for Sewerage Treatment and Disposal Works.

When the project was posed for appraisal to the World Bank, augmentation of Water Supply was given the top-most priority and as against the total Sewerage Project Works costing to Rs. 128 crores for conveyance to Rs. 145 crores for treatment and disposal, sewerage works costing Rs. 33 crores only were ultimately included in I.D.A.I. Project.

After signing of the credit agreement with the Bank in 1973-74, the project cost estimates were again revised at 1974 prices. The revised cost of sewerage works was then estimated at Rs. 99 crores. Since the I.D.A. Credit amount of Rs. 55 U.S. Million dollars and the available resources remained unchanged, some of the sewerage works originally included in I.D.A.I. Project had to be deferred and postponed by limiting the cost to Rs. 33.47 crores only.

Break up of I.D.A.I. Sewerage Project cost was as under :

1.	Sewerage Works	Rs. 24 crores	Engineered departmentally.
2.	Pumping Stations	Rs. 7 crores	Engineered through M/s. Tata Consulting Engineers.
3.	Consultancy fees for Review of methods of Treatment and Disposal of sewage from Greater Bombay area.	Rs. 2 crores	M/s. Metcalf & Eddy were appointed to work, as the Consultants.

The I.D.A.I. Project commenced from 1974-75 onwards and is now considered as almost completed. The status of I.D.A.I. Project is summarised in the following table :

TABLE No. 4

Present Status of I.D.A.I. Project 1974-79

Sl. No.	Description of Item	Physical Target	Physical Achievements	Financial Target	Financial Achievements
1)	Providing & laying sewers	130 kms. of trunk of branch mains	144 kms. of trunk & Branch mains	Rs. 24 crores	Rs. 23 crores
2)	Pumping Station	8	Works for 7 are in progress	Rs. 7 crores	Rs. 2 crores
3)	Consultancy	-	100% complete	Rs. 2 crores	Rs. 2 crores
			Total :	Rs. 33 Crores	Rs. 27 crores

Neither the equipment nor the Civil works were eligible for credit reimbursement except cost of sewer pipes, which were locally procured.

The Consultants M/s. Metcalf and Eddy who were appointed to review the earlier proposals made by M/s. Binnie and Partners in connection with Treatment and Disposal of sewage, started their work in 1976 and submitted their report in 1978. The recommendations made by them in their final report were as under :

T A B L E No. 5

Recommendations of the Consultants M/s. Metcalf and Eddy for Development Plan III.

Sl. No.	Treatment & Disposal site	2005 flow in mgd.	TREATMENT	DISPOSAL
1.	Colaba	10	Screening, Degritting, 1 hour sedimentation, gravity thickening of sludge, vaccum filtration & land fill.	Through 1.2 meter dia. outfall 1.60 K.M. in length in Bombay Harbour.
2.	Worli	170	-do- Chlorination	Through 3.5 meter dia. outfall 3K.M in length in Arabian Sea.
3.	Bandra	175	-do- -do- -do-	-do-
4.	Versova	32	Screening, Degritting and secondary treatment in aerated lagoons by means of floating surface aerators and chlorination.	Disposal into creek and then to Arabian Sea.
5.	Malad	60	-do- -do-	-do-
6.	Ghatkopar	84	-do- -do- but Without chlorination.	Disposal into branch of a creek & then to Thana Creek.
7.	Bhandup	42	-do- -do- Without chlorination.	-do-

Basic Construction Cost of Works proposed in the Development Plan III at 1978 prices was estimated at Rs. 150 Crores (without physical and cost contingencies and without engineering supervision). This cost was also exclusive of the cost of remaining works in the sewerage conveyance system.

The report of M/s. Metcalf and Eddy on the development Plan III for Sewage Treatment and disposal, formed as a base for preparing a feasibility report for appraisal of the World Bank. The feasibility report for Bombay II Sewerage Projext which is now being implemented was prepared by M/s. Tata Consulting Engineers. This was appraised by the World Bank for finalising the credit negotiation for phase I of the Sewerage Project.

Major works included in D.P.III but which were deleted from phase I of Bombay II Sewerage Project are as under :

List of works deferred from Phase I to Phase II

	Treatment	Disposal
1. Colaba -	a) 1 hour sedimentation gravity thickening of sludge, vaccume filtration of thickened sludge Disposal of sludge cake as sanitary land fill.	b) Outfall length reduced from 1.60 KM to 1.15 Km.
2. Worli -	a) -do- -do- + Chlorination	b) Outfall length reduced from 3 K.M to 1 K.M.
3. Bandra -	a) -do- -do- -do-	b) -do-
4. Versova, 5. Malad, 6. Bhandup & 7. Ghatkopar)	-do- -do- + Chlorination	b) No change.

The cost of the works included in Phase I of the Bombay II Project at 1978 prices was estimated at Rs. 152 crores. The broad outline of different works with its break up of cost as appraised by the World Bank for credit negotiations was as under :

T A B L E NO. 6

Broad outline of works & break up of cost as included in Bombay II Sewerage Project, at 1978 prices.

Sl. No.	Description	Cost inclusive of Physical & Cost Contingencies & Engineering Supervision in Crores.	REMARKS
1.	Providing & laying sewers	48.80	To be Departmentally engineeréd.
2.	Treatment & Disposal works including influent & effluent pumping stations.	85.20	To be engineeréd through consultants.
3.	Miscellaneous such as Training contancy fees, land Acquisition custom duties, firm & personnel taxes etc.	13.00	
4.	Sewerage facility for urban poor.	5.00	
	Total :	152.00	

M/s. Engineering Science, a U.S.A. based firm was appointed as Consultants in July 1979 for detailed engineering and construction supervision of the Treatment and Disposal Works. After initial mobilisation etc., the detailed engineering work was actually commenced from October 1979.

Revised project cost based on detailed engineering done by the Consultants during 1979-81 was worked out at 1981 prices and the break up of cost of Bombay II Sewerage Project is now tabulated as under :

T A B L E NO. 7

Broad outline of works and break up of cost of Bombay II Sewerage Project at 1981 prices.

Sl. No.	Description	Cost inclusive of physical & cost contingencies, engineering supervision in crores	REMARKS
1.	Providing & laying sewers	64	Engineered departmentally.
2.	Treatment and disposal works	226	Engineered through Consultants.
3.	Miscellaneous work such as Training consultancy land acquisition, custom duty firm & personnel taxes etc.	36	
5.	Facilities for urban poor.	5	
	Total :	331	

The detailed engineering designs, drawings and preparation of tender documents etc. is almost over now.

All the projects works engineered by the consultants have been divided into 47 contracts. The present position of civil, mechanical, electrical and instrumentation contracts including those invited under I.C.B. (International Competitive Bidding) are tabulated as under :

T A B L E NO. 8

Present position of contracts in respect of Treatment and disposal works.

	Civil		Electrical Mechanical & Instrumentation	
	No. of contracts	Cost in Rs. crores	No. of contracts.	Cost in Rs. Crores
1) Work orders given	8	27.43	2	2.00
2) Tenders invited	4 *	56.23	8	32.00
3) Tender ready but yet to be invited	7	13.64	18	95.00
Total :	19	97.30	28	129.00

* This includes cost of only 1 km. length of outfall.

T A B L E NO. 9.

Distribution of contracts into local & I.C.B. and its cost.

TYPE	Civil		Electrical, Mechanical & Instrumentation	
	No. of contracts	Cost in Rs. crores	No. of contracts	Cost in Rs. crores
1) Local contracts	15	46.22	15	44
2) I.C.B. contracts	4	51.08	13	85
Total :	19	97.30	28	129

Reimbursement from the World Bank is available only for the contracts invited under I.C.B. Reimbursement that would be claimed for civil works is 80% or less and for mechanical and electrical works is 100%, provided however, that the total credit amount will never be allowed to exceed U.S. 196 Million Dollars which includes water supply works also.

The details regarding the present position of the works engineered by the Consultants have already been given in earlier tables.

The present position of the works engineered departmentally through Planning and Design Wing is as under :

Present position of works engineered departmentally

		No. of Works	Cost in Rs.crores
1.	Works completed	70	4.60
2.	Works in progress	76	18.50
3.	Work orders issued but not started	30	12.50
4.	Works for which tenders have been invited	29	8.00
5.	Works for which draft tenders are ready	-	-
6.	Works for which estimates are under preparation	16	8.00
7.	Works for which survey is being done.	48	12.40
8.	Works for which survey is yet to be done.		
	Total :	269	64.00

After discussing these issues let us now proceed to understand some important features of these projects works. Before going into details of works at each treatment plant site it would be desirable to broadly outline, some important features on all the seven treatment plant sites.

1. At Colaba, Worli & Bandra (3 sites out of 7), we intend to remove only screenings and grit from the sewage. In effect, in this phase of the project only raw sewage will be discharged into Bombay Harbour and Arabian Sea.

2. At Colaba, Worli and Bandra (3 sites out of 7) we intend to discharge the sewage effluent through large diameter submarine outfall pipes by means of diffusers.

3. Effluent Pumping Stations will only be provided at Bandra and Worli site (2 sites out of 7). At remaining sites there will be no effluent pumping stations.

4. Secondary treatment by means of floating surface aerators will be provided only at Malad, Versova, Ghatkppar and Bhandup (4 sites out of 7).

Common features for all sewer treatment plant sites have been enumerated as under :

1. Coarse screens in the wet wall.
2. Influent Pumping Station.
3. Mechanically raked fine screens before degritting.
4. Aerated grit chambers for removal of grit and septicity of sewage.
5. Provision of Administrative Office building, store, Workshop & Laboratory on each site.
6. Reservation of adequate land for housing of staff working on treatment plant sites.

It would also be interesting to note some of the unique features of this project which we will only see in Bombay.

Some of the unique features of this Project :

1. For the 1st time in India, disposal of sewage by means of submarine outfall pipe through diffusors is being done. The largest size of the pipe so far provided in the world is 12'-0" dia. and it is only at one place in Los-Angeles. We are providing same size at two places at Bhandra and Worli.

2. For the 1st time in India, sewer tunnels at 100'-0" depth are being provided by B.M.C. (Ghatkopar and Bandra).

3. For the 1st time in India, sewage flows around 170 mgd. are proposed to be handled at one site. B.M.C. will be handling such large flows at two sites Bandra and Worli.

4. For the 1st time in India, sewage pumping stations will be constructed at a depth of about 100'-0" at Bandra and Ghatkopar.

5. For the 1st time in India, secondary treatment of sewage by the extended aeration method in aerated lagoons will be provided by B.M.C. at Versova, Malad, Ghatkopar and Bhandup.

Some discussion on sewage outfalls:

Discharge of sewage through outfalls into a large receiving water body is one of the methods of treatment and disposal of sewage effluent. It works on the principles of diffusion, dispersion and dilution.

DIFFUSER DESIGN APPROACH :

For a given outfall, improved dispersion of the sewerage effluent can be accomplished by appropriately designed diffusers on the section of the outfall. An effective and simple diffuser is one which distributes the flow through all parts over a large area with minimum head loss and interference between rising water columns. The port has to be designed for uniform distribution of sewage flows when the liffuser section is laid on a sloping bottom (for low or average and perk flow conditions). Ports located at the farthest points are allowed to discharge greater than the average discharge, at highrates of flow. Allowing less than the average discharge from the deeper ports may result in clogging of these ports.

To prevent gross deposition of sludges which would interfere with the disposal function of the diffuser, the velocity through the ports is kept high. The ports are rounded to minimise dlogging and to provide a constant and a high value of discharge co-efficient.

The ports initially dissharge horizontally, with no initial upward velocity component for optimum dilution.

The word dilution is a simple one but this dilution has to be achieved more scientifically in the following manner.

1. Make arrangements for diffusion of the sewage through small dia. port holes.

2. Allow the sewage to disperse evenly in the water body to ensure uniform mixing.

3. Allow the sewage to further dilute.

Follwwing studies are required to be carried out for finalising outfall design and it's length.

1. Wind direction and its velocity.

2. Current directions and velocities.

3. Dye and drouge studies.

4. Tidal variations.

5. Sea bed topography.

These studies were conducted for monsoon and non-monsoon conditions and also for spring and neap tides.

The above oceanographic studies conducted for one year ultimately revealed that sewage discharged at 3 KM. length would not come back on the shore and the M.P.W.P.B.'s standard of less than 1000 MPN Count within 1 KM distance from shore would be adhered to.

The results of the above mentioned oceanographi studies ultimately indicated that discharge of sewage at 3 K.M. distance is desireable and that the wind and current directions and velocities were such that the effluent discharge would not come back on the shore. The detailed design calculations were made to work out the exact length of outfall for varying levels of treatment and for varying standards of M.P.N. count/100 ml. This will now be seen in the next table.

T A B L E NO. 10

	Outfall lengths in meters			
	M.P.N. 1 KM. from shore			
	70/100ml.	230/100ml.	1000/100ml.	2400/100 ml.
1. 1 hour sedimentation	8280	7080	5880	5280
2. -do- -do- + chlorination	4980	4080	2980	2360
3. Activated sludge	6280	5230	4980	3230
4. -do- -do- + chlorination	2930	1860	1860	1860

The least cost solution for all these alternatives was worked out and it was found out that 3 KM, outfall length with 1 hour sedimentation and chlorination would meet the 1000 M.P.N./100 ml. standard within 1 kM. distance from shore.

In phase I of Bombay II Project we now intend to provide only 3 KM. outfall without 1 hour sedimentation and chlorination. This would mean that in this phase M.P.W.P.B.'s standards will not be met with.

CONSTRAINTS IN ADOPTION OF LOW COST SANITATION TECHNOLOGY

R.N. SHELAT* AND M.B. GOHIL**

Introduction :

In the developing countries like ours the choice of technology for waste collection, treatment and disposal is to be considered in the context of the limited resources dense population and social as well as cultural traditions. The conventional water carriage system is not only costly to instal and maintain at efficient level but require plenty of water for its working. Use of water for carrying waste cannot be justified when sizable section of the population does not even have potable water supply. Low cost methods for on site and off site treatment of waste are available and are being increasingly considered for adoption in the developing countries. The World Bank has carried out a detailed survey for technical and economic sanitation options, giving guide lines for adoptions, design construction and maintenance of the appropriate system to suit agiven situation. Though these methods are economically viable and technologically feasible, they have certain limitations arising from the basic constraints of the developing countries like inefficient management and inadequate sanitary education of the people. Possible health hazards, lack of demonstration models and unplanned growth of urban and rural areas also pose serious problems in their adoption.

Loc cost sanitation technology is being increasingly recommended by the National and International agencies. However, due to the above reasons they are not finding favour with the local authorities. The paper briefly discusses these constraints in the adoption of the low cost sanitation technology and possible remedial measures.

Management :-

Management of municipal services like sanitation, refuse collection and disposal etc. in the developing countries is to say the least, very inefficient. The local authority being fully aware of their shortcomings is very sceptical in adopting any one of the options available for the removal of human waste without the use of underground pipe-network. The cartrage can be accomplished by hand cart, cycle rickshaw, truck or vacuum truck, depending on the level of sophistication. Each one of these, however, require high degree of efficient central organization for its successful operation and maintenance. When our local authorities are not in a position to collect the solid waste efficiently, they obviously do not feel confident of handling nightsoil from the densely populated urban areas.

It is because of the lack of efficient management and dependable maintenance, that the bucket latrines which are very efficiently managed in places like Sydney, Australia or Vacuum Truck and Vault System which is commonly used in China and Japan are not adopted in many developing countries.

* Prof. & Head, Deptt. of Civil Engg., S.V.Regional College of Engg. & Tech., Surat-395 007.

** Asstt. Prof., Deptt. of Civil Engg., S.V. Regional College of Engg. & Tech., S.V. Regional College of

Education :

Social design, that is the involvement of the user and due considerations of his attitude, belief, customs, and habbits in the design process is very much important to the acceptance and continued use of the installed facilities and therefore for the success of the programme of the sanitation incorporating economic technological options. This aspect is totally neglected in many developing countries. Number of examples can be cited when the attempts to improve excreta disposal in rural and semi-urban areas have failed as a consequence of social and educational rather than technical defficiencies in the design. The pit-privy is a minimum cost solution providing for defecation with or without water use and was therefore immediately adopted. In Brazil, 2000 pit-privy were constructed, but it was later discovered that very few were actually used. In India, in rural area efforts to implement pit-privy programme has failed in absence of the major sociological inputs. This has resulted quite often in abandoning the programme, rather than correcting the approach.

Health Hazards :

Focal matter being malodourous is considered offensive in most societies. It may contain an array of pathogenic viruses, bacteria, proteozoa and helminths that may cause diseases in a new host. Thus focal matter is the beginning of the transmission routes of the diseases.

Economic options of nightsoil disposal on site or off site, is believed to be associated with possible health hazards and the problems arise either from the inadequate excreta disposal facilities or due to inadequate personnel or domestic cleanliness. While number of factors influence technology choice for excreta disposal, the central factor in the mind of the local authority is the health, as it should be. His apprehension about possible health hazards of the low cost technology for sanitation results in his rejecting the same.

Urban Rural Planning :

The low cost sanitation systems are to be installed for existing urban and rural areas which have developed without any considerations to scientific planning. On-site options will have to be installed in an individual house or group of houses. This may not be feasible when the growth is unplanned. Off-site disposal facilities need sufficiently wide roads for the movement of vacuum trucks or other vehicles. The roads in villages or in urban areas are generally narrow and may not be suitable for such movements. The installation of low cost sanitation systems may not pause serious problem for the planned suburban development on the outskirts of the old cities. It may be noted that what is practicable in urban and rural areas of Japan and other well planned communities of developed nations is not practicable in many of our rural and urban areas. In the circumstances, if the local authorities insist on the western sewerage system, which can be installed very conveniently in our high-density urban and rural areas, it is only natural.

Engineer's Approach :

The adoption of the water borne waste disposal sewers in cities and septic tanks in rural areas has taken in the developed countries since quite a long time. However, once adopted, the sewerage has been regarded as a universal solution to the waste disposal, for various reasons. It is perhaps the best technical solution, it provides in built safety for the Engineer, since the waste is taken away from the community automatically. What happens to the waste, once it is removed from the immediate environment, neither the community nor the Engineers need worry. The Engineers often trained by the urban universities in the urban environment on the pattern of technical education adopted from the western model, adopt this simplest though the costliest solution. If other economic sanitation options are to find favour with our Engineers, attempts to change their attitude will be required. It may also be mentioned that quite often the hesitation of the Engineers is also due to the lack of confidence in the sanitation system,s other than sewerage.

Conclusion :-

It has been now widely accepted that when only 13% of the population of developing countries have piped water supply and hardly 6.5% population has sewerage facility, the technologically feasible and economically viable sanitation methods will have to be adopted in place of present sewerage systems. The hurdles in their adoption will have to be removed. The following action in this direction is suggested:

i) The management and maintenance ability of the local authorities will have to be improved.

ii) Social design and sanitary education should from the part of the technical design.

iii) Physical planning and the street design are important considerations in adoption of less efficient technology. It will be desirable to include environmental engineer in the planning team.

iv) The present undergraduate curriculum in environmental engineering emphasises the teaching of sewerage system in most of the universities. It is essential to give adequate emphasise to the teaching of other available systems of sanitation.

v) A few pilot plants based on economic sanitation systems must be constructed to demonstrate to the engineers and to the community its viability and dependability.

vi) It will be necessary to ensure and demonstrate that there are no health hazards associated with sewerless sanitation.

REFERENCES :-

1. Feachem, McGarry, and Mara, 1977. Water, Waste and Health in Hot Climates, John Wiley and Sons, London.

2. Feachem, Bradley and Garelick, 1980. Health aspects of Excreta and Sullage Management, World Bank.

3. Kalbermattern, Julius and Gunnerson, 1980. Technical and Economic Options, World Bank,

4. Lohani B.N. and K. Rajagopal, 1981. Human and Animal Waste Management Strategies in Developing Countries, Environmental Sanitation Reviews No. 4/5, October.

5. Sundaresan BB, 1980. Key Note Address, First National Conference on Technological Options for Sanitation for the Developing Countries, Surat, December 27-28.

++++++++++

SANITATION FOR THE POOR - FIVE DEVELOPING REGIONS IN SEARCH OF APPROPRIATE TECHNOLOGY.

P.K. Saha *

For convenience of programme administration the United Nations have grouped the Developing countries of the world in five regions, e.g. Asia and the Pacific (West to Iron), Latin America including the Carribbeans, Affica, West Asia or the Arab world and Europe i.e. Cyprus and Portugal. The regions vary among themselves widely in terms of size, history and culture. Their political systems cover almost the total available spectrum from the benign democracies to the oppressive military dictatorships. Even in terms of income the variations are wide enough. Sri Lanka, Bangladesh and Bhutan are at the near bottom level with a per capita income below $ 150. At the other extreme are some countries of Africa and the Arab World with per capita income exceeding $. 500. But rich or poor, big or small all these regions have one feature in common. Their crowded cities and the scattered hinterlands are plagued by poor water supply and inadequate sanitation. As a direct consequence, enteric diseases are rampent in these parts of the world. Over 30,000 people succumb to these diseases daily, two-third of them being children. According to WHO statistics almost 87% of the rural and 47% of the urban populations of these Developing Regions are without adequate sanitation facilities. In numerical terms this means nearly 2000 million people by the end of this decade with present level of extension of coverage. (Percentages that lack water supply in the urban and rural areas are 25 and 71 respectively). Among the list of common infectious diseases more than fifty are transferred from a suffering person to a healthy one through routes related to inadequate sanitation. It is invariably the poor who suffer most as a result because they lack not only the means of proper sanitary facilities but also the information on how to minimise the ill effects of the insanitary conditions in which they live.

The commonly accepted method of sanitation is of course the water borne sewerage system. This collects the night soil and other domestic wastes in a watery medium from individual houses and treat these in plants away from congested areas. Effluents from these treatment plants are often not pathogenically safe and will pollute the water where they are discharged. But even this convenient and so called best sanitation system costs between $ 300 - $ 500 per capita and is clearly beyond the capacities of the average beneficiaries in the developing world to pay.

Realisation of this has led to a worldwide search by the World Bank for technolgies in sanitation appropriate for the developing world. Appropriate technology as a term has become topical since the publication in 1973 of E.F. Schumacher's book - Small is Beautiful. There is however, no Universally applicable definition of the term. Appropriateness of technology varies depending upon the developmental goals of the country where it is to be applied, the levels of existing technology, the socio-cultural environment and the strength of existing organisations. There is also the question of opportunity cost of the investment and the net present value of the costs over time. The World Bank Study teams have avoided going into these complications by adopting an operational definition of Appropriate Technology as a method or tech-

full health benefits and at the least economic cost. The basic philosophy is that only those technologies that pass all three tests are appropriate'. Starting with this premise they have ended up in identifying five types of household systems and four types of community systems for sanitation in the developing regions. The household systems are pit latrines, pour-flush toilets, composing toilets, aqua-privies and septic tanks. These are characterised by the fact that they require little or no investments outside home sites. Bucket latrines, vault toilets, communal toilets and sewerage systems are the community systems identified by the study teams. All these are age-old systems in use in various parts of the world with varying degrees of sanitary effects. They also cover the total spectrum of available technologies excepting a few esoteric ones. Conventional construction of these systems did not have the benefit of the knowledge of the path of travels of pathogens nor of the technology of controlled digestion of waste products into relatively harmless ones. In the hands of the expers in the appropriate technology teams each of the alternatives will thus have opportunity of providing more sanitary protection with reduction in odour and fly nuisance than ever before. But any such improvement will invariably increase the price tag. Besides, each has its limitation of applicability both physical and socio-cultural. For example ordinary pit privies will not function hygienically in areas of high ground water level. Pour flush latrines run the risk of being choked if users do not pour enough water (usually where water is to be brought from afar) or where solid materials are used for anal cleansing as in many parts of Africa. Pit latrines are also suitable for low density areas (say upto 300 persons per hectare) where houses are single storied having back yards - a tall order for the urban areas in the developing world. Others like composting toilets need handling of waste materials which are socially unacceptable in many countries. Such lists could be made very lengthy. The study reports themselves show that none pass the three tests mentioned earlier with something even approaching flying colours.

Community systems are the only alternative in places of congested living especially in the outskirts of the cities and in the bustees. Here, beside all other considerations extent of use will depend upon convenience of location and the level of cleanliness both of which devolve upon external organisations rather than on individual users. Household systems, on the other hand ensure avoidance of major cost implications by public authorities by shifting the onus upon the individuals. At some point down the scale of poverty this will become unaffordable. But even before that such expenses are often unacceptable. To make appropriate technology in sanitation acceptable to the client population other parameters beside level of service, health benefit and cost are significant. Individual households accept or reject a new technology based on personal criteria both social and economic. Potential users must be involved in the process of identification of the technologies and the agencies have to provide a structure through which they could respond. In most cultures sanitation practices have become timeshonoured and the norms affecting them are more of functional, aesthetic or ritual in nature. In fact the germ theory of diseases and its control through sanitation normally do not provoke encouraging response among the poor specially in the rural areas where a toilet is accepted more as a status symbol than utility. T[illegible]

hounting the developing world this will have to change albeit slowly. In the attempt to herald such a change we have to remember that it is easier to change technologies than to change behaviour. It is more pertinent to ensure social acceptability than to establish techno-economic feasibility. To quote Dr. David Bradley of the Ross Institute of Tropical Hygiene 'No matter how much we have learnt about the engineering details of alternative sanitation systems and the related health aspects, unless these findings can be translated to the target population in a way, they understand and accept this is mostly an academic exercise'. The other aspect is the cost of sanitation. The World Bank reports admit that household systems proposed by them are mostly good for low density areas, primarily rural; the community ones are good for urban fringes and bustees while for cities and towns in many case sewerages may be the only alternative. Whatever be the appropriate system many of the target population cannot afford the cost of the same and the others will not care as sanitation in contrast to water supply, is rarely considered by them as felt need. So, Government wrill have to pitch in. The whole effort will need high level of subsidy both in capital and up-keeping. For the decade of the Eighties $ 30 billion a year i.e. $.80 million a day is considered by the Authorities to be the sum that could make a reasonable dent on the problem of sanitation for the Developing World. This is over four times their current level of spending. Is this required amount really daunting? Consider for a moment that the world spends $.240 million a day on cigarettes and the global arms is in excess of $.1400 million a day. Even for India, the annual fund requirement for the level of sanitation o for the World Bank programme is about Rs. 700 crores, whereas the current annual defence budget is in excess of Rs. 5,000 crores. The choice is thus not so much between different technoligies of sanitation as in the priorities in budgetary allocation that the world consider politically appropriate to reduce death and suffering of the millions in poverty.

Ref : Appropriate Technology for Water and Sanitation (Vols.1-5), World Bank/Dec.1980.

ECONOMIC ANALYSIS OF WATER SUPPLY AND SANITATION DEVELOPMENT

Dilip Trimbak Shete*

A) Introduction :-

Mother Earth waited for a million years, after giving birth to Adam to see her first billion children, but the next billion due in only another ten years. The world population is expected to reach 6.5 billion by the year 2000. Basic human needs, like food, clothing, shelter, and public services provided by and for the community at large, such as safe drinking water, sanitation and minimum health services, of the additional 1.5 billion people have to be satisfied. Satisfaction of this needs means more water to supply these goods and services.

Again, water and health situation, at current level on a global basis, has been estimated as follows :-

Gastro enteritis :-	400 million cases/years
Schistosomiasis :-	200 million cases/years.
Filariasis :-	200 million cases/years.
Malaria :-	160 million cases/years.
Onchocerciasis:-	20.40 million cases/years.

These statistics clearly reveal that the economic costs of water related diseases are considerable, and a major portion of such costs can be reduced by sational water supply and sanitation development and management.

Water supply and sanitation development is expensive. In a developing country like India where public funds are generally scarce commodity, the decision to proceed with such investment must be made after careful scruting. Hence, as one of many economic inputs, water related investment should be subjected to the same strict investment criteria as are applied to their competing investments, and pricing policies should be adjusted in such a way that efficient resource allocation can be made.

This paper discusses some of the difficulties involved in applying economic theory to the practical problems to get optimal results. These difficulties arise due to gross ignorance of the economic implications of technological innovations which are often seized upon avidly by water supply and sanitation managers. This is due an undue reliance upon financial criteria for decision making. The lack of communication between economists and the decision makers and the fact that organizational responsibility for pointing out these economic implications is ill defined.

In fact, there is an increasing tendering to dismiss economic theory as irrelevent in view of the complex nature of the political, social and technical constraints that are associated with the financing and supply of water for human consumption. However, by applying and modifying certain basic economic principles to deal with the crucial issues confronting the water supply development, a good deal can be accomplished.

This has been illustrated by referring to pricing and investment policies. The role of marginal cost pricing of benefit cost analysis and of shadow pricing in project design, selection and construction is then discussed.

B) Obstacles to the Introduction of Efficient Pricing:

B-1) Economic Effieiency and Marginal Cost Pricing :

The economic effects of any proposed policy can be divided into the effects an efficiency and the effects on distribution. Efficiency relates to the size of the pie available, distribution to who gets what share.

Most of the economic thought concerns the efficiency effects of alternative possible policies. There is a sence in which enlarging the size of the pie may be considered to be good for the consumers as a group irrespective of the distribution of shares. This sense turns upon the possibility of dividing the enlarged pie in such a way that everybody benefits.

Assuming a municipal water supply enterprise can always make another unit of water available by expending more resources to acquire and transport it, that is at a certain additional or marginal cost, the question of where to stop in increasing the supplies made available is then added to the question of how to arrange for the allocation of the supplies in hand at any given time.

Suppose that at a given time this cost is Rs. 30 per unit. Then, if the community as a whole can acquire and transport another unit of water for say Rs. 20 it would clearly be desirable to do so, in fact, any of the individual customers to whom the unit of water is worth Rs. 30 would be happy to pay the Rs. 20 cost and none of the members of the community is made worse off thereby. Hence, on efficiency grounds, additional units should be made available as long as any members of community are willing to pay the additional or marginal costs incurred. To meet the criterion of equimarginal value in use, the price should be made equal for all customers. So the combined rule is to make the price equal to the marginal cost and equal for all customers.

One important practical consideration is that, because of differing locations, use patterns, types of services etc. , the marginal cost of serving different customers will very to find out these variation, arrange matters so that for each class of customers (where the classes are so grouped that all customers within any single class can be served under identical cost conditions) the prices should be the same and equal to marginal cost. Between classes, however, prices should differ and the difference should be pricesely the difference in marginal costs involved in serving the two.

One problem which hunts the decision-makers is whether efficient pricing should be at short-run marginal cost for the reason that the normal sale of water is in the nature of a short-run agreement a purchase of water at this moment does not bind the customer to take more water at any later date. At each moment of time, so the enterprise forced with the short-run problem of selling its output given its current capacity. Pricing at long-run

enterprise would never face any problem of disposing its current output, already arranged for by contract.

B-2) Difficulties of Measurements :-

It is a well known fact that the major obstacles to implementing marginal cost pricing is the difficulty of measuring marginal cost. However this difficulty is more apparent than real. Estimation of future supply costs provide a reasonably accurate signal for investment. It is still to be preferred to the present accounting methods of attempting to recover sunk costs, expected future costs and costs which measure not the burden on society but that felt privately by the water utility.

This last constitutes the real measurement problem. It arises because water supply is such an important part of the social infrastructure that it should be operated with particular attention to the public welfare. One consequence of this that the financial interests of the water utility should be subordinate to the interests of society as a whole, and that pricing policies should ideally recognize the so-called 'external' effects of water production and consumption. These effects may or may not be relevant for economic efficiency, depending on whether or not they represent a net gain to society.

An external effect is one which is felt by parties other than the buyers or sellers of a particular commodity and which in a competitive market situation, would not be reflected in the price of that commodity. An external benefit would arise if water consumption or sanitation utilization by one individual is of benefit, perhaps because of his improved health to his employer. In such a case, optimal pricing would require a price equal to marginal cost minus the benefits to others that accure from marginal consumption.

Efficiency in pricing and imvestment is unaffected by purely "pecuniary" external effects transfers in income or kind resulting from the supply of a commodity between members of the same society. Thus, a water supply project that stimulates industrial development, thereby yielding net gains to a particular region of a country, will not be justified on the grounds of economicefficiency if the result is merely to attract industry and reduce gains by an identical amoung in other regions.

It is not inevitable that efficiency and other criteria should conflict. Thus if subsidization of water consumption encourages industrial growth in a depressed region, income distribution arguments for such a policy may be reinforced by efficiency considrations. This happens where the subsidy results in a transfer of activity, without undue loss of productivity, from a region of high employment, where the value of labour in other user is high to an area where it may tends to zero.

The task of computing real and purely transfer effects is awesome as externalities are difficult to estimate and and any decision regarding the reinvestment of resources or the redistribution of income may invariably set off a complex chain reaction involving repercussions in other parts of the economy. This process is clearly a barrier to the introduction of an efficient pricing policy and it would be idle to pretend that precise answers cah be obtained

Another obstacle to the introduction of an efficient pricing policy is the managers of water supply and sanitation development who are the least concerned with general economic development, income distribution and external benefits, especially when these objectives may be in conflict with their own goals.

B-3) Marginal cost Pricing and Profitability :-

Strict application of marginal cost pricing would result in an enterprise making financial losses when average costs of supply are falling (i.e. when marginal cost by using utility discrimination by setting up a descending scale of prices as a function of quantity takes, but subject to the guiding rule that each customer must pay the same marginal price i.e. marginal cost. This could conceivably be achieved by a process of trial and error. The customers can be divided into various of groups, each with a seperate declining price scale. At the end of first trial some individual would end upon too high a rate block and others on too low a rate block as compared with marginal cost. The aggregate revenue might or might not suffice. A second trial is then run, reclassifying some of the customers and possibly varying some of the scales. Ideally speaking this process could go on until either the optimum was achieved at a satisfactory revenue or it was determined to abandon the project.

Ironically, this abandonment of the project would be treated as anti social or antipoor approach in the developing countries like India where loss making is a virtue and profit making is a vice. Raising prices to meet operational and maintenance costs can raise a hue and cry from the politicians and local chieftains. The introduction of marginal cost prices would require a radical change in social attitudes.

In such situations average incremental cost pricing is a more practical suggestion. Here the price is nothing but the average cost of producing water from the most recent or the next feasible investment. Hence prices can be adjusted occassionally to reflect the average costs of technically feasible new investments. Whenever average costs will rise, profitable operation will result and price increase will be moderate. Thus this policy can be more readily accepted than the marginal cost pricing.

C) Obstacles to the use of Benefit-cost Analysis :-

C-1) Benefits :-

The benefit cost analysis is very difficult to manage because it is very difficult to measure the benefits on the basis of consumer's willingness to pay. Actual revenues from metered water sales leave a considerable consumer's surplus i.e. many consumers would have been willing to pay more than the actual price of water. To assess the benefits alternatively, these can be equated with the cost of the next cheapest investment.

Another way of measuring benefits is the estimation of the public health benefits of a safe, dependable water supply and adequate sanitation. But here the data on changes in mortality and morbidity from water-borne and water associated diseases are as unreliable as the consumer behaviour.

C-2) Costs :-

Investment decisions should be based on economic costs which are nothing but social opportunity costs, i.e. the value of the goods and services given up because of the employment of resources in water supply and sanitation project. The opportunity cost of capital should be rate equivalent to the rate of return on capital in the private sector.

C-3) The Criterion Problem :-

Suppose all the benefits and all the costs associated with a water supply and sanitation development project have been worked out. To determine whether the project is good, generally it has been seen that and between different projects whether it has the higher ratio.

The second condition though commendable tends to erroneous. Suppose we have to select between two mutually exclusive projects, one with a cost of Rs. 1.00 and a benefit of Rs. 4.00 the other with a cost of Rs. 1000 and a benefit of Rs. 1300. The former has a B/C ratio of 4 and the later of only 1.3 but is it advisable to let go a Rs. 300 gain for a more Rs. 3.00 on the other project ? The ratio does not lead us to the right answer.

In selecting the scale of investment in a given project, book B/C ratio leads to the wrong answer again. If costs Rs. 50/- are incurred the benefits will be Rs. 70 (B/C = 1.4). Assuming by expanding the scale of cost by Re. 1, it is po ssible get a benefit of Rs. 1.30, the B/C ratio of the increment being only 1.3, it pulls the overall ratio below 1.4 but unquestionably the increment yields more benefits than costs and is therefore desirable.

Again, if the basic out lay is Rs. 50.00 and benefits of Rs. 200 will be yielded if expenses of Rs. 75 are incurred, the one ratio is (Rs. 200 - Rs. 75) Rs. 50 = 2.5, while the other is Rs. 200/- Rs. 50 + Rs. 75 = 1.6. Neither of these ratios is better than the other, basically the error is in the use of the ratio at all.

What is the right criterion? According to J.Hirshleiferet al, it is the difference between the benefits and costs (B-C) which should be maximized. In the last illustration, the B-C- criterion shows a wealth gain of Rs. 200-(75+40) = = Rs. 85/-, the same result being derived whether the accounting is on a net or gross basis. As between the mutually exclusive projects we thought over earlier the project with a B-C of Rs. 1300 - Rs. 1000 = Rs. 300/- is obviously a better alternative than the one with a B-C = Rs. 4.00 Rs.1.00 = Rs. 3.00. Similarly, any increment to the scale of a project that yields a greater increase of benefit than of cost is one that obviously makes the B-C difference greater, and again the correct answer is achieved.

D) Obstacles to the Use of Shadow Pricing :-

Whenever the optimum allocation of scarce resources are to be made these are made by using a shadow price for that scarce factor equal to its marginal productivity. In this case, the optimum allocation can be made by equalising the marginal productivity, or incremental rate of return, of capital in every project and then setting it equal to

The optimum distribution of any scarce factor can then be made as follows :

a) by finding its marginal productivity,

b) by setting its shadow price equal to this marginal productivity and

c) by maximising profits or discounted net benefits using these shadow prices.

The first step is the most difficult. A whole weries of projects using the scarce factor is evaluated and the marginal productivity of that factor is calculated for each project. Afterwards the scarce factor is distributed to those projects with the highest marginal productivity of the scarce factor. Using this shadow price the net benefits of each project should be maximised.

If the application of shadow pricing were to result in the rejection f a project of higher financial cost than otherwise it would not be equitable to charge the consumers for this increase, since the economic benefits accrueto the whole nation. Also, that the selection based on shadow p pricing is in its best interest.

Even if a selection based on shadow pricing is attempted, severe difficulties of calculation can be solved only by employing economists for feasibility studies.

Probably the greatest problem is the communication gap between the engineers and the economists.

E) C o n c l u s i o n :-

In view of the rapidly increasing cost and decreasing resources it is highly important to ensure that the allocation of water supplies and sanitation facilities are determined in accordance with sound economic principles. The paper has illustrated this and some of the obstacles to the implementation of economic principles.

Economic efficiency and the marginal cost pricing has been discussed in detail. It has also been shown how (B-C) consideration is superior than (B/C) consideration for selecting a water supply and sanitation or any other project . Obstacles to shadow pricing are also noted.

References :-

1) Biswas A.K., United Nations Water Conference - Summary and Main Documents, Pergamon Press.

2) Hirshleifer J, De Haven J.C., and Milliman J.W., Water supply - Economics, Technology, and Policy, the University of Chicago Press, Chicago.

3) James L.D. and Lee R.R., Economics of Water Resources Planning, McGraw. Hill Boom Company.

4) Warford J.J. and Whitford P.W., Economic Analysis and Municipal Water Supply in Developing Countries, Proceedings of the First International Conference on Transfer of Water Resources Knowledge, September 1972, Fort Collins, Colarado, U.S.A., Water Resources Publications, Fort Collins, Colorado.

++++++++++

ECONOMIC CONTRIBUTION OF WATER SUPPLY ANF SANITATION NATIONAL DEVELOPMENT.

Dilip Trimbak Shete*

A) AN INTRODUCTION :-

Because of the important role water plays in human survival, the entire history of mankind is nothing but its struggle to acquire and harness it. The historian, Herodatus was so impressed by the role of the Nile in the Country's survival that he called Egypt "the Gift of the Nile".

The development of water supply and sanitation is important both as an input to the economic growth process and as an element of the basic needs which most countries strive hard to provide for their population. As an economic input, water related investment should be subjected to the same strict investment criteria as are applied to their competing investments, and pricing policies should be adjusted in such a way that efficient resource allocation can be made.

The development and exploitation of a country's water resources plays an important role in both its economic and social development. The first section of this paper discusses water supply and sanitation as an economic good. The second section deals with water supply and sanitation as a social good. The last section reconcils economic and social goals of water supply and sanitation.

B) WATER SUPPLY & SANITATION AS AN ECONOMIC GOOD :-

Economic development is the process of increasing the production of goods and services given a country's resources which are both variable, like labour and capital and fixed like land, minerals, water etc. Combining these inputs to maximize the total output is known as economic efficiency.

To achieve the approximation of economic efficiency, following set of rules should be satisfied:

B-1) Rule-1 The Optimum Allocation of Goods :

Each consumer maximizes his satisfaction by ordering his consumption so that the marginal rate of substitution between any two goods is equal to the ratio of their prices. Each pair of consumers must have the same marginal rate of substitution or a trade of goods would effect a mutual gain. Pure competition achieves equal marginal rates of substitution by making the price of any good constant throughout the economy and hence making all price ratios uniform.

Rule-2 The Optimum Degree of Specialization :-

Each enterprise maximizes its profit by making its marginal rate of transformation between any two outputs produced equal to the ratio of their prices. Pure competition achieves this goal by making the price ratio between any two putputs constant throughout the economy.

Rule-3 The Optimum Relationship between Input and Output:

Each enterprise maximizes its profit by equaling the marginal physical product of input to producing output with the ratio of their prices. Pure competition also [illegible] by giving uniform price ratios

Rule-4 The optimum Allocation of Inputs :-

Each enterprise maximizes its profit by making its marginal rate of substitution between any two inputs used in production equal to the ratios of their prices. Pure competition would maintain a uniform ratio.

Rule-5 The Optimum Direction of Production :-

Overall welfare is maximized if the marginal rate of transformation in the production process between any two outputs is the same as the marginal rate of substitution between the same two goods on the part of the consumers. The uniform prices of pure competition also achieves this goal.

Rule-6 The Optimum Allocation of an Individual's Time :-

Optimum welfare also requires that the marginal rate of substitution between leisure and wages for each person must be the same as the marginal physical product between the work done and the resulting output for each enterprise. An individual maximizes his satisfaction if he equates his marginal rate of substitution between money and leisure with the wage rate he receives for labour. Under pure competition, all enterprises should sell the identical output for the same price and all enterprises must pay the same wage rates for all workers with the same skill.

Rule-7 The Optimum Allocation of Assets over time :-

An individual maximizes satisfaction by equating his marginal rate of substitution between present consumption and future consumption with the rate of interest he can earn in the market. Pure competition equates these two marginal values by making the leading rate equal the borrowing rate.

The correct application of the above rules will produce the greatest efficiency in water supply and sanitation procurement and utilization in terms to, and in competition with, all the other desires of the community. With so much of our national wealth allocated to the non-productive ends like defence. The available wealth for investment being limited, the choice of less efficient project means the region having the project will be poorer in the future than if wiser decision had been made.

Kelso, Martin and Mack have carried out a thorough analysis using a sophisticated set of alternative economic projections, input-output models and linear programming representations of agricultural sector, to study the extent to which water constraints the continued growth of the economy of the State of Arizona. The major findings of the study are :

i) Water is an economically scarce commodity but not so physically scarce as to threaten the State's economy.

ii) Much of the scarce water supply is, through water law and location, locked into uses of very low marginal value in terms of incomes directly and indirectly generated.

iii) Curtailment of these low-valued uses would have very modest negative effects on the State's economy.

iv) The reallocation of existing water supplies from such uses to the emerging high-value uses would

Most of the policy issues in connection with the water supply and sanitation developments discriminates between financial feasibility and economic feasibility. A financial feasible project generates revenues that suffice to cover all costs, including interest on funds borrowed to finance the project. By economic feasibility it means that the economic valuation of the benefits to whomever they accrue, exceeds the economic valuation of the costs to whomever they accrue.

The effect of water on a country's development can be assessed bylocking into the constraints of the lack of adequate water supply on the economic growth. The degree of constraints ranges from absolute to partial. There are recorded cases where whole towns have been abandoned because ground water sources were exhausted and no alternatives were available.

Whenever a water supply and sanitation development project is carried out it is likely that first units of water input would have a very high return in productive output. However, as more and more water is made available, the marginal increases in output attributable to increases in water inputs would diminish. Hence at some stage, one would envisage that further increases in water input would actually have negative incremental effects.

C) WATER SUPPLY AND SANITATION AS SOCIAL GOODS :-

One need only review the social goals related to water supply and sanitation development listed below to realize that an ideal social welfare function is a mirage.

i) Maximum National Income :

People with higher incomes have more resources for providing themselves with a better life. The model of pure competition achieves economic efficiency in that it maximizes national income. Still money is far from the total answer to human happiness. What is?

ii) Ideal Income Distribution :

Collective happiness is not maximized if the maximum national income is achieved by giving the national wealth to an elite group while everyone else lives in abject poverty. A guaranteed equal income for everyone would weaken the incentives of the ambitions. How should income be distributed?

iii) Environmental Quality :-

Everyone has scenic spots, historical landmarks, and wildlife forms which he would like to be preserved and is disturbed by environmental pollution. But all progress would be halted by the preservation of each and every scenic spot, historical alnd marks etc. Where can the line be drawn?

iv) Institutional Stability :

While a static society cannot secure social justice with changing times, a continuing rapid social changes promote undertainities and insecurity. What is the optimum rate of change?

v) Public Health :

Freedom from diseases and preservation of life involve values that cannot be expressed in income units. Is public health a goal to be achieved at all economic cost? Then how much should be spent to preserve health and life?

vi) Regional Development:

A more even geographical distribution of economic development reduces congestion in more highly developed areas throws the gauntlet to make the waterland productive and aids national defence. It improves the income and morale of isolate areas. But should such areas be developed at a net sacrifice in total income?

Minimum levels of water supply and sanitation are a prerequisite to a healthy existence. Recent work carried out by the World Bank has illustrated that water supply services provided through standpipes situated at 100m apart can cut water distribution costs by about one fourth compared with full in house services. Sanitation can be accomplished in a technically feasible and socially acceptable manner at investment levels which are about half of conventional sewer systems. Further, economics in provision of water supply and sanitation tend to reinforce each other. The introduction of less water, through the stan'pipes, lessens the need to dispose of lare volumes of sullage through expensive saver systems.

Ideally, the reduction in the amount of water use could release substantial amounts of growth for new uses or the amount can be used for new areas. As water supply and sanitation development project should try to reach and satisfy one and all of the region, the project should run a programme having the following elements :-

i) Developing a social consciousness towards the creation of individual social obligations to use water without waste.

ii) Inducing plumbing appliances' manufacturers to develop and market water saving units.

iii) Pricing domestic water higher after basic needs are met.

The recent findings of research in low cost water supply and sanitation is that the health and environmental impacts of such investments can be maximized through the addition of 'software' components of the projects. Basic hygenic education can yield a high return when provided alongwith the introduction of new water supply and sanitation project.

Water can affect basic needs of human well beings and productivity of labour through impacts of health and the expenditure of human energy together water. From the quantity point of view, the increase of supply upto 5011 d.c. will improve health and well being through direct consumption, bathing, washing etc.

From the quality point of view, a supply free from pathogems and parasites will be welcome, provided :

i) The supply is reliable,

ii) The people continuously use the new supply without returning to traditional contaminated sources, and

iii) Other sources of exposure to the same contaminants do not simultaneously exist.

The introduction of water supply to an area which had been without water can sometimes endanger the health situations unless it is associated with a satisfactory means of sanitation. This happens in tropical countries, far human wastes rapidly become non-contamination if kept away from water. But after the introduction of water supply the same may persist in a wet state for a considerable period and play havoc.

As per recommendations of W.H.O. the provisions of health care have been reoriented away from centralized hospital facilities towards peripheral services providing a simpler types of care through paramedical workers at the village levels. This approach has been extended to include the provision of water supply and sanitation in rural communities. These changes are the background to the engineer's work and can be used in the task of maximizing the health benefits of water supply and sanitation development.

A topic being vigorously discussed concerns :-

i) Whether water supply and sanitation should be a tool to control growth and

ii) Whether water supply and sanitation should be an organizing concept in planning towards desired changes.

The obvious answers are that water related programmes may asist in growth where it already is occuring or it may provide the necessary capacity for accelerated growth, however, the provision of capacity does not mean surety of growth. This implies that water is basically a contributing and not a necessary factor of the growth.

When there is highly economical and plentiful water supply, the demand rises very rapidly for the manner of living is determined individually for each activity. The demand accompanies but does not result from this attitude. On the other hand if the easily available water supply is not so much plentiful, the manner of living is different and the demand cannot vary to an important extent.

The head of a South Sahara village may be offered a hundred times increase in the water supply. But he would eventually rejedt the offer. This looks odd. The real logic behind his refusal is the sudden abundance of water in his vallage would draw nomads and their herds from near and far. The village structure would be transformed if not destroyed. The herds will stamp on crops. Then there will be water but no crops. Naturally there will be a wastage and increasing number of nomads and herds eventually result in a scarcity of water as well.

This is true for cities and towns also. The civic body strives hard to supply more than enough water to its clients. Urban dwellers, industries in and around the city get lot of water supply. Their sanitation demands are satisfied. There is no problem. But this stage of no problem creates problems. As the news of the high consumption of water supply and sanitation units spread like wild fire number of people throughout the city, number of new industries dot the periphery of the city. Eventually scarcity of water supply and sanitation has been observed. So the circle completes. But in doing so lot of new problems arise like schooling of children of new comers, housing for the new comers more pollution of the atmosphere due to new industries, uncontrollable traffic etc.

As is true of contribution of water supply and sanitation to economic development, its impact on social development also shows diminishing returns. Available medical evidence indicates that the health benefits accrued from the provision of 25 to 40 l.c.d. of water can be very high, whereas consumption over 100 l.c.d. yields very little incremental health benefits. This implies that the optimum development of a country's water supply and sanitation to meet social objectives would be to provide for a relatively low level of consumption for each consumer with additional supplier available for those able to bear the full cost.

D) Reconciling Economic and Social Goals :-

Development of water supply and sanitation project is very expensive. In a developing country, like India, where public funds are in short supply, the decision to proceed with such investment must be carefully taken. The demand for water supply and sanitation can be considered as a demand for raw material, depending on relative prices of the other economic activities, themselves dependent on the socio-economic development set-up. Water in this case is a resource of the national production system and the non-substitutable part of water can be measured by the influence of the socio-economic factors. A water 'price' will resume all these socio-edonomic conditions. The starting point should be the choice of an economic production function (employment of certain technology and marginal cost of water supply) and a choice of technical and financial restraints leading to an economic demand function which maximuzes the marginal water utility. The classic economic approach gives the water demand as follows :

$$D = ap^b$$

Wherein D = Demand

a = Adjustment coefficient

p = Price

b = Elasticity of the demand

In the developing countries, the resource aspect i.e. raw material (water supply and sanitation) of demand is paramount and immediate returns desired. Second position goes to prospective aspect and thirdly qualitative aspect comes. Hence the policy maker dances to the tunes of the financier (foreign country giving the aid) who in turn decides what is the best in the interest of the final consumer who has not an opportunity to put forward his

The two guiding principles for water supply and sanitation investment should be,

i) to undertake the least cost investment consisting with the economic and social goals, and

ii) to place as much of the burden of paying for that investment as possible on to the beneficiaries.

With respect to the first principle, investment criteria for economic analysis are fairly well developed. A project with a positive net present value (and one which is higher than that of competing, mutually exclusive projects) should be undertaken as a rule. The application of this rule to lumpy investment and where benefits cannot be meaningfully quantified is difficult. While numerous attempts have been made to measure the impact of improved water supply and sanitation on health, property, production, etc. most studies have concluded that methodological problems compromise the results. Again, there is danger that while a project may be the leat cost way of meeting a projected level of future demand, there is no guarantee that the demand is at the economically optimal level if the consumer is charged a price which is much lower than the production cost. Thus, in using the least cost investment choices, it is imperative to cross-check demand forecasts, production costs based on long-run marginal costs and consumer income for consistency.

The second principle relates to tarrif policies and cost recovery. The design of a tarrif structure which cross subsidizes from larger users to smaller users is a solution to the conflict between designing projects for maximum cost recovery from the users and providing the basic minimum services to the poorest section of the society at affordable cost. Since economic efficiency requires pricing policy based om marginal production cost there is good, justification for charging marginal cost to industrial and large residential consumers. Since marginal costs are generally higher than average financial costs for water supply and sanitation project, such a pricing policy often generates sufficient fund to permit charging a very low price to small consumers who are usually the weakest section of the society.

E) <u>CONCLUSION</u> :-

As one of many economic inputs investment related to water supply and danitation should be subjected to the same strict investment criteria as are applied to other competing investments, and pricing policies should be subjected to economic theories of efficient resource allocation.

The socio-economic goal of providing adequate water supply and sanitation for everyone to enjoy a healthy existance results in major expansion in standpipe and low-cost sanitation facilities.

Innovative designs of tariff structures which cross-subsidize the poor and packaging of water supply and sanitation with other basic needs delivery systems can be the keys to bring the investment requirements down to manageable levels.

REFERENCES :

1) Hirshleifer, J., De Kaven J.C. and Millman, J.W., Water Supply - Economics, Technology and Policy, the University of Chicago Press, Chicago.

2) Howe, C.W., The effects of Water Resource Development on Economic Growth. The conditions for success, water in a Developing World. The Management of a Critical Resource, Ed. by Utton A.E. and Teclaff, L, Westview Press/Boulder, Colorado.

3) James, L.D. and Lee R.R., Economics of Water Resources Planning - McGraw-Hill Boom Company.

4) Julius D.S. and Bucy, J.B., Assessment of the Economic Contribution of Water Resources to National Development, Water Resources, a Changing strategy? Proceedings of the Conference held in London 2 - 5 October, 1979, The Institution of Civil Engineers, London 1980.

5) Shete, D.T., Economic Analysis of Water supply and Sanitation, Proceedings of Second National Conference on Sanitation to be held in Calcutta 4-14 November, 1982.

6) Teniere-Buchol P.F., Social and Economic Factors affecting water Demands, Water Resources, a changing strategy? Proceedings of the Conference held in London 2-5 October, 1979, The Institution of Civil Engineers, London 1980.

7) Vlaches E and Hendrics D.W., Technology Assessment for Water supplies, Water Resources Publications, Fort Collins, Colorado, U.S.A.

++++++++++

GAMING SIMULATION FOR WATER SUPPLY AND SANITATION

Dilip Trimbak Shete *

(A) Introduction:- The optimal design and operation of water supply and sanitation project embraces such problems as determiniation of the maximum capacity of the reservoir or intake wells. The best operation policy, the best technique to treat the water and the sullage, the best allocation of water supply and sanitation facilities among competing consumers, the best way of pricing the water, etc. Such problems are inter related and most of them are problems of optimal control. For their solutions many more analytical procedures and mathematical modellings have been proposed. The main drawback with these procedures and modellings is the behaviour of the decision makers cannot be readily calculated or modelled in terms of ordinary dynamic equations. Again, another difficulty is that the optimal level of performance estimated by any of the approaches usually cannot be attained. Even if the difficulty of determining an appropriate measure of performance or criterian is overcome and if the criterion to be maximized is same measure of "welfare" of there people affected by a water supply and sanitation development. The optimal design and operation policy cannot be implemented because many of the people affected are not willing to act in a way which will lead to the optimum indicated by the analysis. That is to say, the optimal solution is politically infeasible.

The realities of sub optimal behaviour, conflicts between political, institutional, and social groups, political bargaining, co-operation or collsion, etc. tend to be either omitted even from simulation models or dealt with by priori assumptions.

To encounter such problems gaming simulation approach has been suggested. This approach enlarges the boundaries of the system being modelled beyond the physical and economical systems to include decision makers. Because of the complexity of human nature, the behaviour of decision makers usually cannot be modelled in other approach but can be most successfully modelled by people playing roles in a game.

The approach described herein is designed to overcome the limitations of computer simulations and to exploit the advantages of gaming. It uses simulation for modelling of such phenomena as streamflow, rainfall, evaparation, etc. by automatic computation and the modelling of prolagonists as represented by interest groups by role players in a game. These role players interact with the automatically computed part of the model.

(B) Gaming-Simulation:- The simulation of behaviour by game playing is known as gaming-simulation. It is a dynamic approach different from the static approaches of game theory.

In a typical gaming simulation there are a number of levels of interaction. Not only does each team (which may be

---

* Lecturer in Civil Engineering Department,
Faculty of Technology and Engineering,
M.S. University of Baroda,
B A R O D A.

playing a different role to the others) interact with the model, but other interactions also take place such as player with player team with team. These interactions are essential to the gaming simulation approach. The level and frequency at which these interactions occur is perhaps one of the most important differences among the three main approaches to simulation. The traditional approach is to use only historical records which will probably be of 20 to 80 years' duration, for each simulation run. The synthetic approach is to use a long record of say 1,000 to 10,000 years duration that has be generated from the historical data. The third approach is gaming simulation. A computer model is constructed, but in addition the decision makers in the real world are represented by humna players in a game. The model is then run to simulate a relatively short period of say 6 months to 5 years.

A measure of the success of a simulation is how well its behaviour corresponds to the behaviour of the object system under the same set of conditions. Hence a 'good' simulation can be used to determine the response of the object system to a set of decisions by applying the same set to the simulation.

In a gaming simulation, the planner does not determine the set of input decisions which act on simulated environment. Rather the game players decide most of the course. Again the players and not the planner decide the goals during the game.

The physical environment, the economy and the community at large are represented by a digital computer model, which simulates the behaviour of system in response to players decisions and meteorological conditions. The game is played in rounds, each taking 1 hour to play which simulates a planning period of say 5 years. During each round, the players make decisions that they feel will be in the best interest of them. They are free to lobby and bargain with any other team or with each other in order to try to persuade others to pursue policies that are the best in their interest. As each player is pursuing his own goals, he will not care for what is optimal for the whole system. He will be in conflict with other players and his optimal decisions may well be sub-optimal with respect to objectives applicable to system as a whole. Because of the political and institutional structure of the system, some players will be more successful than others in achieving their goals. So the resulting solution will not be truly optimum but 'realisable optimum'.

At the end of each round, the computer model is run to simulate system response for a period representing 5 years, using the decisions of the players and hydrometeorological conditions syntherized from historical data recorded in the study region, as data. Results are presented to the players to review how the system has responded to their decisions, so that they can plan policies for next rounds.

(C) A Game for Water Supply and Sanitation Development (GWSSD) :-

The development of the GWSSD simulation involves three main tasks viz. (i) the stochastic modelling of hydrometeorological inputs, (ii) the digital computer simulation

of the physical and economic systems, and (iii) the formulation of game rules and roles to model the political and institutional structure of the system. The first two tasks are common to conventional simulations. To achieve the third task, the real life political and, institutional structure of the system should be analysed. The rules must constrain the players to decide their actions within a similar framework of the real life. The rules may be altered for different runs to investigate legislative strategies for water supply and sanitation development. The rules include the delegation of authority to each team, fund raising procedurer, planning restrictions, and so on.

The development of a gaming simulation also involves auxiliary tasks, such as the preparation of player instruction manuals and aids which give the players a written set of rules and guidelines for play. In GWSSD, a playing board displaying a map of the study region indicating location of storage reservoirs, source of future water supply, city map, future town planning, location of sewage disposal units, future means of discharging sullage and effluents, location of industries, etc. is provided. Thus, the players can visualize the state of development of the region as a whole to establish land ownership and to determine the suitability of each area for development. At the end of each round, another board showing the effects of the decisions taken should be displayed.

The river systems and its interaction with the community is simulated by means of four submodels which are,

(i) a river system submodel

(ii) an irrigation submodel

(iii) a power station submodel

(iv) a water supply and sanitation submodel

Though we are concerned with only water supply and sanitation development we cannot use all the water available for the sole purpose as irrigation and power generation being equally important, they should have their share of water.

To represent the major interests in the region, following roles to be taken by players have been established:-

(i) Farmers' Association (F.A.) demanding irrigation water as well as power for lift irrigation,

(ii) Electricity Board (E.B.) demanding power station cooling water,

(iii) Local Government (L.G.) responsible for city water supply and sanitation,

(iv) State Government (S.G.), exercising government policies and funding the different schemes.

(v) Consumers (C), consuming water supply and sanitation units, agricultural products, power etc.

Normally, each role is played by a team of one to four players. As an example the team & requires four players representing common city dwellers having minimum requirements of water supply and sanitation facilities, food and power; Effluent city dwellers having large mansions and lawns and who yield enarmous power due to politking in the city affair, slum dwellers needing the basic needs at the cheapest rate if not possible to get them free of cost and the industrialists.

(C-1) Role Details:

Farmers Association (F.A.):- The game allows for a number of F.A. teams. The main objective of each F.A. is to buy, develop, and manage agricultural land within the region. Their income derive from the production of irrigated and non irrigated goods, selling the land to other F.A. or city dwellers for residential development after getting N.A. from the authority, S.G.

Electricity Board (E.B.):- The object of E.B. is to construct and operate power stations and sell the electricity to the farmers industries and the residents.

Local Government (L.G.):- The interests of the urban and rural population are the concern of the L.G. which:-

(i) Collect rates,

(ii) provides the facilities to meet demands of population.

(iii) makes representations to S.G.

(iv) ensure adequate water supply and sanitation facilities to the community.

State Government (S.G.):- The S.G. can control the development of the region. It implements its policies through :-

(i) Control of land use through the buying and selling of land

(ii) the issuing of loans to other roles and

(iii) the statutory control of the activities of other roles.

Consumers (C):- Consumers C can express their demand, they can influence the thinking of L.G. and S.G. as the representation of both of them is at the mercy of C. But to compel the L.G. and S.G. to heed the advice of C.C. should be united.

(C-2) Role Player System Interaction:- Decisions and transaction made by the role players are recorded on forms to enable easy punching onto computer cards which are then read into the computer. These are processed and system simulation model is run after each round.

At the completion of the simulation run, the computer prints out information in the form a printed bulletin, which gives the players on idea how their decisions have been reflected in the response of the system. However, due to complexity of the system model and uncertainties in the

stochastic nature of hydrometeorological elements, sometimes players can only realize the impact of their decisions after several rounds.

The printout includes:-

(i) a history of rainfalls, streamflows, temperature, etc. at strategic stations in the region,

(ii) the frequency of flood occurance and its effects,

(iii) inputs and outputs of the power station,

(iv) total and individual production in Rs., of all economic sectors including agriculture and industry,

(v) total work force and population

(vi) expenditure on facilities within the community

In addition, the computer acts as a game accountant. A financial statement for each role is included in the printout.

These and other data obtained from the printout will help the players to :-

(i) assess the status of the system

(ii) plan future policies and decisions, and

(iii) modify existing policies in response to problems which have arisen.

Same degree of compromise should be existed among the players if the problems are to be solved.

The players should find out ways to achieve their own goals with least opposition from other players.

This statement can be illustrated by assuming the player acting as an industrialist wants as much water as possible for industry. Hence he may first sound his colleagues in his team C. He may offer to advance the claim of the player acting as a slum dweller for water supply and sanitation facilities free of cost, similarly he may win over other two players. Thus the team C. will direct all its energy to get maximum water supply to the industry. The opposition may be from team F.A., because they require more water fro irrigation. Naturally the team C. may sound some players of the team F.A. so as to encourage them to sell their land at higher premium. As this land may be converted into N.A. the amount of water required for irrigation will be less and that much amount can be diverted to the industry. Similarly to get consent of S.G. and L.G. to the above move the voting whip in the general elections can be threatened by the team C. More over the plans of some players in teams S.G. and L.G. can also be greased by the team C.

(D) Merits of gaming simulation:- Because of the expanded scope of the simulation, three factors are considered, physical, economic and political.

In a gaming-simulation conflicts are resolved by lobbying, bargaining and delegating authority during the

simulation.

The benefits of using a gaming simulation such as GWSSD, rather than a conventional act computer simulation, must be measured in terms of the costs of making wrong decisions or adopting solutions which are unworkable as conflicts were improperly considered.

By using the gaming-simulation approach for the solution of water supply and sanitation development problems, where conflicts surely arise, the risk of adopting an unworkable solution is reduced, and hence expected benefits are increased.

(E) Demerits of Gaming-Simulation:- The cost of implementation and operation of a gaming-simulation is enormously high. It depends not only on the computing costs and costs in terms of the user's salary, etc. but also on the cost of 'employing' players.

It is estimated that this simulation would cost upto 50% more in terms of time and money than a conventional act computer simulation of similar complexity.

It is very difficult to convene the players for each and every round which may be played at mutual convenience.

(F) Conclusion :- The gaming simulation approach can be used to test the political feasibility of a given set of planning and management problems of water supply and sanitation development and to predict how conflicts arising out of the decisions taken can be resolved.

The approach enlarges the boundaries of the system modelled beyond the physical system and purely economic system to include human decision makers.

Though the approach is highly expensive it is economical in the long run as the solutions obtained are workable and they can satisfy socio-eco-political considerations to the maximum possible extent.

Reference :-

(1) Wright G.L.; Developmental and Operational Aspects of Gaming Simulations for Water Resource Systems; Logistics and Benefits of using Mathematical Models of Hydrologic and Water Resource Systems; edited by Askew A.J., Greco F. and kindler J., Pergamon Press.

(2) Wright G.L., and Howell D.T., The Application of Gaming-Simulation to Water Resource Management; Environmental Systems Planning. Design and Control; edited by Sawaragi Y. and Akashi H; Pergaman Press.

DECADE PROGRAMME FOR DRINKING WATER SUPPLY AND SANITATION IN TAMILNADU.

Er. R. KRISHNASWAMY* and Er. S.A. JAGADEESAN**

PREFACTORY

Provision of protected water supply in adequate quantities and disposal of waste water in an hygienic manner are the responsibilities of any Government.

It is reported that in the less developed countries, nearly two thirds of the population do not have reasonable access to safe and ample water supply and a greater proportion lack the means for hygienic human waste disposal.

The United Nations Conference on Human Settlements at Vancouver, Canada, in June 1976, emphasised that safe water supply and hygienic waste disposal should receive priority from Governments and International Agencies with a view to achieve measurable qualitative and quantitative targets serving all the population by 1990 in both Urban and Rural Sectors at the National, Regional and International levels. This laudable objective was approved at the United Nations World Water Conference at Mar del Plata, Argentina in March 1977. It was decided that 1981-90 will be known as the "International Drinking Water Supply and Sanitation Decade". The 31st U.N. General Assembly which met in late 1977 endorsed the recommendations of the Water Conference.

The Government of India like other Governments of the Developing Nations, was represented at all the above mentioned Conferences and it was a signatory to the resolution to try to achieve the targets set for 1990 in the water Supply and Sanitation Sector, namely provision of minimum levels of service of access to safe water supply and sanitation to all the Indian people.

A rapid assessment of the status of drinking water supply and sanitation in India by a Sector study in each State and Union Territory covering the present status of water supply and sanitation sector as well as future need of resources was carried out and it revealed that the Govt. with the co-operation of International Agencies should putforth substantial effort and energy to fill the wide gap in resources(money, material and men) to meet the goal of International Drinking Water Supply and Sanitation Decade.

During the preparatory phase, series of meetings of Chief Engineers and Planners of all the States and Union Territories of this country and a few of the International Agencies responsible for the promotion of the water supply and sanitation sector were held. Taking stock of the rapid

---

*Chief Engineer(General) Tamil Nadu Water Supply and Drainage Board, Madras.

**Superintending Engineer(Designs), Tamil Nadu Water Supply and Drainage Board, Madras.

assessment, sector study, discussions, exchange of views and opinions during the meetings at Delhi, Nagpur and Trivandrum, it was resolved at the Trivandrum Conference that the following coverage target in all the States and Union Territories for the Decade may be adhered to :

(a)	Urban Water Supply	100%
(b)	Rural Water Supply	100%
(c)	Urban Sanitation	100% of all Class I towns with sewerage and sewage treatment and 50% in respect of Class II and other towns with sewerage and other simple methods of sanitary disposal of human wastes, the overall coverage being 80%.
(d)	Rural Sanitation	25% or more by economical and sanitary toilet for disposal of human wastes.

In India, water supply and sanitation coverages in urban towns and rural villages are as follows:

Description		Coverage as on 31.3.1981
Urban Water Supply	..	67%
Rural Water Supply	..	31%
Urban Sanitation	..	32%
Rural Sanitation	..	0.50%

During the Conference on planning for the International Drinking Water Supply and Sanitation Decade held at Uthagamandalam in May 1980, it was unanimously agreed by all the Chief Engineers that each State and Union Territory will prepare a plan of action for the International Drinking Water Supply and Sanitation Decade to achieve the target coverage by March 1991.

With the objectives and guidelines set at the Uthagamandalam Conference, to give true shape to the meaning of the United Nations Water Conference recommendations for International Drinking Water Supply and Sanitation Decade, an assessment was made to project, programme and implement the plan to achieve the objectives of the Decade in India. The base level information collected by the Government of India was processed, analysed and the same was discussed during the All India Public Health Chief Engineers' Conference held at Hyderabad in December,1980.

The base level information collected from all the States and Union Territories revealed that the capital investment required to achieve the Decade target on water supply and sanitation during the decade period will be about Rs. 14,500 crores as follows:

(i)	Urban Water Supply	..	Rs.3,280 crores
(ii)	Urban Sanitation	..	Rs.3,686 crores
(iii)	Rural Water Supply	..	Rs.6,779 crores
(iv)	Rural Sanitation	..	Rs. 745 crores
			Rs.14,490 crores

2. DECADE PLAN FOR TAMILNADU

Demographic Distribution:

Tamilnadu is one of the 22 States in India with a population of 41.20 millions as per 1971 census figures. Of this 15.50 million live in 740 towns comprising the three Municipal Corporations of Madras, Madurai and Coimbatore, 98 Municipalities, 8 Municipal Townships, 13 Panchayat Townships and 618 Town Panchayats. The rural population of 25.70 million is scattered in 47,075 habitations comprising 12,600 village panchayats in 376 Panchayat Unions.

The population of the State as per 1981 census figures is 48.30 million of which the urban population is 21.30 million and the rural population is 27.00 million.

Present Status of Water Supply and Sewerage Schemes

Urban Water Supply

Out of 740 towns in our State, 222 towns have been provided with water supply and works relating to provisiin of water supply to another 70 towns are in progress. Thus 448 towns with a population of 4.88 million (1981) remain to be provided with water supply. Augmentation of water supply in respect of 72 towns is also to be taken up. Regarding the capital city, augmentating the water supply to the City of Madras as well as Metropolitan area, reinforcing the existing water supply to handle the additional water is necessary. Maintaining the existing system to its optimum utility by carrying out timely replacements and improvements is also called for. A coverage of 100% in urban water supply for the entire State is programmed for the Decade.

Urban Sewerage

It is to be pointed out that 720 towns out of 740 Urban towns are yet to be provided with sewerage facilities. It is proposed to take up underground sewerage schemes, in the case of Class I towns (towns with a population of over one lakh) in the first instance. There are 20 such Class I towns in the State. Of these, sewerage schemes have been completed or works are in progress in respect of 8 Class I towns. Hence, provision of underground sewerage facilities in respect of the remaining 12 Class I towns is contamplated during the Decade. Regarding the remaining towns, low cost sanitation facilities are proposed for towns under Class II to VI categories so as to achieve a total coverage of 80% under urban sewerage as per the target fixed. Regarding the capital city, extension of the sewerage system for unserved areas inside and outside the city, reinforcement of the system inside the city and provision of additional treatment works inside the city are contamplated.

Rural Water Supply

Of the 47,075 rural habitations, 5,420 habitations come under Types 1 & 2 and 12,549 habitations come under Types 3, 4, & 5 and the rest come under Type 6. Water supply to all the habitations under Types 1 & 2 is almost completed. Works on the remaining types of habitations have been taken up in stages with due preference to the priority on the need of water. The Government of Tamilnadu has evolved the self sufficiency programme by which it is proposed to provide water supply to all the habitations within the Sixth Five Year Plan period itself. As per the target fixed

Rural Sanitation

The present coverage under Rural Sanitation is practically nil. The target fixed under Rural Sanitation during the Decade is 25% coverage by sanitary toilets in rural areas. Regarding rural sanitation, setting up of an agency solely responsible for tackling the problems in this sector has to be the main objective. Planning and implementation of the facility will have to be geared up during the Decade.

3. FINANCIAL REQUIREMENTS

As explained earlier, in the Urban Sector, about 73 percent of the Urban Population is covered by Water Supply while only 32 percent is covered by Sewerage facilities. In the Rural Sector about 22 percent of the rural population is covered by Water Supply while the coverage under Rural Sanitation is practically nil. Though the global goal is safe water and adequate sanitation for all by 1990, India has consciously fixed the target for the International Drinking Water Supply and Sanitation Decade Programme at 100% coverage in Urban and Rural Water Supply, 80% coverage in Urban Sewerage and 25% coverage in Rural Sanitation. Based on this, the projected requirements of funds for achieving the targets set for the Decade for the State of Tamilnadu is as follows:

	(Rs. in crores)
(i) Urban Water Supply for MMA	365
Urban Water Supply for Tamilnadu (other than MMA)	295
(ii) Urban Sewerage for MMA	131
Urban Sewerage for Tamilnadu (other than MMA)	199
(iii) Rural Water Supply	417
(iv) Rural Sanitation	35
Total:	1442

(MMA: Madras Metropolitan Area)

Thus, the total requirement of funds for Tamilnadu State during the Decade is expected to be in the order of Rs. 1142 crores for both Urban and Rural Sectors including Madras Metropolitan area, of which Rs. 946 crores is the projection for TWAD Board and Rs. 496 crores is the projection for Metro Board. This works out to about Rs. 150 crores/annum. With the existing pattern of funding from the State Government, the Central Government and other internal agencies, it will be very difficult to achieve the target of providing good water supply and better sanitation to all the people in Tamilnadu before 1990. Hence, it is necessary to generate a major portion of the funds required for these programme from International Agencies.

If we look into the history of this sector during the last 8 decades, the progress made in 1971-1980 in this sector is many times more than what was done during the previous 7 decades. Till 1970, only 133 towns were provided with the facilities, whereas during the decade 1971 to 1980 the facilities were extended to 89 towns

The capital investment for this sector in Tamilnadu, during the last 5 years (1975-76 to 1979-80) was Rs. 92 crores excluding the Metropolitan area. As against this, the revised allotment for the Sixth Five Year Plan in Water Supply and Sanitation Sector for Tamilnadu State other than Madras Metropolitan area is Rs. 180.75 crores. In order to implement the programme successfully, the tempo of investment in this sector will have to be increased further in the next Five Year Plan. It is hoped with confidence that the aid from Bilateral and International Agencies may fill the gap if any to achieve the target with the available resources in 6th and 7th Five Year Plans and the first year of the 8th plan.

It may be of interest to note that a total sum of Rs. 18 crores only was provided during the First Five Year Plan for the sector activities under Water Supply and Sanitation in India. As compared to this, the sector outlay for the Sixth Five Year Plan is expected to be around Rs. 4000 crores.

The outlay finally approved by the Planning Commission under the Water Supply and Sanitation Sector for urban and rural areas in Tamilnadu is as follows:

	Water Supply	Sanitation	Total
	(... Rs. in crores ...)		
For MM area (Metro Board)	266.44	48.56	315.00
For Tamilnadu other than MMA (TWAD Board)	161.97	13.78	180.75
	428.41	67.84	495.75

When comparing the Sixth Plan outlay with the Decade requirements, it may be seen that while the projection made for the decade for the whole country is Rs. 14,500 crores, the Sixth Plan allotment is Rs. 4000 crores. This need not be a deterrent because, when we look at the Fifth Plan outlay it was of the order of about Rs. 900 crores only. The provision of Rs. 4000 crores in the Sixth Plan under the Water Supply and Sanitation sector is itself a big jump. It is understood that it is proposed to earmark a sum of Rs. 7000 crores during the 7th Five Year Plan for the whole country under water supply and sanitation sector and hence with one more year in the 8th Five Year Plan, it should be possible to achieve the target. All the above figures are without escalation.

Similarly, when we compare the Decade projection of Rs. 1442 crores for the State of Tamilnadu under the Water Supply and Sanitation sector with the Sixth Plan outlay of Rs. 495.75 crores, on the same analogy, it should be possible to fulfil our goal.

Therefore, it will not be a surprise, if we would provide safe drinking water to all the people by the end of the Decade provided, the political will and the community participation are encouraging.

4. MATERIALS REQUIREMENTS

A major portion of the cost of Water Supply and Sewerage Schemes will be represented by materials such as pipes, specials, valves, pumps, jointing materials, etc., The experience in the State is that more than 70 percent of the cost of any such scheme is accounted for materials used therein.

Among materials, the most important are pipes like Cast Iron, Asbestos Cement, Prestressed Concrete, Reinforced Cement concrete, Poly. Vinyl Chloride, etc., Stoneware pipes will be required in sewerage schemes. The procuring of these materials itself is a challenging task under present conditions and in the quantities involved. The Central Purchase and Stores Organisation (CPSO) now in existence in TWAD Board will be able to meet this challenge. The State and Central Government may endeavour to set up factories to meet the demand. Also action may be taken to increase the production capacities of the existing factories and productivity of the labour force and to obtain full capacity utilisation. The Government should also come forward to help in procuring the pipes, either within the country or by importing.

The availability of essential materials like Cement and Steel is a pre-requisite. The State Government and the Central Government should give priority in allocating these materials required for the Urban and Rural Water Supply Programmes.

Since the investment in materials in a system of water supply and sanitation contribute to more than two thirds of the total investment, materials management offers a challenging task to the Engineer.

The materials projection based on the planned outlay and physical targets for the Decade is as follows:

Cast Iron Pipes	..	2,30,000 tonnes
Asbestos Cement Pipes	..	2,50,000 tonnes
P.V.C. Pipes	..	75,000 tonnes
Prestressed concrete/RCC Pipes		7,20,000 tonnes
G.I. Pipes	..	90,000 tonnes
Stoneware pipes	..	7,00,000 tonnes

The present rated capacity of the five cast iron manufacturing Units in the country is said to be around three lakhs tonnes/annum. Three of the Units are located in West Bengal while the other two are in Ujjaini and Bhadravati. The insufficiency of capacity is obvious when we take into account the corresponding requirements for other States in the Country as well for the decade programme. The desirability of importing ductile iron pipes as an alternate to Cast Iron Pipes is to be examined.

Regarding PVC pipes, two units are located in Tamilnadu itself. In addition several small scale units have been recognised by the Ministry of Works & Housing for manufacture of PVC pipes of small sizes. The country has in all a production capacity of 60,000 tonnes annum

The manufacturing capacity of one A.C.C. Pipe Unit at Hyderabad is around 80,000 tonnes/annum. There is also another A.C.C. Pipe Unit at Ahmedabad of about the same production capacity. One A.C.C. Pipe unit is proposed to be set up in Tamilnadu.

Availability of Prestressed/Reinforced Concrete Pipes is also evident as the manufacturing plants do not require heavy investment and the requirements of Cement and Steel are comparatively less taking into account the Country's requirements as a whole for construction.

The problem is somewhat acute in the case of Stoneware Pipes. Of the three units in our State, one is sick and the production capacities of the other two (Govt. Unit at Vridhachalam and the Private Unit at Dalmiapuram) are affected by problems of coal shortage etc., These have to be tackled. It is said that Government of Tamilnadu is formulating a blueprint for enlarging the capacity of TACEL unit at Vridhachalam. Also TWAD Board has initiated action for setting up a Stoneware Pipes Unit for which TACEL has been requested to prepare a Project Report.

Introduction of alternate materials like PVC pipes to conveyance of sewage should be taken up as a challenging task by the design engineer in-collaboration with the manufactures.

5. MANPOWER REQUIREMENTS

Manpower is a very important resource to achieve the targets of the Decade Programme.

The personnel available at present may be sufficient for the top and middle level to manage the programme for 1981-90. But the lack of trained personnel in the lower cadre is a constraint that has to be overcome. For this, the inputs to Technical Institutions have to be increased and junior level personnel should be given necessary training in technical and accounting during their recruitment.

Monitoring and evaluation of project performance should receive high priority in order to have effective and real appraisal of the project. A massive training programme for all levels of personnel should be undertaken for the successful implementation of the Decade Programme.

The manpower and training needs can be broadly classified as pre-employment training and in-service training. The total requirements of Tamilnadu are estimated at about 4000 Engineers (including Diploma holders) and about 8000 technicians.

So far as graduate and post graduate programmes are concerned there are adequate training institutions. In the case of Diploma holders, our Universities are offering part time courses in Engineering so that a Diploma holder after taking up a job, can continue his studies and go upto a Master's Degree.

There is a greater shortfall in the categories of skilled Technicians such as Drillers, Electricians, Filter Operators etc., Normally I.T.I. trained candidates are employed in these posts but in some fields as for example, Drillers and Filter Operators, there is a backlog and new training courses may have to be started.

The next aspect to consider is in service training. The Central Public Health and Environmental Engineering Organisation under the Ministry of Works and Housing, Government of India has been doing commendable work in this regard by organising refresher courses for graduate engineers and diploma holders. These courses are conducted by engineering Universities and professional bodies for two or three weeks. They are held at various centres in India and cover a particular aspect of Public Health Engineering. The TWAD Board, for example, is conducting courses on Design of Water Treatment Plants, Public Health Engineering Structures, Waste Stabilisation Pond Practices etc.

The most important aspect of in service training is job oriented training for which there is an urgent need. This may be covered by courses of 3 days or one week duration on any one aspect of the duties of the engineer or skilled work man. These are designed to give training in safe and sound working practices and planned preventive maintenance of machinery and also organising and managing labour etc.,

6. CONCLUSION

India is the first among the developing nations which has made an impressive beginning to tackle the problem immediately after the resolution by the United Nations. A rapid assessment of the situation was undertaken by the World Health Organisation with the help of Government of India for a clear picture to emerge in respect of the problems. The sector study in the field of Water Supply and Sanitation was also carried out by the State of Tamilnadu.

A Global effort to bring safe water and sanitation to all people in developing countries within the next 10 years was launched by the U.N. General Assembly on 10th November, 1980 when it adopted unanimously a resolution to that effect. The resolution proclaimed 1981-1990 as 'the International Drinking Water Supply and Sanitation Decade' and called upon member States to commit themselves to improve substantially the standards of drinking water supply and sanitation by 1990 to rid the World of water borne deseases that claim millions of lives.

It also called upon them to develop policies, set national targets, accord high priorities for water and sanitation projects and strengthen the institutions frame work for carrying out the programme. The United Nations Agencies, the United National childrens Fund, the world Health Organisation and the United Nation Development Programme-affirmed they would co-operate in making the Decade purposeful.

The Minister for Works and Housing and Parliamentary Affairs, Government of India, has pledged the country's full support to the aims of the International Decade (1981-90) for Drinking Water Supply and Sanitation launched by the United Nations on 10th November,1980. The Minister for Health Government of Tamilnadu launched the Decade Programme on 24th June,1981 and affirmed Tamilnadu's faith in fulfilment of the goal.

The general goal of the Decade is to greatly improve the water and sanitation service enjoyed by the population of the developing countries. The particular goal(ratified at the United Nations World Water Conference at Mar del Plata in 1977) is to provide all the World's population with adequate access to safe water and to hygienic latrines by 1990. The Indian goal will be to provide adequate access to reasonably safe water to all the population and easy access to sanitary toilets to sizeable portion of its population.

APPROPRIATE POLLUTION AND WATER TECHNOLOGIES FOR RURAL POPULATION

Dr. D.S. Bhargava*

The wholesome water being the nectar of life is by right the prime need of any citizen. Unfortunately, with rising standards of living and allround development, the dangers for the pollution of water resources are increasing. This problem of unsatisfactory water supply sources is becoming even more serious in the rural areas due to the several reasons, such as the following :

1. The tradition bound rural people are ignorant about the concepts of a wholesome water and still believe that their sources of water which are usually a river, pond, or groundwater (wells and hand pumps) that are generally palatable, turbidity free, and without any objectionable taste, odour, and colour etc. are still safe for drinking without any treatment as used to be the case a hundred years ago.

2. Wastes carrying the different kinds of pollutants enter the water resources are generated from several rural activities including:

   (a) modern agricultural practice in which large quantities of pesticides, herbicides and fertilizers are used which ultimately enter the water resources.

   (b) livestock and poultry.

   (c) small scale industries which have in recent times, become the status symbols for the rural areas.

   (d) domestic

   (e) mining.

3. Unsatisfactory drainage system in the rural areas which in improperly and inappropriately entering the pollutants in the rural water resources.

4. The rise in living standards in rural areas has resulted in an increased use of septic tanks and soakage pits outflows from which enters the rural water resources particularly groundwater.

5. Thus unplanned waste drainage and disposal systems cause the pollution of rural water resources, the groundwater through seepage of pollutants in particular which is drawn through the wells and hand pumps.

6. Unsatisfactory overall rural sanitation in houses, habitats, streets, fields, farms etc.

7. Poor finances of the rural areas which does not permit the proper municipal scale treatment and disposal of the various kinds of wastes generated in the rural sector.

8. Lack of knowledge in general hygiene and education relating to the pollution and their implications.

---

* Professor (Pollution Control) Division of Environmental Engg.

An appropriate pollution technology is therefore required to be evolved for the protection of water resources and pollution control for the rural areas. Such technological measures include :

1. General education of the rural population for hygiene, pollutional aspects and hazards from the various pollutants, protection of water resources, sanitation etc.

2. Measures for maintaining the public and private houses, habitats, farms, fields, streets etc., in orderly and clean sanitary conditions.

3. Good organizations formed for the maintenances of the streets in clean state and a safe disposal of the solid wastes.

4. Proper planning for the disposal of liquid wastes of the area so that the wastes do not enter the mini lakes or ponds which are used as a source of water supply in the rural areas. However, if the waste disposal in such ponds, lakes in the only alternative then the disposal outfall points should be chosen after a through analysis of the lake in respect of its self-purification (settling, biodegradation of organic wastes etc.) character, dispersion patterns of the pollutants, effects of the pollutants on the water quality, related implications etc. To aid self-purification, artificial aeration may also be done.

5. Planning or diverting the waste disposal system in such a way that the wastes outfall in the stream at such locations which are downstream of that part of the stream which is used as a water supply source of the area. For proper assimilation of the wastes and maximum utilization of stream's assimilative ability, the stream's analysis is required in respect of location and the optimal interval of the outfalls. Location of reservoirs at upstream of such rivers can be used to augment the river flow in dry months. Such time regulated discharge may also enhance the stream's self-purification ability. Modifications in the stream configurations can be made to increase its reaeration/self-purification. It should be remembered that the stream's quality speaks of the cleanliness status of the neighbouring rural area.

6. Ensuring that the wastes including the outflows from septic tanks, are not able to percolate to reach the underground water of the region where wells and hand pumps are installed. Precautions should also be taken to adequately protect the wells through the provision of covers, construction of parapet walls and making a water proof construction around the wells and hand pumps.

7. Measures should be taken for economical treatment of the wastes. Oxidation ponds or algal ponds would be ideal for rural situations. Such stored wastes can also be regulated for their release according to the flow in the river if necessary. Algae from the algal ponds can be exploited for poultry food as it is found to be a good protein source and the Chicken fed on it are known to grow faster. The effluents could be used for rechanging the groundwater in selected safe areas.

8. The obnoxious wastes orginating from the small scale industries should be seggregated and disposed off safely, or used for some recoveries or byproducts. Such industries should be advised to improve or modify their precess technologies or raw materials such as to reduce the nuisance value and volume of the wastes. They can be encouraged to at least equalize and neutralize their wastes before disposal.

9. The agriculturists should be educated about the optimal use of pesticides, herbicides, and fertilizers so that the quantities of these chemicals entering the water resources through seepage or land wash is minimized. Proper system of land drainage aids this approach. Erosion control measures should be adopted to minimize the erosion which carry the organic matter, fertilizers, pesticides, and herbicides into the water resources.

Over and above such pollution control, technology measures, it is most desired to evolve appropriate treatment of the water before use. In rural areas where economic restraints do not permit municipal scale treatment, the following technology may be appropriate :

1. The wells should be disinfected regularly to ensure a wholesome water supply. This method has been practiced for a long time, and disinfection with potassium permanganate was very common, Bleaching powder has proved to be a better disinfectant. After some laboratory tests, the optimal doses and time intervals for disinfecting the wells in each situation should be evolved for an efficient and economical disinfection. With the help of portable kits such as the chloroscope, such tests can conveniently be made in the rural sites.

2. The individual houses may collect the water in huge vases and treat the water with alum, followed by disinfection and then stirring. Quickly, within an hours time of contact, the clarified supernatant becomes wholesome for drinking. The disinfection may be done with bleaching powder or chlorine tablets which are now available commercially. The optimal doses of these chemicals may however, be determined, by simple tests, for each source of water. The containers may be cleaned periodically. The frequency of cleaning would depend on the quality of the raw water source, and may vary from few days to a month. Mini treatment basins may be constructed and the water treated thus can be suitable for community consumption in the rural sector.

3. The individual houses may disinfect their jugs of water by chlorine tablets. This however, requires a little educating the rural population.

Short film documentries may be prepared by the Films Division of India on this subject as a part of the rural education programme, and these can definately prove very useful in educating the rural population and making them conscious about the wholesome water needs as well as about the simple methods of achieving them.

CHOICE OF APPROPRIATE TECHNOLOGY FOR SANITATION IN DEVELOPING COUNTRIES

Dr. R. Guruswamy*

1. State-of-art of Sanitation in Developing Countries

1.1. Types of problem

The one underlying common factor between all the developing countries is insanitation. In sanitation, invariably is an offshoot of poverty and ignorance. With nearly 80 per cent of the people living in rural ardas and about 80% of them being illiterate, the problem of insanitation assumes serious properties. The basic problem of insanitation in developing countries is mainly due to

Sewage : The problem due to this is more of an urban nature common to cities and towns.

Sullage: This is a problem typical of rural areas.

Night Soil: Where there are no latrines, this poses a very serious problem and is typical of urban fringe areas, slums and squatter settlements and rural areas where no latrines are used.

Solid Waste: This is a typical urban problem. In villages, this problem may be well within the threshold limits. However night soil and animal dung also could be classified under this category. In such a case, this may be a major rural problem. The disposal of solid agricultural wastes is also a typically rural problem, but with the present practices in developing countries, this does not pose a serious environmental problem in most villages.

Sanitation as a problem is not yet tackled in all its seriousness in the developing countries. It still remains the prerogative of a selected group of urban communities only. Very little has been done in this regard in rural areas. The problem of sanitation/insanitation can be categorised into three groups:

1. Those of the urban poor
2. Those of the urban fringe population and
3. Those of the rural people.

1.11. Urban poor

These are mostly people who have migrated from rural areas to cities and towns in search of livelihood. They carry with them their traditions, habits and customs typical of their rural counterpart and try to fit them in an urban

---

* Assistant Professor of Public Health Engineering, Centre for Environmental Studies, College of Engineering, Guindy, Madras-600 025.

environment. But because of the limitations imposed by the urban environment, new habits and customs are evolved by the urban poor which make the problem of insanitation more complex. In fact, there is a deterioration with regard to their sanitation habits and customs. The urban poor develop a greater tolerance towards insanitation; they even develop a kinship with it, as compared to the rural poor, out of sheer necessity. The pressure of urban living being so high, it leads to the proliferation of slums and to squatter settlements. The word Slum probably stands for Sanitation Lacking, Ugliness in the Making, where the Standard of Living is Undoubtedly Minimal. The luckier of the lot get themselves accommodated in the slums and the less fortunate occupy the platforms. The growth of these settlements invariably goes unchecked and uncontrolled. The demand for water mounts and where they are in sufficient strength, they could get this demand conceded through provision of public fountains nearby. Public conveniences also come up in due course. Till then, the areas in the vicinity whether residential or business or public, bear the brunt of abuse by these people. Open defecation is the only alternative left to them and they practice it most nonchalantly. Even where there are public conveniences, the users put it to all sorts of abuse, because

(i) it does not have adequate capacity to cater to their peak hour needs.

(ii) water supply and drainage facilities are inadequate within the public convenience.

(iii) there is no proper maintenance of this latrine.

(iv) it is not conveniently located.

(v) it is a combination of one or more of the above factors.

Ignorance of the user also contributes to its abuse. Invariably these public conveniences have a limited number of seats and are of the flush-out type with connection to the street sewer. But because of abuse of this facility, the trap gets chocked, the water-seal gets lost and the latrine is soon turned into a 'miniature hell'. Flushing which is vital for the proper maintenance of these latrines is not done either due to shortage of water or due to ignorance and ultimately the so-called public convenience turns out to be a 'Public inconvenience'. Once bitten, twice shy . Similarly once misused, the misuse continues and is perpetrated. The pan becomes full, the floors are soiled and people are repelled from these latrines for further use, with the result, the outskirts of the public convenience become open yards for defecation. Thus the ambit of insanitation grows making a large area around it absolutely filthy, highly insanitary and therefore extremely dangerous. Apart from promiscuous defecation and urination, the area also collects stagnant pools of water from the taps provided inside or near the public convenience. This leads to a highly intolerant situation causing environmental degradation of an order that erodes all values of decency in human living This is unfortunately a common occurrence in and near many of the urban slum conglomerations. This can be extremely dangerous and can lead to disastrous situations. These types of public conveniences are potential centres for communicable disease explosions'. So even with a sewer system, the people of the city are not saved from the onslaught of communicable diseases.

The less said about the platform dwellers, the better. Nearly a third of the population of M[illegible]

which these 'once-rural' people are used to, dies hard. It is also not justifiable to expect these platform dwellers to defecate elsewhere. As one platform dweller put it, "where do you expect people, who are living in platforms to defecate, except in platform ? The problem is more basic and human than one of mere insanitation. Even the few public conveniences are not easily accessible to them. The result is that a substantial part of the city platforms in many areas get littered with human waste. This is thus not only a case of insanitation, but also a case of large quantities of a natural resource going waste without being ploughed back safely into the soil to fertilise it. Here again the nearby sewer system laid at a great cost lies buried bearing silent witness to the abuses going on above ground: Thus the sewer has again failed to deliver the goods to the community.

1.1.2. Urban fringe population

Invariably in most of the urban areas, the benefit of a central wastewater collection system does not extend to all its residents. Like the expanding universe, the urban areas also continue to keep expanding in all possible directions. The pace of expansion is so rapid that the facilities do not expand commensurate with it, with the result there is a long time lag. In some cases, the time lag looks almost infinite. The people living in the fringe areas are generally not that powerful, influential and vociferous but belong to the middle and the lower middle class groups which are generally law-abiding and silent. So they cannot successfully exert any pressure on the authorities concerned for the implementation of sewer systems in their areas. In some cases, in view of the cost of the system and the consequent heavy burden to be borne by these residents, they do not demand such a system but still look for alternatives. In the initial stages of development of the fringe areas, the systems they adopt for collection of wastewater, its treatment and disposal may be adequate, but with more and more of development, they invariably find that the systems in use have either failed or are not adequate, leading to dirty water stagnation, mosquito breeding and so on. Though the conditions may not be as bad as those of the city clums, conditions gradually deteriorate and tend to catch up with those around slums. With growth, the cost of land also increases in these areas with the result that certain methods of treatment and collection which were once accepted as being cheap and effective are no more so. Hence these people look for more acceptable, cheaper and sound alternatives. Most of these people are fairly literate, well informed and also quite aware of the problems of sanitation, unlike the slum and the platforms dwellers. However, the absence of an effective alternative, in their opinion, is what is landing them into serious difficulties.

1.1.3. Rural People

In spite of the mammoth growth of our cities and towns, still about 80% of the people continue to live in rural areas. The sanitary conditions in most of the rural areas seems to be generally better than those that prevail in the urban fringes and the urban slums. However, motivation with respect to sanitation is very poor among the rural folks. Sanitation, as we understand to-day, is generally viewed as an alien cult, by these people. Their views on sanitation are

conditioned by their own beliefs and disbeliefs, their traditions, customs, habits and their way of living. In very samll villages, the prohlem of insanitation may not be very apparent or obvious in view of the large space available and the small quantities of wastes including wastewater generated. Still, insanitation as a problem of concern particularly with respect to the health of the people is very much present even in such villages. Open defecation is a tradition handed over from generations and the land which these people till is invariably the receptacle for their waste. This leads to soil pollution. The incidence of hookworm infection is very high in such cases. Roughly more than 70% of the rural people in India are said to be infected with hookworm. The same may be true in slightly varying degrees with respect to the other countries of the region. Besides hookworm, these people also suffer from many forms of water-related and other faecal-borne diseases as well. Sanitation as a way of life is not accorded any priority by these people. Their problems are more basic and sanitation is an unwanted luxury for many. In fact, many of them are prejudiced against the use of latrines. This prejudice is born more out of their experience of having seen or used an ill-maintained public convenience in a city or town which they had visited. This prejudice is deep rooted and unerasable. According to them 'they know to live better, healthier and happier than their urban counterpart'. In fact, they attribute many of the evils of urban living to their 'latrine habit'. This may look strange, but it is true. With regard to wastewater, it is not a problem in many rural areas. The quantity of water used by the rural people is so small, that whatever wastewater is produced is absorbed by the soil over which it is allowed to flow through. The wastewater produced is only sullage, since they do not have latrines and invariably this water is used for gardening purposes'. But of course, with improvement in water supply amenities, the problem may become different. More of sullage water may be produced which will overflow the soil and remain as stagnant pools of water leading to all associated problems. Then it may be more relevant to take up appropriate measures to tackle this problem. However, the villager is not going to be concerned with that. His problem stops with the production of wastewater. He no more bestows any attention as to what happens to it thereafter. He cannot also relate it to the diseases, which he may suffer from as a result of wastewater stagnation. And even where he can, he learns to live with it. He is resigned to his fate. Even where he is aware of the problem and is really concerned, his socio-economic condition is such that he cannot afford to spend any money to improve the situation. By and large, the rural man is poor, ignorant and illiterate. He is also unfortunately prejudiced in matters of sanitation. He may have nothing against a sewer system to be provided for his village, but he is not really interested and therefore is not going to pay for it. It is not only a question of unwillingness on his part, but also a question of his incapacity to pay. Under such a situation, a sewer system for a village is ruled out. But basically any system of sanitation for a village with regard to wastewater will involve some change in the habits and customs of the rural man. Yes . he has to use a latrine first. That means he must be motivated to use a latrine and become latrine-conscious, which is the first step towards making him sanitary conscious. A type of latrine that will suit him, that will involve minimum departure from his customs and habits, that will be acceptable to him and that which will not pinch his purse, therefore, is to be suggested, if available, or developed, if not available.

1.2. Need for Alternative Technology for Sanitation

The problem of sanitation is not confined to the problem of wastewater alone. It is also associated with solid and other wastes generated by a community. However, the quantity and the nature of the wastewater being such, among the several other problems of sanitation, it occupies a place of importance. Regarding solid wastes, we know that this is a very acute urban problem and not such a serious rural problem. But if night soil is to be classified under this category, then this becomes the most acute problem of the villages. These problems need to be tackled carefully using appropriate technological alternatives. For a large town, it could be planned a little more extensively and elaborately and for a small town and a village, not that elaborately. However, in all these cases, protecting the community from the hazards of instanitation taking the background of its people and recovering whatever is economically feasible, (fertilisers biogas, etc.) from these wastes should be given consideration. Where there is scope for recovery and reuse at a reasonable cost, it could be resorted to, all within the sonstraints prevalent in the region; otherwise safe disposal will suffice. The willingness and readiness of the people of the community to reuse the waste must also be ensured before the relevant technology is applied. Simple thrusting a technology on an unwilling user does not produce the desirable result.

The problem of sanitation has thus several dimensions. It is not only the cost which is an important factor, but motivation and acceptance by people which are equally important. The well-informed urban people are prepared to accept sanitation as a way of life but even then they would like the cost of the system to be well within their means. They expect the system to offer them convnience and save them from unaesthetic conditions and health hazards arising out of insanitation. They in fact demand better, cheaper and more acceptable sanitation alternatives. The urban poor on the other hand may not be averse to sanitation as such but because of the many pressures and tensions mounting up and because of their past habits and customs, would continue to defile and live amidst filth and squalour and may not appreciate any efforts in the difection of improving their environment until and unless their basic demands of food, clothing and shelter are met. The urban fringe dwellers on the other hand demand a sanitary system alternative that may not be as costly as a sewer system, but will be cheaper and quite effective from the point of view of sanitation, their problem being one of incapacity to pay heavily towards sanitary amenities even though they are a motivated lot. For the rural man who is steeped in poverty and ignorance, sanitation has no priority and latrines have no relevance. For him, living is a problem. Hence the same kind of approach adopted in the case of the urban man cannot solve the problems of the rural people. Different technologies have to be adopted under different situations to cater to the needs of these people with varying background and thinking. This involves application of alternative technologies that are appropriate not only to a region but also within a region to different communities with different socio-economic and educational background levels.

2. The Magnitude of the Problem

The International Drinking Water Supply and Sanitation Decade 1981-1990 has been launched. It aims at 'Water for All' by 1990 and assigns high priority for Water Supply and

Sanitation. Its original target of 100% Water Supply and Sanitation was considered rather Topian and hence this has been modified slightly by different countries to make it more pragmatic.

The cost of sanitation for India is estimated to be Rs. 36,860 millions for urban sanitation and Rs.67,790 millions for rural sanitation. The target for India is 100% for Water Supply, both Urban and Rural, 80% for Urban Sanitation and 25% for Rural Sanitation. Even with this revised target, the cost of realising the Decade objective is quite enormous. To-day some 1.1 billion people in developing countries lack sewerage and in 1990, this number is likely to grow to 2.0 billions. All these people will have to be provided with sanitary amenities by the end of the Decade.

On a global level, based on very general estimates available, it is said that the cost of providing water for All will be about 60 billion dollars and that for sewerage 300 to 600 billion dollars. The cost involved is very high and on a per capita basis, it works out to 150 to 650 dollars. This is far beyond the capacity of most of the beneficiaries to pay. Particularly for those in developing countries, this is more so. Hence, there should be some means by which this cost is to be brought down. This is possible to a great extent by introducing alternative technologies in place of traditional technologies. The decade programme is drawn fully aware of this fact. That is why the programme does not mention how exactly the Decade objective is to be achieved. The option is left to the countries and the technologists.

3. Limitations of Conventional Sewerage

The present method of wastewater collection through sewers is a very costly one. This system of course was not developed overnight. This was developed over a period of about 100 years by slowly changing, improving and correcting the then existing systems. With the introduction of piped water supply sustems, the idea of carrying the wastewater through pipe lines also gained currency. This was subsequently followed by the elaborate, now well known treatment systems. To-day we have a range of options for treatment to achieve the desired degree of sanitation improvement. Unfortunately the waterborne sewerage has proved to be technically, economically and culturally not suitable for many cities and communities in the developing world. This system needs enormous water, and the cost of collection, treatment and discharge is also very high. It is therefore suitable for high density, high water consumption areas. The main technical constraints with regard to the sewer system are :

- its large water requirements
- difficulty of excavation in very dense areas or those with poor ground conditions
- problems of laying sewers in fairly straight lines through areas of unplanned growth
- susceptibility of pipes to corrosion in hot climates

- blockage and extra maintenance problems in the early years

- Environmental hazard created by point discharge of large volumes of wastewater.

Some have already raised the question as to whether it is wise to use fresh water which itself is a rare commodity in many places just for this most nonproductive purpose of carrying the night soil away from the community. Yet another question is whether we are justified in polluting large quantities of fresh water by using it for flushing the solids, conveying them through sewers and then spending enormous time, energy and money separating the solids from the liquid before its safe discharge into a water course. In the light of the above doubts, there is a great need for reexamination of the desirability of a water-borne sewer system. Water-borne sewerage has been designed to satisfy convenience and local environmental, rather than health requirements. Many less costly alternatives formerly used have been abandoned as a result of the introduction of sewer systems. There is a now a greater need to study and improve them. Very few attempts have been made in this direction, towards design and implementation of low-cost sanitation technologies: In this context, we have to remember that sewerage is not designed to maximise health benefits. It is also not an optimal environmental solution. There is therefore, a need for appropriate sanitation technologies, particularly for developing countries. At the same time, the principles of sanitation should not be a given a 'go by' in the name of providing a cheaper alternative.

4. Choice of Appropriate Technology for Sanitation

In the choice of appropriate technology for sanitation, the following factors should be considered:

1. The present bias in favour of sewerage should be overcome

2. The technological options available should be thoroughly and critically examined

3. The many technologies available between the unimproved pit privy and sewerage should be identified and recommended for wide scale application depending upon their suitability for a particular situation.

4. Improved designs of the above system now not so much in use should be made.

5. In scattered rural and urban communities, more than one technically feasible option, each with a range of design alternatives could be used.

6. Sanitation sequence could be practised (i.e.) the community can initially select one of the low-cost technologies and as their socio-economic status improves, it can be upgraded in a known series of improvements to a sophisticated 'final' solution. This flexibility is absent in the case of conventional sewerage, since its initial cost itself is very high.

7. It should result in the reduction of non-economical water use.

8. The technology chosen should maximise health benefits achieved with the funds available.

9. A multidisciplinary team including sociologists should be used from the first phase of planning and demand analysis through the final phases of technology selection and detailed design.

10. The user should be involved in the selection process.

11. Different institutional arrangement for implementing these technologies than those appropriate for sewerage is required.

12. Government should subsidise those technologies that promote the goal of health improvement and good personal hygiene habits and not stick to outmoded priorities and precedents.

5. Alternative Technologies Available

A few examples of alternative technologies that are appropriate to developing countries are :

House hold sanitation technologies

1. Improved pit latrines
   (Ventilated Improved Pit - VIP)
   (Read Odourless Earth Closet - ROEC)

2. Pour-flush latrines (PF toilets)
   (Sewered PF needs off-site facilities for treatment of sewrage).
   Needs user education programme

3. Composting toilets (can be used in areas where there is a demand for reuse)
   continuous composter: and
   Double-Vault composting (DVC) toilets.

4. Aqua privies

5. Modified septic tanks

Community Sanitation Technologies

1. Bucket latrines

2. Vault privies with Japanese type vacuum Cartage (Off-site facilities needed)

3. Communal facilities

4. Sewerage (Off-site facilities needed)

PF toilets are feasible where water is required for ablution. If water used exceeds 50 lpcd, then sewerte PF toilets are possible. Soil condition, housing density, the habit of people(particularly the user hygiene habit), availability of water, space and cost decide the type of latrine. Where there is house connection for water supply,

cistern-flush toilets and conventional sewerage are possible. The only technology, the introduction of which into new sites should be avoided is the bucket latrine.

The approximate cost of alternative technologies are presented below : (The base year for the cost is 1978).

APPROXIMATE COST OF ALTERNATIVE TECHNOLOGIES

Type of System	Cost per household per year (Including Capital and Recurring Costs) in Rs.
1. Improved pit latrines, composting toilets and pour-flush toilets	200-700
2. Aqua privy and Japanese type vacuum cartage	1500-2000
3. Septic tank	Rs. 3500
4. Sewerage	Rs. 4000

The cost of the cheapest to that of the costliest system, is approximately 1 : 20.

6. Conclusion

In the context of the above, it is apparent that any technology that is imported from the West where conditions and values are different, will have little relevance to the situation prevailing in he Developing Countries. The concept of convenience and the habits and customs have been different in the West. The sewer system as we know now, has been developed by them due to exigencies of situations prevailing then and the need for better convenience, but the cost factor has not been of any great consideration in its development. Even in the West to-day, there is a growing feeling that the environmental cost of the sewer system is pretty high and there is a need to develop an alternative technology for a sewer system. When that is the case, the need for such alternative technology is even greater in the developing countries, particularly of the east, where because of the tropical climate, instanitation can play a greater havoc. And with the varying background of the urban elite, the urban poor, the suburban dwellers and the rural folk, different forms of appropriate technologies to suit each category of people need to be evolved. An appropriate alternative for a region has to be developed by the region itself and should not be imported from another area which has nothing in common with the region under consideration. The need for such technologies is never more keenly felt than now when we have ushered in the International Drinking Water Supply and Sanitation Decade.

LOW COST SANITATION PROGRAMME IN TAMILNADU

* ** Er. George Mathew and Er. T. Ramchandran

(a) Introduction :

A convenient supply of safe water and sanitary disposal of human wastes are essential ingredients of a healthy productive life. Water that is not safe for human consumption can spread disease, water that is not conveniently located results in the loss of productive time and energy by the water carrier and inadequate facilities for excreta disposal reduce the potential benefits of a safe water supply by transmitting pathogens from infected to healthy persons. Coupled with man-nutrition, these excreta related diseases take a dreadful toll in developing countries, especially, among children. Invariably, it is the poor, who suffer the most from the absence of water ans sanitation, because they lack not only the means to provide for the necessary facilities, but also information on how to minimize the ill effects of the insanitary conditions in which they live.

Thus, provision of protected drinking water supply along will not give the desired health benefits to a community unless a sewerage system is also implemented along with water supply. However, due to constraint in the available resources in our country, it has been decided that during the International Drinking Water Supply and Sanitation Decate (1981-90), all class I cities (with a population of 100,000 and above) will be provided with sewerage and sewage treatment facilities and about 50% of Class II and other cities (with a population of less than 100,000) will be provided with Sewerage and other economically safe and sanitary methods of disposal of human waste so as to have a total coverage of 80% in urban sanitation as of March, 1991.

In India, the programme of construction of low cost pour flush water seal latrine is being implemented through a number of organisations, with the result that there have been some variations in the design and specifications of such latrine systems. Based on the past studies and experience gained by various institutions, such latrine systems could be standardised and optimum requirements could be specified taking into account the cost, the social and cultural habits, pollution aspects and technical feasibility.

Some of the important technical design requirements of the water seal pour flush latrine with leaching pits finalised by the UNDP Global Project are furnished in Annex 1.

---

* Chief Engineer, Project Formulation, Tamil Nadu Water Supply and Drainage Board, Madras-5.

** Superintending Engineer, (World Bank Schemes Appraisal), Tamil Nadu Water Supply & Drainage Board, Madras-5.

b) Demonstration Units :-

The Government of Tamil Nadu, in co-ordination with the UNDP Global Project have selected 15 towns during 1981-82 for constructing 50 demonstration units (water seal latrines) in each of the towns. The list of towns selected is given in Annex 2. The construction of these water seal latrines has been taken up by the local bodies themselves and is nearing completion. The cost of construction of each unit (without superstructure) is Rs. 500 in the case of all towns except the hill station of Kodaikanal where the cost of each unit is reported to be Rs. 575. The costs of these units have been deposited by the beneficiaries with the local bodies and the construction work has been done by the local bodies.

c) Scavenger Free Town :-

Recently the Government of India had announced that 50% of the estimated cost of conversion of dry type latrines into water seal latrines in a selected town in a State will be given as grant to make the town "Scavenger Free". Udumalpet town in Coimbatore District has been selected and a detailed Project Report for Providing "Low Cost Sanitation" facilities for this town has been prepared at an estimated cost of Rs. 1.16 crores. 50% of the cost of the Project will be released as grant by the Government of India and the balance 50% will be met by the Government of Tamil Nadu. The construction period for the Project will be 3½ years. The Project has been taken up for implementation during 1981-82 and will be completed during 1984-85.

d) Low Cost Sanitation programme with World Bank Assistance :-

The UNDP Global Project on Low Cost Sanitation established by the World Bank was requested by the Government of India to prepare a Master Plan Report including preliminary Engineering and Feasibility Studies for providing Low Cost Sanitation facilities for 110 towns in seven States in India including Tamilnadu. A Master Plan Report for the 15 towns in Tamilnadu where construction of demonstration units is nearing completion has been prepared by the UNDP Global Project after studying in detail, the various aspects such as Socio-economic conditions of the people, geological, geohydrological and physical conditions etc.,

The Project prepared by the UNDP Global Project on Low Cost Sanitation comprises two stages. The first stage is proposed to be implemented during 1982-86 and will provide a total coverage of 48% of the population in these 15 towns and the second state to be implemented in 1986-91 will cover 100% of the population. The cost of the first stage is estimated to be Rs. 63 million (as of December 1980 prices) and that of the second stage is about Rs. 97 million. In total, 93,701 new pour flush household water seal latrines will be provided. 28,423 highly insanitary existing dry latrines will be converted to water seal latrines and nearly 4,352 new water seal community latrines will be made available benefitting a total population of 7.5 million.

The first stage of the above project has been included in the "Tamil Nadu Water Supply and Sanitation Project" proposed to be taken up with World Bank Loan Assistance. The project is expected to be taken up for implementation during 1983-84 and the total construction

The first stage contemplates conversion of 28,423 dry type latrines into waterseal latrines, construction of 20,426 new waterseal latrines and 1,562 community latrines.

The unit cost of the household latrines ranges from Rs. 569 to Rs. 1,735. If new superstructur is also provided, an additional amount of Rs. 452 to Rs. 724 will have to be provided. Individual households will receive between 0 and 75% of the cost as subsidy, the proportion depending upon the affordability. The overall subsidy element of the programme is 56%. The balance will be recovered at 9.5% interest over 25 years. Monthly payments range from Rs. 1.15 to Rs. 21.55 with more than 71% having to pay Rs. 5; another 23% in the range of Rs. 5/- to Rs. 10/- . The programme of execution will be undertaken by the respective municipalities with special engineering cells created under the overall supervision of the State Level Low Cost Sanitation Unit (LOSANU) formed with the full-time senior representatives of the TWAD Board, Research-cum-Action Project, Poonamallee, Madras and the Directorate of Municipal Administration.

The Project will be supported by substantial promotion and health education activities mounted by the municipalities and Low Cost Sanitation Unit (LOSANU). A special State Level Unit will be created with senior representatives of the principal organisations viz., TWAD Board, Directorate of Municipal Administration and Research-cum-Action Project for monitoring the work. Even though certain legislative changes are desirable to support the project, they are not critical to the project.

Choice of Technology :-

Stage I of the Project will concentrate on provision of waterseal latrines in the 15 towns; but in the course of this stage, other alternatives will also be piloted in areas, where hydrogeological or social considerations indicate that water seal units would be inappropriate.

The flush latrines consist of a white glazed ceramic or a fibre glass reinforced polyster plastic (FRP) pan with 20 mm water seal. After use, it is flushed by hand using a small container holding about 2 litres of water. The excreta is carried into two underground leaching pits consturcted in the house compound or if space is not available under the adjacent footpath or road. These pits are constructed of honeycomb brick work so as to allow the liquid in the pits to percolate into the adjoining soil, leaving the solids behind. The pits are used alternatively, each pit lasting for about 3 years. When the pit is full, it is then taken out of use and the excreta directed to the second pit. When the filled pit has been left for about 2 years, the contents will be converted into a rich humus, which is free of pathogens. When convenient, it is emptied and contents used as manure. It is then ready for reuse again when the second pit becomes full.

Implementation :-

The Project will be implemented by special cells created in the municipalities (Engineers deputed by TWAD Board) supervised by the newly created seperate State Level Low Cost Sanitation Unit (LOSANU) with 3 senior representatives from the responsible organisations viz., TWAD Board, Directorate of Municipal Administration and Research-cum-Action Project. The financial monitoring cell will be

economic execution of the Project, a State Direction Committee is proposed. The LOSANU which is the Unit at the State level will be incharge of preparation of overall and detailed budgets, channeling funds, preparation of standard designs, guidelines for the designs, general technical guidance to the project, central procurement of scarce materials, estimating annually the cost, type of latrines installations, conducting training courses, overall performance, developing details for plans for Stage II of the project and making alternative arrangements for implementation, if any of the municipality fails to undertake or implement the project satisfactorily. One Superintending Engineer of TWAD Board with 2 Executive Engineers and 5 Assistant Executive Engineers will supervise and monitor the work at the Engineering cells constituted in each of the municipality. The Deputy Director of Health Services with the help of Sociologist and Health Educator will monitor training, motivation and sociological aspects including the production and development of necessary media. The special cells in the municipality will be responsible for preparing detailed programme of the work, identifying the number of households or community latrines, redeipt and disbursement of loans and grants for LOSANU, licensing local contractors, execution of the programme, recovery of loans from beneficiaries and making repayments to LOSANU, operation and maintenance of community latrines, emptying the household latrines on request, marketing humus and providing any service required for the maintenance of private latrines.

Cost Estimates :-

The Project cost comprises the following :-

basic cost, physical contingencies, engineering costs and price contingencies. 15% has been adopted as physical contingencies in the hilly areas of Coonoor, Kodaikanal and Thanjavur and 20% in the case of Attur, where the roads and lanes are of cement concrete. For other towns, only 10% is provided as physical contingencies. Engineering cost at 12.5% have been provided for. Basic costs have been calculated at December 1980 prices. In order to allow for price increases during the implementation period, the following percentages of escalation have been adopted for capital works, while a uniform annual rate of increase of 7% has been adopted for operation and maintenance costs.

1980-81	...	15%
1981-82	...	9%
1982-83	...	8.5%
1983-84 to 85-86		7.5%
1986-87 & beyond		6%

The total costs of the project for Stage I and Stage II works out to Rs. 83 million and Rs. 161 million respectively at current prices.

Plan Provision :-

A provision of Rs. 30 million is made towards Low Cost Sanitation in the last two years of the VIth Five Year Plan (ie.) 1983-84 and 1984-85.

Financing Pattern :-

It is suggested that a combination of grant and a long term loan within the affordability of the people is essential for the successful implementation of the programme. Householders are proposed to be categorised into 3, depending upon their access to the 3 basic utilities viz., electricity, water and dry latrines. The grant element for individuals having any two or all the facilities viz., electricity, water connections and dry latrines will be zero, whereas if anyone of these 3 facilities is available, the grant element will be 50% and if none of the 3 facilities is available, the grant element will be 75%. In the case of community latrines, the grant is 100%, which will be given to the local bodies. Based on the above, the total grant needed for Stage I of the project works out to Rs. 24 million out of the total project cost of Rs. 64 million (1980) prices) and the grant element for Stage II will be Rs. 66 million out of the total project cost of Rs. 97 million (1980 prices).

It is suggested that the monthly recovery towards the loan will be collected from the beneficiaries after the latrine is constructed without allowing any moratorium period. The calculations furnished in the report show that monthly instalments varies from Rs. 1.30 to Rs. 18 with more than 71% paying less than Rs. 5 per month and another 23% in the range of Rs. 5 to Rs. 10 falling broadly within 1% to 1.5% of the monthly family income and also within the reasonable or affordable limits. The municipality will be responsible for the recovery of the loan instalment as a charge to be collected as a first charge along with house tax, water tax, water charges and other taxes at quarterly or half yearly intervals or whatever is the existing system.

Community latrines :-

Nearly 10% of the households cannot be provided with individual household latrines due to constraints of space. They will have to be necessarily served by community latrines. In view of the slender municipal resources, it is recommended in the project that 100% of the capital cost of the community latrines and at least 50% of the recurring costs of the community latrines be given as subsidy to the municipalities.

The overall cost of the Project at December 1980 prices is worked out to Rs. 161 million with 56% grant element as detailed below :

	Stage I		Stage II		Total	
	Loan	Grant	Loan	Grant	Loan	Grant
	(.....Rs. Million .....)					
Individual latrines	40	18	31	55	71	73
Community latrines	..	6	..	11	..	17

Operation and Maintenance :-

The individual latrines will be maintained by the householders. The diversion of the discharge from the first pit to the second pit can also be done by the householders. Only the emptying of the pits will have to be done by the local body through local contractors. The cost of the service at 1980 prices is estimated to be Rs. 25 per cubic metre inclusive of transport and storage. It is expected that this cost can break even with the cost of the humus.

e) Pollution Aspects :-

One of the important aspects of on-site excreta disposal as envisaged in the low cost sanitation programme is pollution of the ground water and piped water supplies located close to the disposal pits. The fundamental requirement for prevention of pollution of both surface and ground water will call for a proper design and construction of the latrines in such a way that under no circumstances, there will be any water logging around the latrine or ponding of the pit will happen due to over flow of pit contents.

Ground water pollution by on-site excreta disposal system depends on the nature of occurence of ground water. Ground water occurs inaquifers which are classified as either confined or unconfined.

When water is drawn from confined aquifers which are relatively deep, on-site excreta disposal poses no pollution hazard provided the well construction is carried out properly to preclude direct flow from unconfined zones and sanitarily protected to prevent surface contamination. Under these conditions the main concern is the water distribution system which can well be taken care of by ensuring certain minimum distance between pit and distribution pipes, and protecting vulnerable sections from external contaminations.

The unconfined and marginally confined aquifers are the main concern from the point of view of pollution hazard. Here, two situations are met with, viz., i) where the pit is located entirely in the unsaturated zone and (ii) where the pit is located partly in the unsaturated zone and partly in the saturated zone. The studies carried out in USA, India and elsewhere have shown that in alluvial soil (with predominance of silt mixed with clay and fine sand) where pits are located in the unsaturated zone, the risk of bacterial pollution is minimal provided the bottom of the pit is at least 2 metres above the maximum ground water level and the hydraulic loading in pits does not exceed 50 mm/day. Where the pit extends in the saturated zone, the pollution travel depends mainly on the velocity of ground water. In alluvial soil, the distance of pollution travel is equivalent to about 10 days travel of ground water. The velocity can be found out for different soil conditions. It was also observed that with the continued usage of the pit, clogging of the soil around the pit takes place resulting in the regression of pollution plume which ultimately stabilises at about 1 metre distance.

These studies clearly indicate that in continuous unsaturated/unconsolidated strata greater than 2 metre depth (with size of soil < 1 mm) beneath the base of the latrine, the risk of ground water pollution due to faecal contamination would be minimal, provided the hydraulic loading in the pit does not exceed 50 mm/day.

The recent observations carried out by the Technology Advisory Group (TAG) in Gujrat, Tamil Nadu and Bihar States in India seem to be in conformity with the foregoing statement.

Very little field work has been carried out on the travel of viral pollution of ground water with reference to on-site excreta disposal. But, some laboratory studies on this aspect have indicated that the viral pollution is reduced if adequate interposing soil layer exists and the hydraulic loading is also limited to 50 mm/day.

Among the chemical pollutants arising from the leaching pits, 'nitrate' is significant. The transport of nitrate through the soil and ultimately reaching the ground water and rising to levels to pose a health risk is dependent on several factors like back ground levels of nitrates, extent of aerobic activity, dilution etc. Periodical monitoring of ground water thus becomes important.

Proper information/investigation of hydrogeological conditions of the sites where the pits are to be located are pre-requisites for the implementation of the programme in order that the pollution risk to ground water and water distribution pipes is minimal. Even in unfavourable hydrogeological conditions such as coarse soil, high ground water velocity and high water table, these systems can be used provided certain modifications and precautions are taken, such as providing an envelope of fine sand of average size not more than 0.2 mm and a minimum thickness of 500 mm all round and the bottom scaled off by any impervious material such as fine clay, puddle clay or polythene sheet. If fine sand is not available, whatever coarse material is available may be sieved through a sieve of 0.597 mm (30 meshes to a inch) and the material passing through is used while the coarser material retained on the sieve is discarded. These modifications are also applicable where soil beneath the pit is less than 2 m to water table. In high water table conditions, the inlet to the pit should be kept at least one metre above the maximum ground water level. This condition may necessitate raising of the latrine floor.

In conditions such as rock with fissures, chalk formations, old root channels, pollution can flow to very long distances. These conditions demand careful investigations and necessary modifications of the system of adoption of alternative sanitary system.

It is desirable to periodically monitor the quality of the ground water in the area where the programme is implemented. The monitoring programme should cover periodical sampling of ground water and analysis for at least faecal coliforms and nitrate.

Annex 1.

Important technical design requirements of waterseal pour flush latrines

Item		Optimum Requirements
a) Latrine Chamber Size	...	750 mm x 900 mm
b) Latrine Pan :		
i) Top opening	...	125 mm
ii) Harizontal length	...	425 mm
iii) Material	...	Ceramic, Porcelain FRP, PVC
c) Water Seal Tra.		
i) Depth of water Seal	...	20 mm
ii) Dia of water seal	...	70 mm
iii) Material	...	Ceramic Porcelain FRP, PVC
d) Connecting Pipe		
i) Material		Stoneware, Concrete, AC, PVC, Burnt Clay Pipes, Channel in brick work.
ii) Size of pipe	...	75 mm.
iii) Size of Channel	...	115 mm x 75 mm
iv) Slope	...	1 in 10
e) Inspection or Junction Chamber		
i) Size	...	250 mm x 250 mm
ii) Cover	...	Removable concrete
f) Leaching Pit		
i) Shape	...	Circular
ii) Size (5 users)	...	900 mm diameter
iii) Minimumeffective depth	...	1,000 mm
iv) No. of years of Service	...	3
v) Minimum spacing of pits	...	Effective depth
vi) Emptying of pit	...	2 years after pit is taken out of service.
g) Lining of interior of Pit	...	Honey combed brick work in Cement mortar, burnt clay rings, laterite brick and others.

Annex 1 (Contd.)

Item		Optimum requirements
h) Pit cover Material	...	R.C.C., Stone Slab, Wooden blanks etc.,
i) Latrine flooring	...	Smooth, impervious and durable.
j) Foot rest		
i) Size	...	250 mm x 150 mm
ii) Thickness	...	25 mm above floor level
k) Superstructure	...	Brick work or concrete.
l) Water requrements	...	3 litres per use (5 litres/cap/day).

Annex 2

List of towns included under World Bank Project for provision of Low Cost Sanitation facilities.

Sl. No.	Name of Town	District	1981 population
1.	Thanjavur	Thanjavur	1,83,464
2.	Pollachi	Coimbatore	82,115
3.	Ambur	North Arcot	66,026
4.	Chengalpattu	Chengalpattu	47,324
5.	Panruti	South Arcot	43,036
6.	Attur	Salem	50,537
7.	Coonoor	Nilgiris	44,750
8.	Theni-Allinagaram	Madurai	53,023
9.	Pattukottai	Thanjavur	49,484
10.	Sirkali	Thanjavur	25,508
11.	Tenkasi	Tirunelveli	49,214
12.	Gobichettipalayam	Periyar	43,846
13.	Thuraiyur	Tiruchy	23,599
14.	Kodaikanal	Madurai	20,451
15.	Aranthangi	Pudukottai	23,227

RURAL SANITATION - A CASE STUDY

R. Guruswamy*
R. Desigavinayagom Pillai** and
S. Sundaramoorthy

A case study on rural sanitation at Nilakkottai, a major Panchayat in Madurai district of Tamilnadu State was undertaken by the authors along with a group of participants of a regional course on Project Formulation and Appraisal in Water Supply and Sanitation sponsored by CPHEEO/WHO and EDI and conducted by the Centre for Environmental Studies, Anna University, Madras during February-March 1982 and a summary of the report based on the above studies is presented in this article. The report is based on a rapid random survey conducted by the group at Nilakkottai as a supplement to the detailed house to house survey conducted earlier by the Gandhigram Rural Institute, a Deemed University about 40 km away from Nilakkottai.

The objective of the present study was

1. to study the magnitude of the problem of environmental sanitation due to indiscriminate defecation
2. to ascertain the resistance of the community for acceptance of latrines in rural areas and
3. to develop effective educational methods for helping the people to accept, use and maintain sanitary latrines
4. to suggest more acceptable designs and methods for the construction of sanitary rural latrines for the town and
5. To suggest a feasible work programme

State of Art of Sanitation at Nilakkottai

The population of Nilakkottai, as per the 1981 census, is 11,917 of which about 246 have entered the portals of a college, about 3512 have studied upto the secondary school level 2710 upto the elementary school level, the rest being illiterates. The people are predominantly engaged in business, weaving, manufacture and sale of brass utensils, agriculture, government service etc. This town being a business centre, attracts people from the neighbouring villages, particularly during Sundays where the weekly shandy is held. The people are generally poor. The town has a protected water supply system, the average supply rate being

---

* Assistant Professor of Public Health Engineering, College of Engineering, Anna University Madras.

** Formerly Dean, Gandhigram Rural Institute, Gandhigram

*** Superintending Engineer, MMWSSB, Madras.

about 22.5 litres/c/day. There are 12 open wells, 12 bore wells and some private wells supplementing the water supply to the town. Because of inadequate supply of water, the effect of protected water supply in eliminating water-borne diseases could not be felt. The wastewater produced by the community is presently collected in unlined open drain and discharged at several points in a lake located in the outskirts of the town, the drains themselves acting as latrines in many places. The lake water used for bathing and washing purposes is thus heavily polluted and no notice is taken care of by the local people. There are four refuse carts available in the town for transportation of refuse to the disposal site. 50% of the refuse produced alone is cleared everyday and the refuse so collected and transported is composted in a very unscientific manner. The weekly market generates large quantities of garbage which are never cleared but only dumped in one corner of the market itself, resulting in vector breeding. The market attracts about 20,000 people but has no organised public convenience system worth the name. Drinking water is being sold at 5 paise/cup. The latrine facilities in the town are also not adequate and the details of latrines available in the town are as follows:

Number of septic tank latrines	9
Porcelain flush type latrines	26
RCAP type latrines	337
Service type latrines	43
Public latrines	22
Cess pools	16

All road sides and open spaces in the town are used for open defecation. All public places including cinema theatres, hospitals, bus stand, schools etc., are extremely insanitary and emanate intolerable stench of urine. The latrine facilities in the schools are very inadequate, but the students and the staff who were interviewed by the sanitation group were found to be well motivated and inclined to have latrines. The latrine acceptance was particularly strong from students belonging to the higher, upper middle and middle income groups and teachers whose literary level was high. Many students pleaded that they would like to have sanitary latrines, but their parents could not afford to spend money for it. For a theatre of capacity 600, there are only 8 urinals, 4 latrine seats and two water tanks with two taps each. There are about 12 big hotels (with more than 25 users each) and 30 small eating places (with less than 25 users each) catering to the needs of the people. The sanitation of the kitchen, of the plates and cups and the seating arrangements are far from satisfactory, not to speak of the sanitation of the food handlers! There is a bus stand being used by about 3000 people daily with no sanitary public conveniences. Community latrines with 4 seats and with no urinals are being used (or rather misused!) One is naturally driven to open defecation rather than using these facilities. A slaughter house with a capacity of 12 goats/day produces wastes which are indiscriminately disposed off and the air and the area around are heavily polluted. It poses a great threat to the well-being of the people nearby. There is a hospital with 32 beds actually accommodating about 70 inpatients. There are 6 latrine seats, 4 baths and 2 urinals and a septic tank. About 20 people per day are being treated as outpatients. A total number of 6000 people are being treated annually and that 80% of them are suffering from one disease or other arising out of poor environmental sanitation and malnutrition. The irony is that while

inpatients are provided with some public convenience facility, the doctors and staff are compelled to go without any such facility ! In short the present level of sanitation at Nilakkottai is not satisfactory at all. This probably reflects the condition prevalent elsewhere also in the country. Sanitary collection and disposal of human excreta was studied in depth, since this problem was considered to be of utmost priority among the several sanitation problems of the town.

Health Education and Motivation

The suggested methodology for motivating people to accept the programme of sanitation through health education is as follows : It is suggested that the services of the available local agencies such as the taluk level personnel of the Directorate of Health Services, the ladies association, the primary and secondary school teachers, the social and voluntary organisations such as Lions club, rotary club, cine fan's association, Jaycees etc., the sanitary inspector and the maistries of the town panchayat, the personnel available with the Integrated child development centre and the Research-cum Action Project (RCAP) Centre at Dindigal and the extension service of the Gandhigram Rural Institute must be used for this purpose. The programme should be taken up at the three categories of population, namely, the school students, the women and the general public. The executive officer of the town panchayat could act as the co-ordinator and officer in-Charge of this support project. All the works from the above agencies could be given an orientation training to successfully implement the health programmes. The Gandhigram Rural Institute has the training facilities in this field and this institute could be in charge of the training and orientation programme. The programme will consist of issuing handouts and handbills, flash cards and slides giving pictorial as well as descriptive materials highlighting the advantages of sanitation and the harmful effects of the present sanitary habits of the people, and depicting the values of sanitation and healthful living and arranging for the projection of short films and film serials, puppet shows, hoardings etc., and by conducting periodical meetings in schools, women's association, in bazaars during festivals and carnivals. A question and answer session will form part of this campagin. Demonstration of construction of latrines will be arranged and their use explained. People who come forward to construct their own latrines will be honoured publicly. The above programme will be designed to create awareness and educate the public about good sanitation habits and the new sanitation programme. The public will be provided opportunities to try, evaluate and accept latrines as means of better sanitation for the community. This programme will involve training for health workers. 25 workers from all the institutions referred to above are proposed to be trained for 3 days. The cost of training is estimated to be Rs.6050/-. The cost of handouts, bills etc., works out to Rs.53,000/-. The health education programme will be taken up before the commencement of the sanitation project and carried through the period of execution of the project. There will be continuous monitoring and evaluation during the continuation of the health education programme and the strategies could be modified suitably to correct deficiencies, if any.

Technology Selection

Technology selection involves consideration of the Public

Health Aspects, the water supply service level, the housing density, the soil conditions, the economic and financial costs of the project, acceptance by the community and its participation, affordability, maintainability and use etc. The conventional sewer system, even though satisfactory from the point of view of sanitation, is not feasible for Nilakkottai in view of the large water requirement, the high per capita initial investment and the subsequent high cost of maintenance. The next best alternative seems to be individual septic tanks with disposal arrangements for their effluent. This too requires large volumes of water, large area of land for the disposal of the effluent and involves comparatively high initial and maintenance costs and hence is not feasible. However such of those willing house owners who have water-service connections in their houses and who have adequate space for installation of latrines, septic tanks disposal arrangements and who could afford them can get these constructed in their houses. The third alternative is the use of low cost water seal latrine. Considering the present situation in the town, this seems to be the only appropriate technology. The RCAP type of latrine which is a water seal latrine is popular in the area. The UNDP has also developed a water seal latrine under its low cost sanitation programme. Basically these two work on the same principle except for some minor modifications. The pan in the RCAP type is of concrete, whereas the one in the UNDP type is of glazed ceramic. In the RCAP type, only one pit is constructed while in the UNDP type, double pits are provided. The initial cost for the RCAP type latrine is Rs.275 (without subsidy) and that for the UNDP type is Rs.700.00 each., excluding cost of enclosures. Both these types are suitable for the town. For household latrines, the RCAP type is recommended. Where house-owners agree to bear the cost of the UNDP type, they can be provided with that type. For public latrines however, the UNDP is preferred since they are used by a larger number of people and they could be maintained clean much easier in view of the superior finish of the pan. Both these types of latrines as proposed above can be connected to a sewer system in course of time, without disturbing the enclosure or the pan, when sewer system becomes possible in the locality.

Work Programme

The programme of work at Nilakkottai can be divided into three types as under

Conversion of existing dry latrines to water seal latrines

Construction of new latrines

Conversion and construction of public latrines

Conversion of existing dry latrines to water-seal latrines

There are 43 household bucket latrines existing within the town Panchayat. In view of the demeaning and horrid nature of these latrines, it is proposed to convert them into water-seal latrines.

Construction of new latrines

There are 2137 assessed houses at Nilakkottai without latrines. The project envisages construction of water-seal latrines (both RCAP and UNDP) in about 80% of the residen-

tial households where space is available. Thus 1710 houses come under this category. Leaving aside some commercial and institutional buildings, this project envisages construction of 1500 water seal latrines within the panchayat area. About 2/3rd will be of the RCAP type and 1/3 of the UNDP type.

Conversion and Construction of Public Latrines

There are at present eleven 4-seaters and one 6-seater type dry public latrines making a total of 50-seats in all. There are no public standposts near any of the latrines. About 25% of the present population is proposed to be served by public latrines. At the rate of one seat per 30 people and for a total population of 11,957, nearly 100 seats will be required. There are already 50 seats of the service type which could be converted into sanitary type. 50 more seats will have to be provided to meet the total requirement of public convenience. These will be provided in places where there are no public latrines at present. Ward numbers 9 to 12 are scattered and do not have this facility. It is therefore proposed to provide four blocks of 5 seats in each of these wards. The remaining 30 seats will be provided either in 5 blocks of 6 seats each or 3 blocks of ten-seats each in wards 7 and 8. It is also proposed to provide one stand post near each block. The institutions such as cinema halls, public offices, market places etc., would construct the required number of latrines at their own cost.

Cost of the Project

The total estimated cost for the construction/conversion of latrines as detailed above at the present price levels is given below :

Conversion of dry latrines 43 Nos. at Rs.275/- each	: Rs.0.12 lakhs (approx)
Construction of new latrines	
(a) 1000 Nos. of RCAP type at Rs.275/- each	: Rs.2.75 lakhs
(b) 500 Nos. of UNDP type at Rs.700/- each	: Rs.3.50 lakhs
Conversion of dry public latrines and construction of 50 seats (UNDP type latrine) including enclosures, etc.	: Rs.3.25 lakhs
Total	: Rs.9.62 lakhs
Supervision and Engineering charges at 15% of the above	: Rs.1.44 lakhs
Incentive and bonus to the best motivators and acceptors	: Rs.0.38 lakhs
Total	: Rs.11.44lakhs

This expenditure could be phased out over a period of two years.

Financial Resource Mobilisation for Implementation

Since the Panchayat cannot mobilise the funds for the project, the following alternatives are suggested.

The State Government may finance the Project out of their plan allocations.

The town Panchayat may acquire loan from LIC/Banks etc and try to repay the annuity by imposing new taxes on the beneficiaries.

A part of the cost may be met by the State Government as onmight developmental grant to the Panchayat and the remaining part as loan to be returned within 5 years.

In some states, the State Government bears two-thirds of the cost and the balance is given as loan. It is therefore suggested that the State Government consider giving at least 50% of the cost of the project as grant and the balance as loan at 10% interest repayable within 5 years. At this rate, the annual repayment of loan for the RCAP type works out to Rs.36-20 and that for the UNDP type Rs.92.05 per latrine.

In the beginning, the house-owners will have to invest from their ends for construction of enclosures. Thus in this suggested financing pattern, the beneficiaries, the State Government and the town Panchayat are equally involved. The grant and loan will act as a catalytic agent and it is believed that more and more beneficiaries will come forward to get latrines constructed and make repayment in instalments. Such concessions are nothing new.

Benefit Cost Ratio

The benefit-cost ratio for the above scheme is presented below. Details of loss due to sickness associated with insanitation can be calculated as follows :

Number of patients	: 6600/year
Children	: 20%
Adults	: 80%

Assuming 60% of the cases among adults to be due to faecal-borne diseases, their number is approximately 3300/year. Assuming loss of man days at 10 days per year and assuming free medical treatment.

Total loss of man days at 10 days per year/person is 33,000. At Rs.12/- per man day, the loss works out to Rs.3,96,000/year.

The details of expenditure in connection with the implementation of the latrine programme are

1. Health education	: Rs.	53,000/year
2. Construction/Conversion of latrines	: Rs.	11,06,000
3. Incentive and Bonus	: Rs.	38,000(for the initial three yrs.)
4. Maintenance staff (Additional)	: Rs.	20,000/year

5. Maintenance staff (new recruitment) : Rs. 67,200/year

Taking a 15-year period,

Capital investment : Rs.11,06,000

Annual expenditure : 1,40,200

For 3 years at 10% interest, the present worth factor is 2.49

For 15 years at 10% interest, the present worth factor is 7.60

Hence B/C ratio = $\frac{3,96,000 \times 7.60}{11,06,000+38,000 \times 2.49+1,40,200 \times 7.60}$

= 1.33

which is satisfactory.

Agency for Project Implementation and Maintenance

For maximum involvement of the beneficiaries, it is proposed to constitute a sanitation committee of the prominent beneficiaries who will initiate actions at all stages and work for the progress. The Rural Institute at Gandhigram will act as technical adviser and extend all assistance and support in imparting training to some local masons/plumbers to cast and construct the different components of the latrines. The town Panchayat administration could streamline their grant and loan disbursement procedures so that willing beneficiaries could get them without delay. For public latrines, the town Panchayat administration will get the conversions of dry latrines into water seal latrines done through their own agency utilising the grant/loan. To meet any emergency, a gang of two maistries, one mason and one plumber along with three coolies should be kept under the direct control of the Sanitary Inspector. The maintenance of public latrines will be directly under the Town Panchayat. The town Panchayat will engage twenty two care-takers for all blocks(eight who will be relieved from the scavenging work which they are doing at present due to the conversion and the remaining 22 by fresh recruitment) who will be regularly attending to the cleaning of the latrines after use. The entire additional expenditure (Rs.20,000 + Rs.67,200 per annum) is suggested to be met by levying sanitax, about half of the water tax. Since this facility is intended to serve 3000 population, the per capita cost per month works out to Rs.1.90 which is a very meagre sum when compared to the public health benefits derived therefrom.

Evaluation

The objectives and the actual achievements of the above programme have to be monitored and evaluated so that any shortfall along with constraints coulle be removed afterwards and in their replication at other places. The result of the programme will be evaluated with respect to health benefit aspects, acceptability of latrines by users, technological adequacy and change in user hygiene related habits by uuder-taking studies before and after the implementation of the project.

Acknowledgement

The above paper is a condensed version of the report prepared by the authors as part of the workshop programme of the Regional Course in Project Formulation and Appraisal in Water Supply and Sanitation. The cooperation and assistance extended by the various agencies in collecting the required data is acknowledged with thanks.

INSTITUTIONAL,FINANCIAL,SOCIOLOGICAL AND LEGAL ASPECTS OF LOW COST SANITATION -LATRINE CONSTRUCTION PROGRAMME.

B.J.VASAVADA *

Introduction

The ten years period from 1981-1991 has been declared as the International Water Supply and Sanitation Decade by the United Nations. The Government of India is one of the signitaries of the United Nation's decision in this regard and hence is fully committed to the success of the Decade.

The National targets for the decade have been accepted as under.

(1) Urban Water Supply 100% of the population to be covered by March 1991.

(2) Rural Water Supply 100% of the population to be covered by March 1991.

(3) Urban Sewerage and Sanitation 100% of the population to be covered in respect of Class-1 cities with sewerage schemes and the remaining urban population to be provided with simple sanitary methods of disposal. The over all coverage in each State should be 80% of the urban population.

(4) Rural Sanitation 25% of the population to be covered by sanitary toilets.

The working-group on the financial resources set up by Apex Committee on the International water supply and Sanitation Decade has worked out total requirement of funds for the implementation of the above mentioned Decade Programme to the tune of Rs. 14,500 crores to cover the target population by March 1991. Sectorwise break up of the figure is as follows:

1. Urban water supply	Rs. 3280	Crores
2. Rural water supply	Rs. 6779	"
3. Urban sanitation	Rs. 3685	"
4. Rural sanitation	Rs. 744	"
Total	Rs.14488	Crores

2. Problem of Sanitation

The investment required for the decade are huge and resource mobilisation would be the major constraint for the successfully implementation of the Decade programmes.

The question of evolving an appropriate solution to the problem of urban sanitation has been under consideration for some time. Many of our urban reas have a large number of dry latrines which create insanitary conditions and also involve employment of scavangers who are obliged to follow the

degrading job of carrying night-soil manually.

On the other hand conventional sewerage scheme have become very expensive making them beyond the reach of most urban areas which suffer from lack of adequate resources either for construction or operation and maintenance.

The alternative is to deal with safe disposal of night soil. 90% of the diseases are due to the hazards that are created from the insanitary disposal of human extreta. This can be done by providing low cost sanitary latrines to each house. Whenever, sewerage scheme comes up, the latrine can be connected conveniently leaving only the leach pits out of use. Sullage water disposal will have to be dealt with separately.

3. Feasibility studies.

To explore the possibility of evolving safe and suitable low cost sanitation system for our urban areas, particularly those with a population less than 1 lac, the Government of India had requested the UNDP to assist in the preparation of reasibility studies for providing low cost water seal pour flush latrines. In the first phase of the project seven States viz. Asam, Bihar, Gujarat, Maharashtra, Rajasthan, Tamil Nadu and U.P. are included and covering a total number of 110 towns in these states. The feasibility studies in respect of Phase-I of the project have been prepared. The World Bank have also expressed interest in assisting in theimplementation of some of these States. Besides, these studies would enable the State Govts. to prepare similar studies for the remaining towns. Once this study is available, they could be posed for external assistance or for financing by local financial institution.

The UNDP is to further assist the preparation of similar feasibility studies in some of the other State and Union Territories. Accordingly 100 towns in all are proposed to be taken up under Phase-II of the project.

Out of the seven States covered under Phase-I of the project, World Bank has agreed for a credit for implementation of the project for the towns in Gujarat and Tamil Nadu.

4. The Technology.

As mentioned above the low cost sanitation project basically envisages to construct water seal latrine in the urban areas so as to provide this facility to theentire population which do not have such facility at present. The project deals with every house in a town or city as it involves construction of latrine by the private beneficiaries. It also deals with the construction of public latrines and its operation and maintenance.

The technology for the project has been already finalised by the UNDP and has been accepted by most of the States. The technology is very simple. It consists of constructing a latrine with a squating platform and two leaching pits for the disposal

of night soil by anaerobic digestion. The cost involved also varies from Rs. 2,000 to 2,500 for a family of five people. The researches under taken by the UNDP and by the other organisation has proved that there is no danger of pollution of sub-soil as well as ground water due to the leach pit type latrines, particularly when the soil conditions are favourable. No further engineering skills or sofisticated know-how is required for the successful implementation of the project. In a way the project design involves no complex engineering methodology but still it has been observed that a lot needs to be done for successful implementation of the programme.

5. Governing factors.

As discussed above, the technology is known, but the following important aspects need to be examined and resolved so that the project implementation gets momentum and the programme becomes popular.

1. organisational aspects including training
2. Financial aspects
3. Legal aspects
4. Sociological aspects
5. operation and maintenance aspects

The scope of this paper is limited to the discussions of these vital components affecting the implementation of the project.

6. Organisational aspects

(a) As mentioned above, we have all the technology available with us. We have also plans, projects and schemes available for implementation. The very important factor that effects the progress of the project and the achievements, is the organisation aspects. Institutional building has become the most important factor affecting the success of the project. If the organisation is not sound, the implementation and the operation of the project can never be efficiently and successfully done.

For the low cost pour flush latrines programme, it is necessary to set up a suitable institution for programme planning and implementation oriented to the people's need. In absence of well planned national or State programme, executed by efficiently run governmental bureaucracies, community participation and appropriate technology will count for little. The organisational aspects requires to be examined in details taking into consideration the following aspects.

(a) Identification of an appropriate organisations for implementing the various stages of the programme at the town level The stages involved are broadly :

(i) technical approval and control (including soil selection siting and engineering aspects of construction)

(ii) actual construction (department or through contractors)

(iii) advancing loans, where required, providing grants and ensuring recovery of loans.

(iv) Selection of towns, motivation of communities, overall management (including coordination of related efforts).

(v) monitoring and evaluation, including rehabilitation of scavengers;

(vi) operation and maintenance of community toilets; and

(vii) emptying of filled-up pits and disposal of manure.

b) Creation of a technical and monitoring committee/cell at the State level to provide guidance and solve problems relating to all aspects-engineering, financial, managerial etc.

c) Conducting orientation courses for the managerial staff of implementing agencies & training courses for the technical staff, contractors and others involved.

d) Ensuring availability of scarce materials like cement and steel;

e) Construction of demonstration units in the project areas covered by the UNDP study &

f) Delegation of powers and setting up of procedures for speedy implementation

(b) Government organisation :

At present in most of the States the latrine construction project are being implemented by the local self Government i.e. the Municipalities, Panchayats, etc.. These bodies are autonomous public bodies. The Directorate of Municipalities is the nodal authority under whose control the municipalities are under taking such programmes. However water supply and sanitation has been considered to be the primary function of the local self Government.

The Municipal authorities can be entrusted with the following functions related to the project implementation.

(i) Receipt of funds from the State level agency

(ii) Disbursement of funds to the beneficiaries

(iii) Recovery of loans from the beneficiaries.

(iv) Repayment of loans

(v) Execution of work

(vi) Training to local masons

(vii) Maintenance of public latrines

(viii) Desludging of pits of private latrines

Water supply and sewerage Boards, as corporate bodies constituted under the - respective statutes are coming up in most of the States. These Board are quite high powered bodies to undertake sewerage or any other sanitation scheme in the areas under their authorised jurisdiction and raise, borrow or secure money from L.I.C. International and Bilateral agencies, State and Central Govt's for such schemes. These Boards could be made responsible for the preparation of detailed engineering studies and project report and raising of funds.

(c) Voluntary organisation

Experience has shown that if the programme is all together left at the mercy of the local bodies, it may not be possible to achieve the desired results. The latrine construction project as mentioned earlier deals with each and every house and as such involves sociological aspects.

Motivation and programme promotion play a very important role for the success of the programme. For motivation, programme promotion, training and health education what we need is a voluntary organisation devoted to this service, and having devoted persons. These organisations can very well educate the people and convince them that for the betterment of their health, they need latrines. These socially oriented organisation can take up the programme with a sociological angle so that the programme and projects are well responded by the beneficiaries population.

We have experience of some such voluntary organisations dealing with the latrine construction programme. They are the Safai Vidyalaya of Ahmedabad in Gujarat. The Sulabh International of Bihar, and the Rajasthan local Self Government Institute in Rajasthan.

There is a definate need to have a voluntary body to monitor, formulate, guide and help the low cost sanitation programme.

(d) State level bodies

The low cost sanitation - latrine construction projects are getting momentum in most of the States. It is therefore necessary to constitute a State level committee in each state to over see and guide the implementation of the programme. The State Departments of Health, Local Self Government and Urban Development and also the Social Welfare Department can be represented in the committee as the programme is well connected with the activities of these Department.

It is also necessary to have a District level committee for the implementation of the programme headed by the District Collector of the District and having the District Development officers, Health officers and Chief officers of the Municipal bodies as the members.

If all this is done and the sanitary Inspectors and other staff involved in the implementation of the programme, are well trained, the programme will definately come out with glorious success and there woukd not be any difficulty in achieving the decade targets.

The moot point is that whatever type of organisations we have the local body should be always kept at the centre as it can very well understand the nerve of the beneficiaries population in the town.

7. Financial aspects

As mentioned earlier the cost of the latrines with the the UNDP design has been estimated as Rs. 2,000 to 2,500. Resources with local Self Government as well as State Government are always scarce and resources mobilisation poses a difficult problem for the project. It is therefore very essential to resolve thefollowing issues.

Financing patterns should be so decided that there is an element of contribution from the beneficiary people who get thes services. There should also be an element of Government subsidy so that there is no over burden on the people. If the pattern provides a minimum of 50% subsidy from the State Government, it would ease the financial burden on the house owner and would further promote and motivate the programme.

So far many of the States have adopted the policy of subsidising the construction cost of the conversion of dry latrines into sanitary latrines. For the UNDP projects, Gujarat has adopted a financial patterns which is more attractive. It envisages to provide a C.I.A. of 75% and municipal subsidy of 25% for the Harijan beneficiaries requiring no contribution from the harijans. The pattern for non harijans consist of providing 50% subsidy, 30% loan and 20% beneficiary contribution. This pattern has been very well accepted by the people in Gujarat and it this pattern is followed with necessary modification according to local situation, by all the States, I feel, there would not be a problem of resources - mobilisation.

If the State Government have a problem of resources they should pose the same before the 8th Finance Commission which has been recently constituted and make efforts to generate as much funds as possibleso that the Decade targets of sanitation are well achieved. This programme also needs to be taken up sincerely by the Government of India and has to be matched with financial-assistance. The funding Institution like the L.I.C. the IDA of the World Bank and the Asian Development Banks can also be approached with a shelf of such projects, so that money does not become a probla for the project.

The project involves raising of loan and wherever there is a loan, problem of recovery and repayment has been very difficult Local bodies do not enthusiastically come up for the recovery and repayment and as such the funds get locked up. It is very necessary to revolve the funds, so that over a period of time, all sections of thesociety can get the benefits of such projects. It is therefore very essential to take some steps to speed up the recovery and this may be done by the following methods.

1. Payment of collection agents by the local bodies who would go to the door steps of the beneficiery people and collect the charges.

2. Reduction in the recovery period

3. Incentive for prompt payment

4. Introduction of a general latrine taxes etc..

8. Legal Aspects:

The latrine construction programme under the Low Cost Sanitation Project is connected with the Municipal bodies, beneficiaries and the people in every house in a town or city and involves certain legal aspects. The Municipal Act, the Panchyat Act and the Bombay Provincial Municipal Corporation Acts are the basic legislations which concern the project. These legislations are insufficient to certain extent and need modification as under.

(i) There are specific provisions in these acts for conversion of the dry latrines into sanitary latrines, but the law does not enforce the construction of the latrine in a house which does not have a latrine. It is therefore very essential to add such a provision in the legislation so that the municipal authorities get more power and can provide latrines to the entire population. Since the existance of dry latrines as well as the practice of open defications areundisputedly health hazardous and as the municipal authorities are solely responsible for sanitation, they must be made responsible for this primary duty to the community.

(ii) The programme of conversion and construction of latrines for each house, looking to its magnitude as well as socio economic conditions of the people, would more or less envisages granting of financial assistance to the beneficiaries by way of loan and grants. It should, therefore, be made obligatory by way of legislation to utilise these funds only for the purpose of the latrine construction programme. Specific provision in every municipal law making it obligatory for the municipal authorities to provide either wholly or partly out of the municipal property and funds, for granting of financial assistance by way of loans & grants for conversion of dry latrines or for providing new latrines is very essential.

(iii) The municipalities should be charged with the responsibility of providing sanitation to the people has been well advocated, but if these authorities are not empowered to raise adequate

funds for the programme, the programme would turn out to be a paper programme. It is therefore necessary to include a special latrine taxes and to provide for the creation of a special funds viz. the water seal latrine - construction fund ear-marked for the latrine programme only. This needs to be provided in the municipal act.

(iv) We have been all the while talking about the nuisance that has been created by the open defecation system, people are used to open defecation because of two reasons.

1. People do not have a latrine
2. People do have a latrine but specify there is no temptation to use the same. This is because the people are not properly educated as regards hazards that are created due to open defecation.

A suggestion has been made at many levels that open defecation should be banned. A reference to the "Arthshastra" by "Kautilya" reveals that even in the days of Kautilya, there existed a provision in the law banning on the open defecation. If this is thecase why can not we make such legislation in these days of developing society ? The reason is, we have not so far, provided adequate facility of sanitation to the people. The other reason is we have not seriously taken up the motivation and health education programme so as to convince the people that as a measure of health safety, they must have latrines and must use them, if adequate funds are made available and if the programme is taken up, sincerely, a time would come, when each house will have a latrine and the people would have been educated and convinced as regards their use and this would ultimately lead to stoppage of open defecation systems. Here the sociological aspect is very important. If we ignore this aspect and go for a legislation we are sure to fail very badly.

(v) It is also necessary to have specific by-laws for the latrine construction programme and the municipal Acts should make it obligatory for the local authorities to adopt the bye-laws.

(vi) Municipal authorities are not prohibited from according sanction for conversion of any latrine in building an occupier who is not an owner. Since the tenant can not be forced to convert into or construct a waterseal latrine as per the existing municipal law, suitable amendmat therein, enabling the exercise of such a power - enforceable on the tenant also has been recommended. But that will not be enough, because there is a seperate law other than the municipal law which governs the relationship between the landlord and the tenant and the provisions of the rent control and eviction law relevant to our objective shall have to be brought in harmony with the municipal law.

With these modification and a sociological approach, the law can be well enforced to make the programme all success.

9. Sociological aspects

We have talked too much about thelatrine and its utility. There have been good number of conferences and discussions on the subject. There are good number of manual and study reports, but still we have not seriously resolved the basic issue of the scavanger rehabilitation to the desired extent. once we go for a water seal latrine for each house, we must also think of providing alternative employment and work to the scavangers. Their participation in the latrine construction programme itself should be maximum so that they get work and the programme gets momentum, the rehabilitation of scavangers should also be the ultimate approach of all such programme and if that is not the case, we would achieve the targets of sanitation but would lag behind the- humanitarian approach.

Though scavangers do not face any economic crisis due to latrine conversion programme it is desirable and advisable that some economic planning is promoted for them. A two stage programme of economic rehabilation has to be chalked out. Firstly for scavangers who are dissatisfied with the scavanging jobs, an appropriate incentive system, aimed at satisfaction of vital economic needs, has to be provided. Secondly, for scavengers who are neither satisfied nor dissatisfied with scavenging work, a job restructing programme to inculcate positive attitude towards the alternative job.

Besides the above, other measures suggested for economic rehavilitation are as under

a) Training Programme - opening vocational training may bring vocational training within thereach of almost every body who is keen to take advantage.

b) Economic self employment programme - Introducing measures like increased subsidy, grants to co-operative societies, concessional and loan facilities from the Govt.and the credit societies will help the scavangers to take more interest in non-scavanging works. Loans at low rate of interest can also be advanced to those who want to open small provision shops/stores.

10. operation and Maintenance

The operation and maintenance of the individual latrines would not pose a problem as every family will look after their own latrine. We also need public latrines for the convenience of the urban poor. - Principally it has been accepted that as far as possible public latrine should be avoided but still we need public latrines to serve the poor and slum areas. These public latrines are the spots of nuisance and health hazards as in most of the cases they are very badly maintained. Unless we have a solution to the maintenance problem, these latrines would add to the problem, rather than solving the same. It is worthwhile to adopt the pay and use system, wherethe user should pay for use to the extent of five to ten paise. This

system would generate some funds so as to maintain the latrines by keeping an attendant. This system also can be implemented only if it is properly motivated and promoted. Here again the came the sociological and health education aspects. The planning and maintenance of public latrines can also be entrusted to contracting agencies who can maintain the latrines on the pay and use basis.

The idea of having a public latrine for a group of house say four to five houses is also worth encouraging. This group of house should be made responsible for the maintenance of these latrines so that they remain clean.

11. Conclusion

Some of the important institutional, financial, legal and sociological aspects have been discussed above. These are not the only final solutions. We can have alternative systems by way of experience, but central idea is that the programme should be implemented with a sociological and health objective, involving beneficiary population to participate to their maximum, so that the technological option can reach the door step of the people.

If we can achieve this and provide latrines to all during the decade or two, I would consider it to be the most important and significant achievement in a developing country like India and would evaluate even more in comparison to the achievements in the field of science, industry, and space research. The reason is well known. Unless we are able to provide basic sanitation and better health to our people, there is no point in advocating the success in the field of industry and science. I do not say that industry and science are not important, but priority has to be given to the health of the people. A healthy society can very efficiently contribute to the development of science, industry and agriculture.

References :

i) Special studies done by Technology Advisory Group of UNDP (India)

ii) UNDP Feasibility studies.

BASIC FUNCTIONS FOR SOLID WASTES MANAGEMENT

M.M. TAMAKUWALA *

INTRODUCTION

There are three basic aspects to the problem of engineering for collection and disposal.

i) Finding and developing a set of techniques to motivate collection and disposal crews to work efficiently effectively, given the nature of the capital equipment available to them.

ii) Finding the optimal capital-labour ratio, i.e. the ratio that minimizes the cost of operation. This involves problems of crew size and the design of collection vehicles.

iii) Finding the optimal set of spatical relations for routes, transfer stations, disposal sites, and garages.

All of these aspects are important determinants of the average and marginal or incremental costs of collection and disposal, and in a comprehensive study of the SWM problems, they cannot be assumed to be optimal. In point of fact, until relatively, research on the SWM problem was directed principally towards problems of engineering efficiency. It is obvious that, improved operations can lead to reduced system costs and can be the source of fairly significant savings. By themselves, however, they will not reduce the waste load; rather, to the extent that waste-generation practices are related to systems costs. They will raise the waste load at least in communities that now utilize some form of user charges.

Management of any activity is a decision-making process consisting of basic functions and activities that lead to the successful attainment of objectives. Modern SWM practice with respect to collection and disposal requires 'Scientific' knowledge to aid in understanding and solving problems and 'art' to agsist in implementing actions, which involves two major areas of activities.

First, it involves activities that centre on people. Effective SWM requires that internal and external human problems be handled in such a way as not to impede the accomplishment of the task at hand, and also to contribute to a harmonious operation. In addition to the internal interactions of workers and supervisiors, the SWM manager must properly relate to other managers at the same level and at higher levels within the organization. External human interactions include those with citizens, elected officials; and a union or other bargaining agent for solid-waste workers.

---

* Lecturer, in Civil Engg. Deptt., S.V. Regional College of Engg. & Tech., Surat - 395007, Gujrat, India.

The second activity area involves problems that are technical in nature. These include the normal day-to-day business activities of sustaining solid-waste collection and disposal operations, record keeping, equipment assignment and maintenance, and ongoing development of improved collection and disposal operations requires the solution of complex technical problems involving detailed route design and the location of transfer and/or final disposal sites.

BASIC MANAGEMENT FUNCTIONS

The management process requires :

i) the planning function,
ii) the organizing function,
iii) the directing function, and
iv) the controlling function.

Each of these above functions has distinguishing characteristics, in most management situations all are inextricably interrelated and must be properly co-ordinated to produce managerial effectiveness.

The Planning Function: Planning may be short-term or long term and is utilized to develop and select the best course of action on a timely basis. Short-term planning includes plans for day-to-day operations: equipment maintenance, budget, manpower recruitment and assignment. Long-range planning usually is focused on improving operations. Typical long-range project include evaluation and justification of the purchase of replacement equipment or technology improvements, assessment of service levels, location of future disposal sites, and the development of improved collection/disposal systems. As per the American Public Works Association, the planning of improved solid-waste systems must consider the following factors:

I) The community refuse problem

   a) Types and quantities of refuse produced
   b) Responsibility for disposal
   c) Extent to which municipal, contract, and/or private methods are used.
   d) Collection frequency

II) Disposal methods

   a) Extent of separation required
   b) Location of disposal points
   c) Pollution control regulations

III) Materials to be handled

   a) Weight of materials
   b) Compressibility
   c) Method of preparation and storage at origin of Production
   d) Quantity

IV) Types of equipment available or selected

V) Population density

VI) Location of refuse for collection

VII) Organization of crews

VIII) Work output in man-hours per ton collected

IX) Physical layout of area

X) Climate

XI) Type of zoning

THE ORGANIZING FUNCTION

Organizing is the arrangement of activities to be performed, and the determination of responsibilities and authority assigned to individuals. No single organizational structure is appropriate for all collection and disposal operations. This is usually accomplished by balancing the work to be accomplished and the physical facilities available, and by properly assigning the people who possess the skills necessary for task completion.

The basic organizational principles useful for the management of collection/disposal operations are :

1) Define and clearly understand the objectives to be accomplished.
2) Delineate major activities and estimate thetime required for each job-category.
3) Define and communicate priorities of various work activities or objectives.
4) Assign responsibility and delegate authority to supervisory employees. All employees in the organization should understand their assigned work activities and how they fit into the organizational structure.
5) Determine the proper span of control (number of workers assigned to a supervisor) for each level of supervision. A supervisor should be assigned no more employees than can be effectively supervised by one person.
6) Assign qualified personnel. Job requirements at all levels should be matched to individuals with the experience and/or training needed to accomplish their assignments.
7) The solid-waste organization should have sufficient supportive personnel. In addition to collection and disposal, the organization should include personnel for maintenance, clerical work, and systems planning.

The best measure of an organization's composite quality is the ability to accomplish defined objectives efficiently and respond to any changes that evolve. Change in SWM may be experienced in many areas, including equipment technology, personnel, and public and political views. It has been suggested that the key criterion for judging organizational health is its ability to cope with change.

THE DIRECTING FUNCTION

In SWM, directing may be defined as the implementation of planning and the operation of collection and disposal activities through the organization structure. Both of the above require dealing with people, and consequently the supervisor or manager must have an understanding of human behaviour. Typically, individuals have considerably different socioeconomic charactwristics and motivation levels. The key to successful direction in SWM is to develop and motivate individuals to accomplish the assigned task. Different management approaches may be used in directing employees. Managers in an organization will react differently on the basis of their practice of autocratic leadership versus participative involvement. The autocratic managers as the Theory X group, and feels this type of manager believes the following :

--- The average man dislikdes work and will avoid it to the extent he can.

--- Most people have to be threatened or forced to make the effort necessary to accomplish organizational goals.

--- The average individual is basically passive and prefers to be directed rather than to assume any risk or responsibility. Above all he prefers security.

The participative manager practices more employee involvement, lessclose supervision, and lesscoercion and control. According to this type of manager is defined as the theory Y group and believes the following :

--- Work is as natural to man as play or rest and, therefore, is not avoided.

--- Self-motivation and inherent satisfaction in work will occur in situations where the individual is committeed to organizational goals. Hence, coercion is not the only form of influence that can be used to motivate.

--- Commitment is a crucial factor in motivations and is a function of the rewards coming from it.

--- The average individual learns to accept and even to seek responsibility, given the proper environment.

--- Contrary to popular stereotypes, the ability to be creative and innovative in the solution of organization problems is widely, not narrowly, distributed in the population.

--- In modern organizations, human intellectual potentialities are only partially realized.

Most collection and disposal operations can be managed best by using beliefs from both Theory X and Theory Y. For example, the Theory X type of supervision is appropriate for defining equipment maintenance duties. Theory Y supervision will produce better results in waste-collection activities, providing the "team" concept is utilized with a time incentive that permits employees to leave work when the day's assignment has been completed. This obviously requires correctly designed (fair workday) and balanced collection areas for all assigned teams.

A recent example of participative involvement in SWM was reported by Shebanek, Shell, and Shupe (1974). This investigation involved the application of sociometric analysis to permit collection personnel (foreman, drivers, and labourers) to select teams and individual truck crews. This resulted in better cooperation on the part of the team and crew members in working together to improve overall effectiveness.

As improved systems are developed and as better-trained personnel are available for collection/disposal work assignments, greater effectiveness can be achieved by practicing Theory Y supervision. Given the above, developing Theory Y supervisory skills remains a major future challenge for solid-waste organizations.

THE CONTROLLING FUNCTION

Management control is the function of determining accomplishments, comparing them with planned objectives, and applying corrective action to insure acceptable future performance. The information system for collection and disposal operations requires general data on a continuing basis. The following data types have been suggested.

1) Locations of landfills, incinerator, and transfer station sites.

2) Maximum capacities of the facilities to be considered

3) Proposed haul routes from each community to each disposal site and from each incinerator and transfer station to each landfill site.

4) Average round-trip travel time for each route computed from the average vehicle speed from each solid waste generation source and the proposed route distances.

5) Cost per ton per hour for hauling solid waste in collection vehicles for current and future time periods.

6) Population and per capita solid waste production for each period.

7) operating costs for the various disposal sites for each period.

8) Purchase price of thelandfill sites and capital costs for incinerators and transfer stations.

CONCLUSIONS

In this paper the author has reviewed some basic management functions for collection and disposal operation which canbe used to raise the efficiency of the SWM.

WATER AND WASTE WATER RECYCLING FOR SMALL COMMUNITIES

K. RAGHAVAN NAMBIAR

INTRODUCTION

As civilisation progresses, the pressure on the limited sources of available water is becoming increasingly great. As such water conservation and waste water recycling have become inevitable features in water and waste water technology. Some of the methods of water conservation and waste water recycling along with a discussion on the philosophy of this science are described in this paper.

ENVIRONMENTALLY SOUND TECHNOLOGY

An equilibrium environment means that nonliving renewable resources are being consumed at such small rate compared to their availability that their concentrations are virtually unaltered. Thus Reddy (1981) summarises the principle of exploitation as : "Use renewable resources renewably, failing which minimise the depletion rate of non-renewable resources".

The problem of resource inputs and pollutants can be tackled by transforming wastes into resources. This can be done by making them inputs for society's activities of production, distribution and consumption. Each society is dependent or inter-related to other societies. Interruption of imports or exports of materials or resources from one system to other may affect both the system of societies to a considerable extent. So self reliance of ecosystems involving the society must be strengthened. This can be achieved by :

1. recycling of local resources.
2. production for local consumption only.

Thus theprinciple of recycling is very much pertinant to the present day world. So far as water resources are concerned, the problem is very acute now. Water conservation and recycling for individual households, small communities etc. are as much essential as for large cities.

DOMESTIC SYSTEMS

In domestic systems water conservation by use of rain-water and waste water and methods of purifications are discussed. A domestic slow sand filter is one device which can be used to purify surface waters, rain water or well waters. The filter consists of a tank filled with 50 cm. depth sand of effective size 3.5 mm. This system is shown in Fig.(1). The rate of filtration will be 90 - 140 $l/m^2/hr$. There should be 30 cm. of water constantly flooding the filter sand. This may prevent formation of dirty mat on the surface.

A trickling filter and an upflow filter are shon in Figs. 2 and 3 respectively. These devices are suited for a group of houses, which rely on surface waters. These are domestic scale plants. As a conservation method, dirty water from bath rooms, wash basins and possibly laundry could be collected up through a hopper and used to flush conventional W.C.

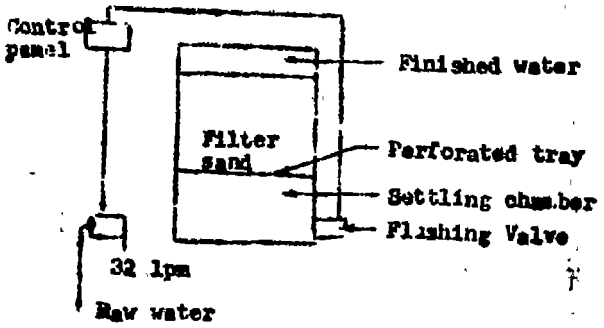


Fig.(3). AN AUTOMATED [illegible] FILTER FOR DOMESTIC SUPPLY

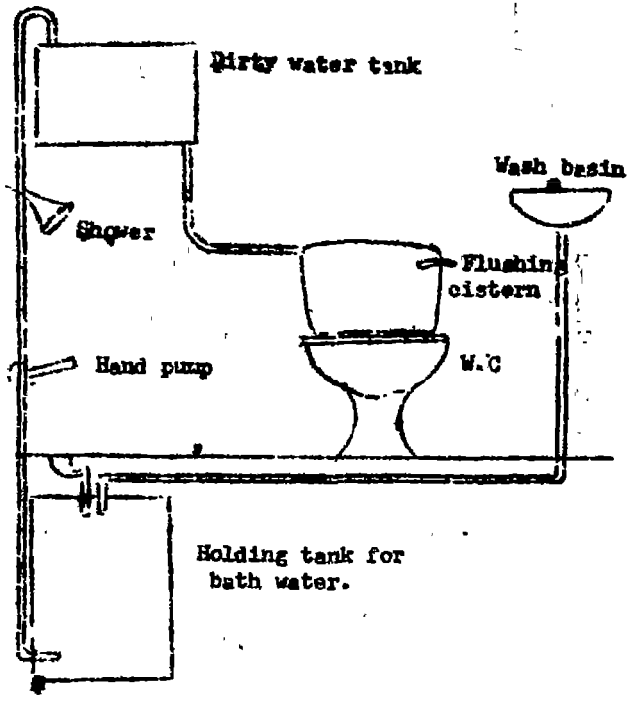


Fig.(4). A SYSTEM FOR CONSERVATION OF WATER

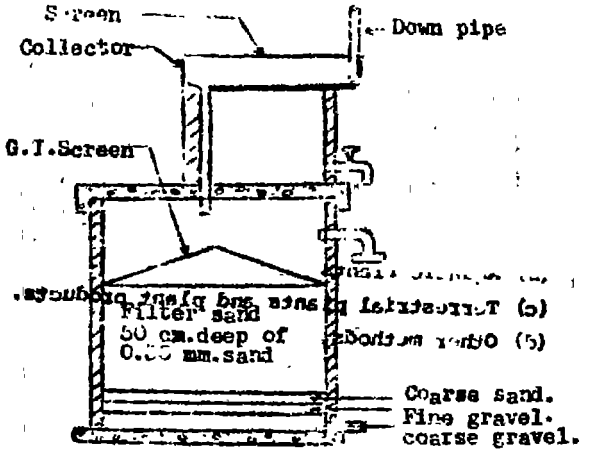


Fig.(1) SLOW SAND FILTER FOR DOMESTIC APPLICATION.

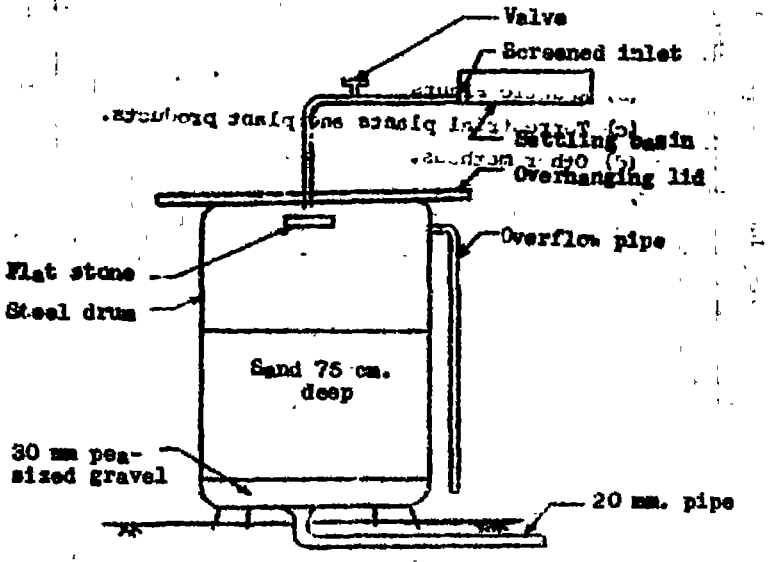
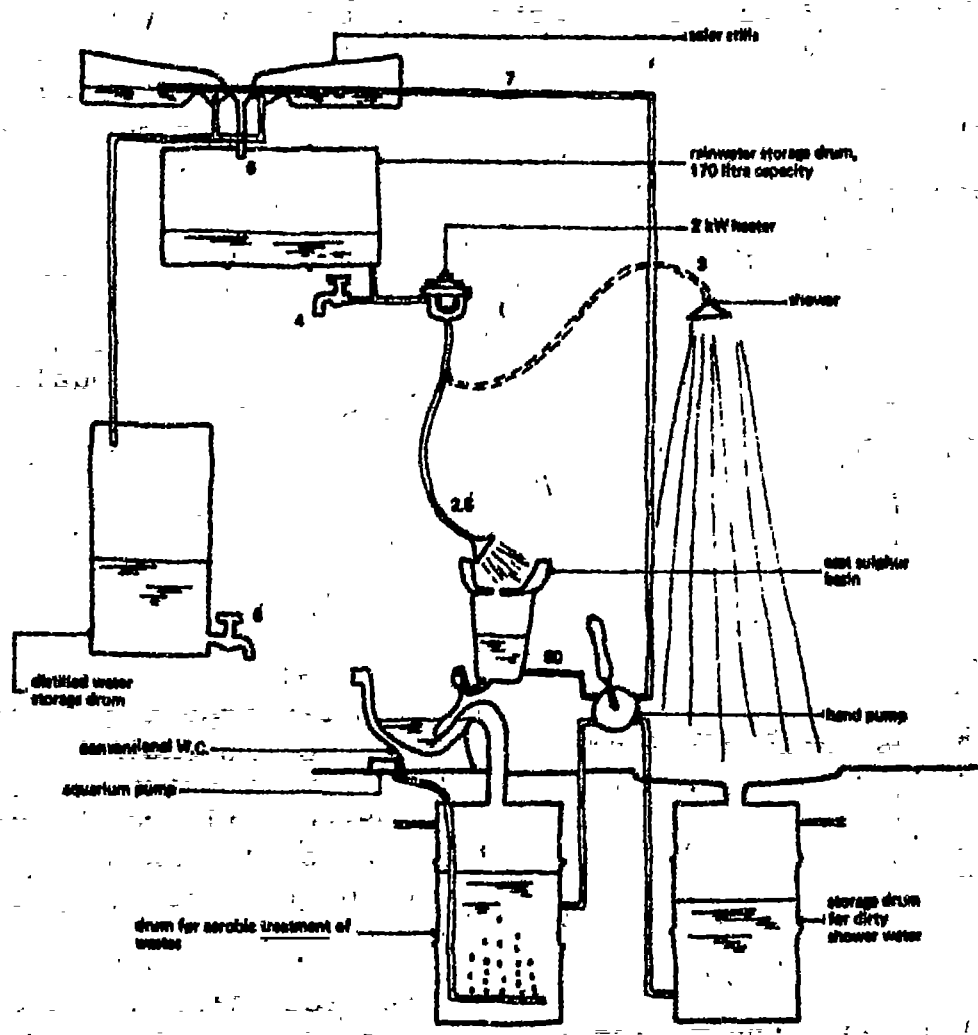


Fig.(2) A [illegible]



5 *The Ecol water collection, purification and waste treatment system (after Ortega* et al., *1972). The figures show the quantities, in litres per head, passing through the system per day.*

The system is represented in Fig.4. For Indian conditions the average laundry and personal hygeine requirements slightly exceed the volume of water needed for flushing thelavatory. The quantity required for W.C. flushing is 30 lcd, whereas waste water produced from bathrooms, wash basins and cloth washing exceeds 55 lcd. As such this system will be sufficient to reduce flushing water requirement of 30 lcd totally. However, a small low level tank, a hand pump and a small overhead tank become inevitable in such system. The cost of water saved will commensuratethe capital cost incurred for these additional tanks and pump.

Another classical system of water recycling has been described by Orgega (1972). The system is shown in Fig.5. In the figure the quantity passing through each device is indicated in litres. This has been used for two individuals within a practically closed cycle system. Similar methods with or without some modifications can conserve the water resources to a large extent in our country. This may not only concerve water, but also energy and alloviate pollution problems.

WASTE WATER RENOVATION BY UNCONVENTIONAL METHODS

Presently there are very many Engineering and Chemical methods, which have been widely used for treating domestic and industrial effluents. These methods are energy intensive highly expensive and create indirect environmental pollution. Biological methods are by far the best available. Though slow in work, they are environmentally sound and economically viable. Algae, bacterial fungi and aquatic and terrestrial plants could be used in this direction.

Biologically based waste water recycling systems would be designed so as to optimise both the production of economically and socially useful products and water quality improvement. Major benefits of such systems may include savings in costs of fertilizer, cultivation and irrigation of crops. For many urban related situation biologically based waste water recycling sysgem should be viewed as components of multiple pathway system for waste water treatment, not as single pathways capable of handling all waste water produced by communities of substantial size. Substantially increased development efforts should be directed towards lower technology, lower capital and less energy interime approaches to biological methods of waste water recycling. Careful consideration should be given to reducing the quantities of water used or for developing new non water carrier for nutrient rich water. By adopting these methods, nutrients are recycled along with water. Pollution is prevented. Biological methods discussed are under the following heads.

a) Algal-Bacterial system
b) Aquatic Plants
c) Terrestrial plants and plant products.
d) Other methods.

(a) Algal-Bacterial System:

Oxidation ponds of any type and Algal-Bacterial flocculating system come under this category. Nutrients and organic carbon are utilised by bacteria and algae. This algal and bacterial biomass can be collected and digested. or else pisiculture is carried out for cleaning the waters. Industrial wastes, fertilizer wastes and domestic wastes have been treated by this method. The renovated water is further utilised for pisiculture.

Nambiar (1978) developed a biological system for treating fertilizer wastes. The ammonia and urea in waste was stripped off by clocculating Algal-Bacterial system. The biomass could be digested or fed as such as manure. The renovated liquid effluent can be recycled for any useful purpose.

(b) Aquatic Plants:

Water hyacinth, duckweed and other aquatic weeds have been utilised in waste water renovation processes. NASA formed a water hyacinth lagoon to serve a population of 2500. The frow rate of the weed was at 15% of the surface area per day. At this rate 20 - 40 tons of wet hyacinth could be harvested per hectre per day removing nitrogen from 2000 people and phosphoses of over 300 people. Under ideal conditions water hyacinth can remove the following elements at specified rates as given in Table- 1.

Table- 1. Recovery Capacity of Water Hyacinth

Element	Recovery kg/ha/d
Nitrogen	22 - 44
Phosphorus	8 - 17
Pottassium	22 - 44
Calcium	11 - 22
Magnesium	2 - 4
Sodium	18 - 34

Water hyacinth culture removes algae, and fecal bacteria, greatly reduces suspended matter and remove odour causing compounds. ToC removal to the extent of 98% within a two week period has been documented. Nambiar et al (1982) observed that chloride concentration could be reduced from 3000 mg/l to 693 mg/l in 20 days by water hyacinths. Ammonia N concentration could be reduced to a considerable extent. Wolverton (1977) found that this weed can remove 80% of nitrogen compounds and 40% of phosphorus compounds from sewage in 2 days. This aquatic weed can effectively remove phenols and phenolic compounds and other toxic metal ions such as Cd^{2+}, Ni^{2+}, Hg^{2+} Cr^{6+} from industrial wastes (Gupta et al 1977). Raman (1978) observed that these weeds are capable

of removing upto 95% of BOD from wastes. Khan (1976) has reported that water hyacinth is capable of reducing total coliform bacteria from septic tank effluent from 1,70,000 to 10 per 100 ml. in 24 hr. Aowal et al (1981) documented that waste waters from vanaspathi manufacturing process could be renovated by the use of water hyacinth. This weed removed not only 97% of BOD, but also odour, oil and grease from the effluents. This water hyacinth can be successfully used for removing pollutants from any waste water. Hyacinth could be harvested and used as a manure, animal feed and as a raw material for biogas generation and paper and plastics manufacture. Nutrients and other pollutants are biosorbed, waste water renovated and the weeds are put as resources for various uses. This is a typical way of recycling waste waters and elements.

(c) Terrestrial Plants:

This method has been known long time since. Subsoil irregation or surface irrigation for fodder crops are accepted methods of waste treatment. The nutrients are absorbed by the plants and organic matter stabilized by soil microflora (Chaphekar, 1981). The water that percolates through the soil enters the ground water as a renovated clean water. Max Plank Institute, West Germany has tried reeds and bulrushes to purify waste waters. In this method the untreated waste water passes through a bed of gravel topped with sand in which common reed is planted. The reeds grow upto 4 m. tall and spread their roots through the gravel. The waste water percolates downward. Dissolved organic and inorganic matter are absorbed by the reeds and decomposed by microorganisms. The plants reduce accumulation of sludge and the gravel and sand provide through aeration. So the sludge stabilisation and absorption take place simultaneously. Bulrushes have been used on sloping beds. These methods of waste water renovation have been used in the Netherlands too. The renovated water has a pH of 7 and do not exert any oxygen demand. The reeds and bulrushes could be harvested for paper or pulp manufacture.

(d) Other Methods :

Application of waste water on soil renders it free from organic pollutants. Nutrients are also removed. Kotiah et al (1981) has observed that sorption, chemical precipitation, plant uptake and microbial immobilisation are the major mechanisms in the retention of phosphates by soils. Similar studies by many authorities have conclusively proved that soil has properties to remove many of the pollutants, found in waste waters. Nitrogen BOD and other materials could be removed by land application. Purified water flows down to recharge ground waters.

Eckenfelder (1974) reported the treatment of boxboard wastes by spraying alfalfa cover at a rate of 0.53 - 1.42 cm/day. The crop was grown on a sand-loam layer with a gravel under layer. Spraying a cannary waste water over stoping ground reduced the BOD from 1095 mg/l to 80 mg/l with the final run off being 37% of the initial waste water flow, the balance being removed by soil absorption, evaporation and transpiration.

Pisiculture in oxidation ponds - primary and secondary - have opened up new areas for resource recycling. Very many studies have conclusively proved this fact. Bhatia et al (1982) have found that secondary oxidation ponds could be utilised as excellent breeding ponds for reariry fishfry. The growth rate of fishfry in secondary sewage stabilization pond was much more that that observed in nursery ponds. The nutrient removal ratewas also much higher that that found in tanks with no fish breeding. The Zooplankton density in secondary ponds have been observed to be much greater than that in nursery ponds. It is because of this that fishfry grew at a faster rate. The increase in Zooplankton is attributed due to the presence excessive phytoplankton. Phytoplankton, in turn removes nutrients at a fast rate. So pisiculture is an additional method for polishing of waste waters. Moreover nutrients are transformed into food.

Pitchai et al (1982) observed that the growth rates of O. carpio, L.rohito and L. fimbriatus were higher in secondary oxidation ponds. The total yield of fish in the primary pond was found to be 4245. Kg/ha/yr. and that in secondary pond was 7300 Kg/ha/yr. The waste flow was 1,60,000 lpd. The conversion factor for algal biomas into fish (F/A ratio) was 0.71 - 1.452 in primary pond and 0.47 - 1.24 in secondary pond. Thus pisiculture removes floating algal biomas, thereby cleaning the secondary effluents. Waste water from septic tanks could be renovated by upflow an aerobic filter or coarse media filter. The water that flows out can be diverted for cultivation. Thus waste water utilisation becomes complete, before purified water emerges out. In water-logged and rocky areas, sand and soil mounds of 1 - 2 m. height and of required area are raised and performated pipes laid and waste waters from septic tanks applied to the soil. Aerobic action stabilises the waste organics and treated water flows out. This water can be utilised for irrigation or allowed to mix surrounding water as the case may be.

Utilisation of agricultural wastes for waste water renovation have been attempted all over the world. Waste waters that contain toxic metal ions such as Cu^{2+}, Pb^{2+}, Zn^{2+}, Cd^{2+}, Cr^{6+}, Cr^{3+}, Ni^{2+} AND Hg^{2+} could be renovated by several unconventional methods using agricultural wastes. These methods are economically viable and ecologically berign. Peanut skin, walnut expeller meals meals, modified cotton, modified bark, paddy husk, paddy straw, bagasse and onion skin have been investigated with regards to their effectiveness in binding heavy metal ions. Most of these heavy metal ions could be reduced to levels lower than permissible limits by accacia plant bank (Kumar et al (1981). In batch as well as column experiments; Kumar et al (1981) could remove copper con. from 85 ppm to 1.1 ppm, lead from 30 ppm to 0.05 ppm, zinc from 37.5 ppm to 2.5 ppm, cobalt from 2.5 ppm to 0.01 ppm, nickel from 40 ppm to 3.3 ppm, chromium from 1.1 ppm to 0.05 ppm and iron from 31.1 ppm to 0.1 ppm. Tree barks are by-products of timber industry. These could be economically used in renovating industrial wastes. Thus both waste products are utilised to obtain clean and renovated waters.

Recycling of refinery effluent by land application will achieve many objectives such as renovation of effluent, utilisation of used water and prevention of pollution of surface water streams (Mishra et al, 1981). Sugar can cultivation can be accomplished by pulp and paper mill wastes. No adverse effect has been observed on the yield of crops like cotton, corn and grasses by using waste water from pulp and paper mill (Reddy et al, 1981). Wheat, paddy and ground nut cultivation have been attempted with waste water from paper mill wastes. Sugarcane yield increased considerably when irrigated with treated paper mill effluent. The water recharged into the ground gets renovated. Thus waste water is recycled both for beneficial use of irrigation and renovation of the effluent.

SUMMARY AND CONCLUSION :

Water conservation and waste water renovation have been discussed with special reference to unconventional but ecologically acceptable and economically feasible methods. The prime thrust in this paper has been with the idea of utilisation of water with great stringency and recycling the same to the greatest extent possible. Energy intensive technolo-ties are slowly replaced by biological methods. The pattern of water utilisation also requires a great probel Bath room waste should be utilised for reflushing, thereby saving 30 - 40% of water supplied per person per day. This will involve in saving of crores or Rupees. Fodder crops, fish culture and fertilising the soil are other plus points in the recycling process. In certain cases total recycling of water as that done in space flight opens up new vistas of water conservation. Application of industrial waste water for irrigation and cultivation of certain crops would reduce the cost of pollution control besides utilising the water.

Such of the measures discussed in this paper and other similar measures along can bring forth an equilibrium environment where, renewable resources are renewably used and non-renewable resources exploited to the minimum extent. This alone can prolong the life sustaining capability of this plant.

REFERENCES

1. Aowal, A.F.S.A., and Singh, S.K., (1981). "Treatment of Vanaspathi Effluent by Water Hyacinth", Jour.Inst.Pub. Heal.Engrs.1981, 4, 13-19.

2. Bhatia, H.L., and Sastry,C.A.,(1982). "Rearing of Fish Fry of Indian Major Corps in Sewage Stabilisation Ponds". Proce. 8th WEDC Intn. Conf.1982, PAUT, Madras, 35-1-35-4.

3. Chaphekar, S.B., and Mhatre, G.N.,(1981). "Role of Aquatic Plants in Water Pollution Control", Ind.Ass.on.Wat.Poll. Contl. Tech. Annu., VII, 108-115.

4. Eckenfelder, Jr., W.W.,(1979). Principles of Water Quality Management, CBI Publishing Company Inc.Boston,Mass -660

5. Gupta, R.C., and Khan, R.H., (1977). "Water Hyacinth for Benefit of Man", Yojana, June, 16-17.

6. Khan, R.R., (1976). "Put Water Hyacinth to Use", Science Reporter, 13, 11, 669 - 670

7. Kotiah, B., Ramaprasad, G., and Pratapa Mowli, B.,(1981). "Removal of Phosphates from Sewage by Soils", Jour.Inst. Pub. Heal. Engrs, 1981, 4, 101 - 109.

8. Kumar, P., and Dara, S.S., (1981). "Removal of Toxic Heavy Metals from Lead Battery waste using Modified Accacia Bark" Jour. Inst. Pub. Heal. Engrs., 1981, 4, 1 - 6

9. Mishra, R.P., Sharma, L.N., Dixit, R.C., and Raman, A., (1981). "Recycling of Refinery Effluents for Agriculture", Ind.Assons. Wat. Poll. Contl. Tech. Ann. VII, 116 - 128

10. Nambiar, K.R., (1978). "High Nitrogenous Waste Treatment by Flocculating Algal-Bacterial System". Ph.D. Thesis, Indian Institute of Technology, Kanpur.

11. Nambiar, K.R., and Iyer, T.S.R.,(1982). "Desalination by Aquatic Weeds", Proc. 8th WEDC. Intnl. Conf. PAUT,Madras, 15 - 1 - 15 - 3.

12. Ortega, A., (1972). "The Problem No. 2", The Ecol operation, School of Architecture, McGill University, Montreal, Canada.

13. Pitchai, R., and Govindan, V.S.,(1982) "Reuse of campus sewage for Pisiculture and Agriculture", Proc.8th WEDC Intl.Conf. PAUT,Madras, 8-1-8-4

14. Raman, V., (1979). "Water Hyacinth - Foe or Friend", News Letter. Ind. Assn. Wat. Poll. Conf. Aug. 8 - 9

15. Reddy, A.K.N., (1981). "Principles of Environmentally Sound Development", Rural Technology, Vol. I, Proc. Short Term, Course Co-ordinated by ASTRA, Indian Institute of Science, Bangalore, 2.5 - 1 - 2.5 - 14.

16. Reddy, M.R., Hivendra, and Jain, S.C., (1981) "Paper Mill Effluent for Sugar-cane Irrigation", Ind. Assn. Wat. Poll. Contl. Tech. Ann. VIII, 129-146

17. Wolverton, B., (1978). "Flower Power and Aquatic Energy Source", Int. Exch. News, 19, 3 - 5

THE POTENTIAL OF WATER HYACINTH IN WASTE WATER TREATMENT

DR. M.N. RAO*

1. INTRODUCTION

Water hyacinth, Eichornia Crassipes (Mart) Solms, the free floating fresh water plant is one of the most successful colonizers in the plant world. Originating in Venezuela, the water hyacinth has now spread profusely throughout the sub-tropical regions of the world and has been the subject of many scientific investigations. It can also survive equally well in temperate climates. The water hyacinth has proved to be a persistant and expensive aquatic weed problem in every part of the world it has invaded. Most of the earlier studies of this aquatic plant were directed towards eradication, since the rapid growth rate of mat-forming water hyacinths obstructs navigable water ways, prevents proper drainage of land, interferes with aquatic recreation, restricts the supply of sunlight to submerged plant and fish life, reduces yield from rice when it invades flooded croplands, and increases the evaporation rate of water bodies by 3.2 to 3.7 times through evapotranspiration through the leaves.

Large mats of water hyacinth have about 95% liquid content. This is because for each part of solid created, the water hyacinth soaks up asmuch as 19 parts of water. This can have drastic consequences, especially in arid or semi-arid regions like Nile valley, wherewater hyacinths sponge up water that could be otherwise used for irrigation.

The image of water hyacinth is being changed by the U.S.National Aeronautics and Space Administration (N.A.S.A.). The charactristics that have caused this plant to be cursed for decades, make it an ideal and the most promising candidate for solving many serious problems in areas of food supply, energy requirements, and water purification.

The water hyacinth shows promise for partially supplying life-sustaining functions for space stations (oxygen,food,pure water, waste treatment, etc.) in addition to providing many earthly benefits. Boys and others have shown that vascular aquatic plants such as the water hyacinth are a possible food source for animals and human beings (in their studies examining the amino-acid,protein, vitamins and mineral nutrient content of these plants). The conversion of plant material to usable products such as compost and methane gas through anaerobic fermentation is a promising approach to the problems of depleted energy sources. It can also purify domestic and certain industrial waste waters and produce large quantities of freash water.

2. PROPAGATION:

Water hyacinth propagates both by seed germination and by vegetative means whereby mature plants produce rosettes of leaves and fibrous roots at each node of the growing stem. In an observation

---

* Professor-in-charge, Technical Teachers' Training Institute Extension Centre, Bangalore - 560 001.

made in Lousiana, two plants produced 380 off spring in 23 days and 1200 within four months under the most favourable conditions. It is known that 10 plants can multiply to 6000,000 and virtually carpet an acre of water in only 8 months.

The main reason for the water hyacinth's ability to spread so rapidly is very simple. Its swollen petioles or leaf stalks allow it to float, thus freeing it from a terrestrial grip. The plants' leaves act as sails and when driven by the wind, E.Grassipes has been observed travelling upstream against the current. Consequently the water hyacinth is widely recognised as one of the most serious aquatic weed problems known to exist in warm climates. (1).

3. CONTROL AND ERADICATION MEASURES:

The water hyacinth is able to reproduce itself faster than it can be killed off. So far, all the control methods used have proved unsatisfactory in some respect. Herbicides like sodium arsenite and 2, 4-D, a plant harmone, that kill hyacinths are are available but they are suspected of adversely affecting aquatic life, areexpensive to apply and it is difficult to spray these herbicides efficiently.

For over 27 years, 2, 4-D, alone has been used in an effort to control the water hyacinth. other control measures involve biological agents such as insects and diseases. Recently, integrated programmes using both chemical and biological control efforts have shown a greater degree of success. Control and eradication measures in most of the countries have been greatly hindered by the remoteness of many of the heavily infested areas and by the lack of modern technology and equipment necessary for either spraying of machanical harvesting. (1)

4. UTILIZATION OF WATER HYACINTHS :

Although water hyacinth has been considered an uncontrollable monster for a hundred years, its image is now being changed by the U.S. National Aeronautics and Space Administration (N.A.S.A.) by conducting a series of experiments at the National Space Technology Laboratories. NASA's multifaceted programme for the effective utilization of water hyacinths can be divided into four areas:

4.1 Domestic Waste Treatment

4.2 Chemical Waste Treatment

4.3 Growth rate and harvesting studies

4.4 Product development (Water hyacinth products) to utilise the tremendous quantities of bio-mass that can be removed daily from lagoon during favourable conditions. (1)

4.1 Domestic Waste Treatment: For several years NASA has been experimenting with the use of water hyacinths, as an inexpensive, natural biological waste filtration system. This system promises to be economical, versatile waste water treatment method for upgrading sewage effluent from existing lagoon systems. This is highly preferable to the alternative of installing an entirely new waste treatment system. (1.2).

4.11 Type of domestic waste water lagoons:

Domestic waste water lagoons can be generally classified into three categories :

- Anaerobic
- Aerobic and
- Facultative, combining features of anaerobic and aerobic ponds.

The effectiveness of sewage lagoons or any domestic waste treatment facility is evaluated from the measured reduction of bio-chemical oxygen demand and total suspended solids in the waste water, from the influent point to the discharge or effluent point. Removal of certain nutrients, primarily nitrogen and phosphorus is also receiving attention in order to prevent the accelerated eutrophication (nutrient enrichment) of lakes and streams which receive waste water discharge. (2)

The development of relatively inexpensive methods for upgrading lagoons that do not require sophisticated and constant operation and maintenance is urgently needed. Effective reduction of algae and suspended solids in lagoon effluents is the highest priority research goal. (1,2)

4.12 Water Hyacinth for upgrading waste water lagoon:

In an effort the upgrade the existing facultative lagoons at the NSTL, as inexpensively as possible and without building new facilities in order to meet the new EPA regulations, the water hyacinth (because of its nutrient removal ability via their extensive root systems) was introduced into the main lagoon. Based on the measured growth rates, Rogers and David (3) estimated that 1 ha of water hyacinths could remove the nitrogen and phosphorus waste of over 800 people/day. These concentrated nutrients can then be removed from the system by harvesting the water hyacinths. The harvested plant material has potential economic value as a soil amendment, livestock feed and perhaps even as a human protein supplement.

NSTL lagoon consists of a single cell with a surface area of approximately 2 ha had an average depth of 1.22 m and received a relatively low organic load. Wolverton and Mc Donald (2) have reported the performance of this lagoon before and after the addition of water hyacinths. Results indicated that when water haycinths assume a primary role in waste water lagoon, the operation of the system is significantly altered.

The algal community is rplaced by a rapidly growing macrophyte that continuously converts dissolved organics and nutrients into a standing bio-mass which is not rapidly re-cycled and does not contribute to Total Organic Carbon (TOC) of the system.

As a result effluent from a haycinth covered lagoon will be lower in suspended solids, BOD_5 and nutrients.

During the evaluation period, average effluent BOD_5 was reduced by 95% from 110 mg/l to an average of 5 mg/l in the effluent. Also during the same period the average influent suspended solids were reduced by 90% from 190 mg/l to 10 mg/l in the effluent. The average monthly total kjeldahl N_2 (Ammonia and organically bound N_2) was reduced from 12.0 to 3.4 mg/l prior to discharge and the total phosphorus was reduced from 3.7 to 1.6 mg/l. Due to the improved quality of the lagoon no odours were evolved. (2)

4.13 Water Hyacinths for up-grading Secondary Facultative Lagoon:

In a similar study using a secondary facultative lagoon which received the discharge from a primary aerated lagoon, water hyacinths also effect a significant improvement in water quality. Field tests using water hyacinths as biological filtration agents were conducted on the Mississippi Gulf coast region in the vicinity of NSTL. The plants were installed in a single cell, and one multiple cell sewage lagoon systems.

4.131 Single Cell Sewage Lagoon System:

The Bay St. Louis sewage lagoon experiment established or reaffirmed that water hyacinths will thrive on raw sewage and the high nutrient levels present in this medium stimulate rapid growth. A smaller (4 to 6 hectares) water hyacinth covered lagoon would be more efficient in serving the residents. A system of this size would produce a sewage effluent of excellent quality within the prescribed limits of 30 mg/l BOD_5 and 30 mg/l TSS.

4.132 Multiple cell sewage lagoon system- Orange grove lagoon System:

A multiple-cell sewage lagoon system designed by Wolverton and McDonald consisting of two aerated and one water hyacinth-covered cell connected in series demonstrated the ability to maintain BODS and TSS levels below 30 mg/l year round. A water hyacinth covered lagoon with a surface area of 0.28 hectare containing a total volume of 6.8 million litres demonstrated the capacity to treat 437,000 to 1,893,000 litres of sewage influent from 2.65 hectares of aerated lagoons daily and produce an effluent that met or exceeded standards year round.

Results:

The water hyacinth covered lagoon demonstrated the ability to reduce the total suspended solids year-round from a yearly average level of 40 mg/l to a yearly average effluent level of 14 mg/l.

The BoD_5 was reduced to 70% from influent level of 50 mg/l to an effluent level of 15 mg/l. Water hyacinths successfully reduced the level of this nutrient below the maximum allowable level of 6 mg/l. Water hyacinths maintained the pH of the effluent within the prescribed limits of 6.0 to 7.8 during all months. In addition, the plants created a buffer effect, reducing the magnitude pH fluctuations. Water hyacinths substantially reduced the concentration of dissolved O_2 from an average of 5.3 mg/l to an average of 2.1 mg/l. Water temperature was slightly but not significantly lowered throughout the year. This effect is perhaps due to shading and evaporative cooling (4).

Cornwell et. al. conducted waste water treatment experiments using water hyacinths to upgrade treated waste water from a trickling filter plant and polishing pond system in Florida. These experiments reaffirmed the idea that the nutrient removal capacity of a water hyacinth system is greatest during the active growth phase and is dependent on the surface area to retention time ratio.(5)

Several other experimental prototype water hyacinth systems are currently in design or under evaluation.

4.2 Chemical Waste Treatment:

The water hyacinth's unique survival capacity has made the permanent eradication of this plant very difficult.

This characteristic was further tested in static laboratory experiments with toxic chemicals in order to evaluate its potential for purifying not only domestic waste water but also industrial waste water. (1)

The discharge of industrial waste must be regulated, since its constituent components-both organic and inorganic have been shown to have deleterious effects. Toxic heavy metals tend to concentrate in the fauna and flora of the aquatic environment and produce a variety of effects in man once they are injected.

One hectare of water hyacinths could potentially purify two million litres of water polluted with 1 ppm cadmium, 2.2. million litres polluted with 10 ppm lead and 3.4 million litres of water polluted with 1 ppm mercury in 96 hrs. Since these plants grow and photosynthesise very rapidly and since they are adapted to an aquatic mode of existence, water hyacinths could prove very useful to environmentalists in two primary ways. First, water hyacinths might actually be used as agents to aid in the removal of spilled heavy metals; Second, since a rapid up-take of metallic ions occur even during the first hour of exposure, water hyacinths could be used as indicator or monitor organisms to assess chronic pollution levels at factory out-flows, in high risk areas or even in drinking water lakes and rivers. (7)

4.21 Water hyacinths for removal of organic chemicals:

Phenol and phenolic derivatives are common organic pollutants found in domestic and industrial waste water and in drinking water supplies.

Wolverton and McKnown demonstrated that the water hyacinth can effectively remove 36 mg of phenol per g dry weight of plant material in 72 hrs. Since 1 ha contains approximately 162 x 106 plants and the average dry weight per plant was determined to be 2.75 g, 1 ha of water hyacinths could concievably remove 160 kg of phenol in a 72 hour period.(8)

4.3 Productivity Studies:

Previous growth rate studies by Dymond, Penfound and Earle were used by Westlake in estimating that theannual productivity of the water hyacinths is 11.33 m.t./ha dry weight. A later study by Wooten and Dodd(11) found a production of 30 m.t organic matter/ha in only 105 days. Westlake (12) projected that possible maximum annual production rates of 110 to 150 m.t organic matter/ha/year could be obtained if the plants were regularly thinned out to reduce self-shading and grown in tropical or sub-trophical climates.

4.4 Harvesting Techniques:

In order to maximise the efficiency of nutrient removal by water hyacinths, the plants should be periodically harvested as they become saturated with excess nutrients. Although the necessity of periodical harvesting of the water hyacinths adds to the cost of operation of the lagoon system, these floating plants are much more easily harvested than submerged or rooted aquatics.

Ideally, the harvested plant material should be utilised, in order to defray the cost of removal. Various investigators have proposed using harvested water hyacinths as food supplement both for cattle and humans, as a soil additive, as a source of paper and fibre and as energy source.

Confinement of harvesting activities to single location would minimise transportation and handling costs, thus increasing the economic feasibility of utilising water hyacinths' by-products.

Locating dryers, choppers and other water hyacinth processing operations near the lagoon would further reduce processing and transportation costs (2).

4.51 Nutritional Composition of Water Hyacinths:

In the last few years, many investigators have directed their research endeavours to the utilization of water hyacinth. In favourable climate zones water hyacinth grown in enriched mediums, such as sewage lagoons, could potentially serve as a dietary supplement or nutrient source. Gosset and Norris (14) have demonstrated a definite relationship between nutrient

availability and the nitrogen and phosphorus content of water hyacinths. Haller and Sutton(15) analysed water hyacinths grown in nutrient solutions with different phosphorus concentrations and found that the phosphorus content in the plants increased as the phosphorus content of water increased upto a maximum level of 40 ppm phosphorus in H_2O.

The nutrient composition of water hyacinths is generally proportional to the nutrient content of the medium in which the plants are grown. Sewage grown water hyacinths should be particularly high in protein and minerals, ie., plants grown in lagoons with higher loading rates contain proportionally greater amount of curde protien.

4.52. Composting:

The relatively high mineral content of the Water Hyacinth comparable to that of many crop species, suggests that this plant could make a good soil additive. In a study comparing water hyacinths with commercial fertilizers, Parra & Hortenstein (17) found that water hyacinth applications produced as good or better drop yields than did applications of commercial fertilizers for certain soil types. Water hyacinth udergoes an aerobic decomposition process, in composting in which all of the organic matter is stabilised. The water hyacinghs are piled six to eight feet high and allowed to decompose naturally. The piles should be turned atleast once a month to keep them aerobic. This process requires three to six mohths for completion depending on the temperature and the amount of turning. Once the decomposition is complete, the compost should be spread to dry and then coarsely ground. Due to the hygroscopic nature of the water hyacingh, this compost has high moisture retention properties. It is an excellent organic soil supplment for sandy soils(1). Basak (18) found that the nutrient content of the water hyacinth compost was approximately four times greater that that of Farm Yard manure and twice as great as compost prepared from town refuse and night soil.

4.53 Bio-gas:

The third product which is receiving much attention is bio-gas. Bio-gas is produced from the anaerobic fermentation of the substrate-water hyacinth. Batch digestar incubated at 36° C at NSTL has produced 350 to 411 litres of bio-gas per kg dry wright of water hyacinths. This bio-gas contains approximately 60% methane. With the phenomenal growth rate of water hyacinths , the possibility of producing a substitute natural gas is more and more appealing. Based on the annual productivity of 154 mt/ha when grown in a fertile sewage lagoon, one hectare of water hyacinths could produce sufficient bio-mass to generate approximately 58,400 m^3 of bio-gas containing 35,100 m^3 of methane.

4.54 Fresh Water Recovery:

Another potential by-product of a water-hyacinth waste treatment system, which has received little attention to date, is the tremendous quantity of pure water which can be recovered from the evapotranspirati n f th

at NSTL have shown that with properly sized systems, upto 40% of the daily waste water can be recovered as pure fresh water by collecting the water that is literally pumped into the atmosphere via the plant leaves.

4.55 Author's experiments:

Encouraged by the results published by NSTL, the author performed experiments on water hyacinths in the areas of harvesting techniques, domestic waste treatment, industrial waste treatment and bio-gas generation. The results obtained by the author compared favourably with the NSTL results. The details of the experiments conducted and the results obtained will be presented in a subsequent paper.

4.56 Conclusions:

Water hyacinths provide a means of sewage treatment which is sound both ecologically and economically. Agricultural projects using the water hyacinths appear to be a promising addition to the currently accepted waste treatment methods. Water hyacinths must surely be recognised as the plants of the future for their capabilities of (1) purifying waste water (2) for their high nutrient value (3) for their potential to be converted to food, feed, fertilizer and energy sources and (4) for freshwater recovery by evapotranspiration. In this time of increasing ecological awareness and tightening pure strings, such a water hyacinth system is not only desirable but also essential.

References :

1. WOLVERTON (Billy C) and McDonald (Rebecca C) "Water Hyacunth: From Profilic Pest to Potential Provider" (Ambio pp 2-9)1979

2. WOLVERTON (Billy C) and McDonald (Rebecca C) "Upgrading Facultative Waste Water Lagoons with V ascular Aquatic Plants", (Journal Water Pollution Control Federation) February 1979 pp 305-313)

3. ROGERS (HH) and DAVID (DW) "Nutrient removal by Water Hyacinth". (Weed Sci, 20 (5), 1972 pp 423)

4. WOLVERTON (Billy C) and McDONALD (Rebecca C) "Water Hyacinths for upgrading sewage lagoons to meet advanced Waste Water Treatment Standards: Part II "(NASA Technicak Memorandum TM-X-72730, Washington DC, 1976.

5. CORNWELL (DA) et al. Journal Water Pollution Control Federation 70,57,1977.

6. WOLVERTON (Billy C) and McDonald (Rebecca C) Proceedings of the 1977 National Conference on Treatment and Disposal of Industrial Waste Waters and Residues, April 26-28, 1977 pp 205-208.

7. WOLVERTON (Billy C) and McDonald (Rebecca C)
Water Hyacinth Sorption Rates of Lead, Mercury and Cadmium.
NASA/ERL Report No. 170 1978.

8. SMITH (RW) et al. (Journal of the Mississippi Academy of Sciences supplement 22,20,1977)

9. WOLVERTON (Billy C) and McKnown (Mary M)
Water Hyacinth for removal of Phenols from Pollution Waters.
(Aquatic Botany, 2 1976 pp 191-201)

10. SMITH (RW) and SHORE (FL), Ibid, 23,22 (1978)

11. WOOTEN (Jean W) and DODD (John D)
Growth of Water Hyacinths in Treated Sewage Effluent
(Economic Botany, 30(1), pp 29-37)

12. WESTLAKE (DF) Comparisons of plant Productivity
(Biological Review,) 38 pp 385-425,1963)

13. WOLVERTON (Billy C) and McDonald (Rebecca C) "Water Hyacinth Productivity and Harvesting Studies. ERL Report No.171, March '78

14. GOSSET (DR) and NORRIS (WE). Relationship between Nutrient availability and content of Nitrogen and Phosphorus in tissues of the Aquatic Macrophyte Eichornia Crassipes (Mart) Solms, (Hydrobiol, 38 (1), 1971, pp 15-28).

15. HALLER (WT) and SUTTON (DL)
Effect of pH and high phosphorus concentration on growth of Water Hyacinths (Hyacinth Control Journal, 11, 1973 pp 59-63)

16. WOLVERTON (Billy C) and McDonald (Rebecca C)
Nutritional Composition of Water Hyacinths grown on domestic Sewage.
NASA/ERL Report No. 173, 1978.

17. PARRA (JV) and HORTENSTEEN (CC)
Plant Nutritional Content of some Florida Water Hyacinths and response by Pearl Millet to incorporation of water hyacinths in three soil types (Hyacinth Control Journal. 12,1974 pp 85-90).

18. BASAK (MN) Water Hyacinth Compost pp 13-15
In Little, E.C.S., ed., 1968. Handbook of Utilisation of Aquatic Plants, FAO Publication.

COLLECTION AND TRANSPORTATION OF HIGHT SOIL FOR SEWERLESS SANITATION SYSTEM.

N.C.SHAH *

INTRODUCTION

The need for a safe and acceptable sanitary methods of disposal of night soil need not be further emphasised as an essential requirements for protection of public health in any urban community. It is observed that the average rate of urban population growth in developing country is about 5-6%. With industrialisation and rapid urbanization in last 30 years, the situation in our country in regard adequate water supply and proper treatment of waste water is not satisfactory. Very few towns have been able to provide underground sewerage systems. Installation of a complete piped sewerage system and treatment plants are beyond the reach of municipalities of the medium sized towns and have always been remain on the blue prim sinee several years. This is due to a number of limiting factors such as limited fund, shortage of materials and technical skill, lack of precise municipal regulations and codes. The rural sanitation technique in the form of pit privy and bore hole latrines can also not be feasible for these towns. Under this circumstances, some alternative solutions to the conventional system should be investigated for their feasibility and economical viability.

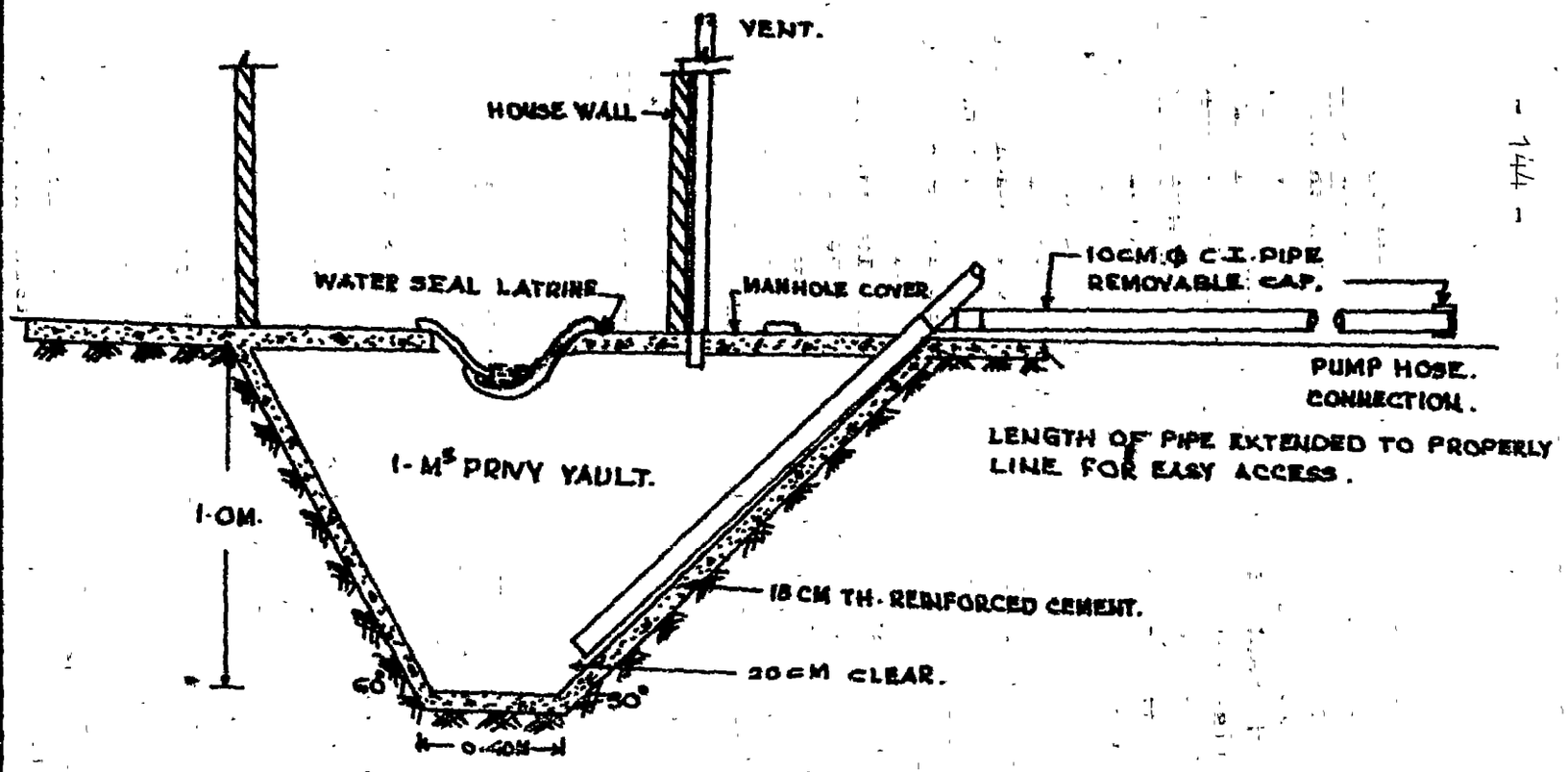
In applying alternatives to the piped sewerage and thereby reducing costs, certain compromise in technical efficiency is to be made. Where settlement is sparser, local disposal can be effective by land disposal provided the soil conditions are suitable. The collection in privy vault, transportation by truck, the heat treatment of night soil and its utilization as fertilizer may be investigated as promising alternative systems. This is so where the piped water supply schemes are not provided or where the water supply is quite inadequate to go for costly sewer lines. In this context, the transporting cost of night soil plays important role in the overall economy of the project. The attempt have therefore been made in this paper to discuss only the collection and transportation aspects of the system, the cost of which is estimated at about 60% of the total cost of the system.

THE COLLECTION SYSTEM

The individual household toilet system should be so designed as to allow easy access for the labourers to pump out the night soil. One typical arrangement of the toilet system is shown in Fig. 1. The volume of the privy vault is determined by the number of persons per household, the rate of night soil production the amount of water used for flushing the water seat bowl and the frequency of collection. A basic

---

* Lecturer in Civil Engg. Deptt., S.V.Regional College of Engg. and Tech., Surat- 395007



TYPICAL TOILET SYSTEM. FIG NO. 1

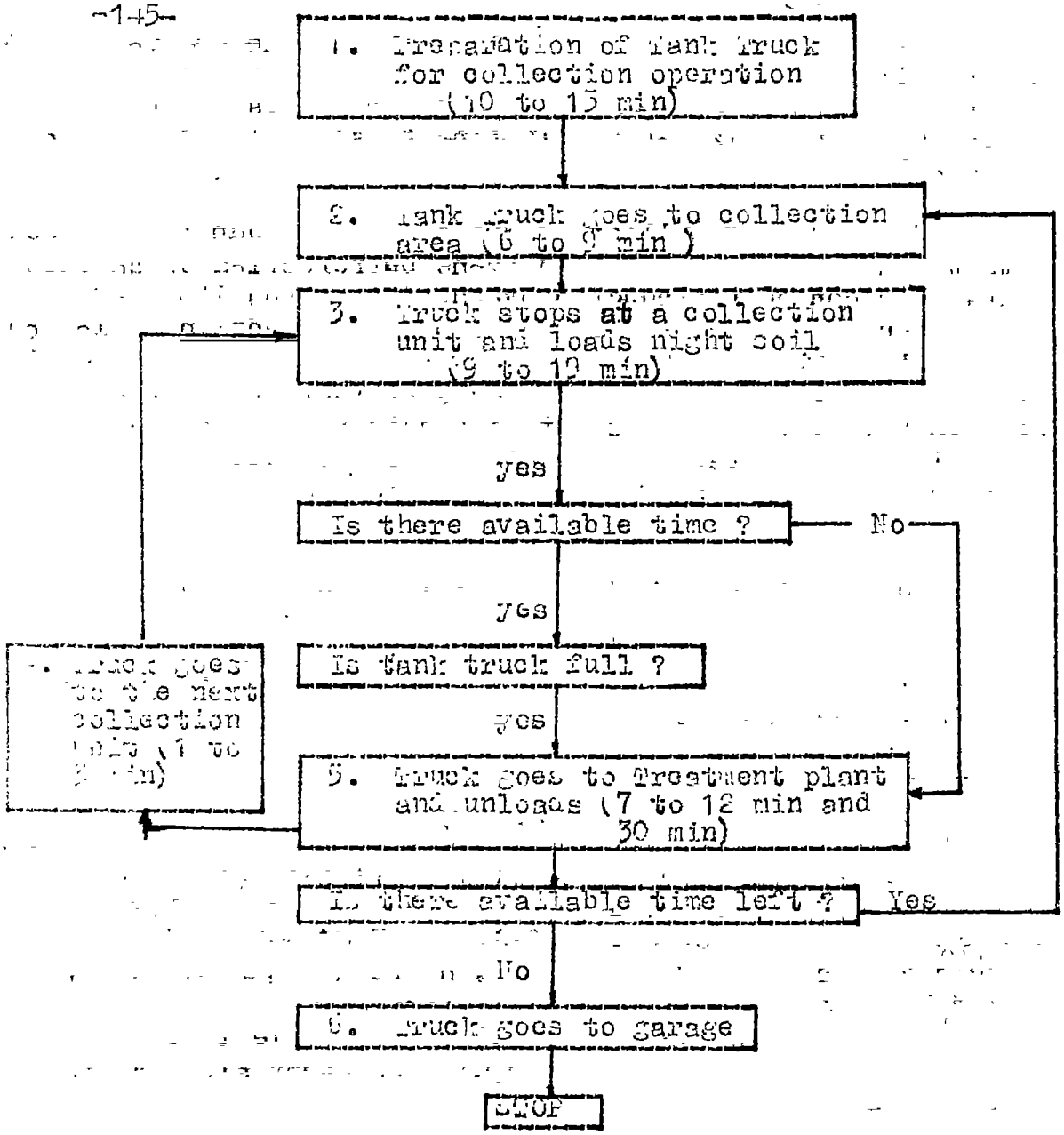


Fig. 2 Logical Flow chart of a collection operation

assumption must be made to be able to determine the volume of night soil including flushing water deposited in the vault. The flushing water may range between 1-3 litres per flush depending on the size of the latrine flush pail and habit of the people.

The frequency of collection practised in Japan is 3-4 weeks with the night soil having undergone putrefaction to some extent. An experiment conducted by the Taiwan Institute of Environmental Sanitation on the effect of detention period on night soil indicated about 50% reduction on N.P. and k nutrient in 6 days. It is therefore necessary that collection frequency interval be as short as possible to conserve the fertilizer nutrients. The added cost of collection due to shorter collection frequency interval must be balanced against the cost of nutrient losses.

The estimate volume of night soil including flushing water produced by an average family of 7 persons at the frequency of 4 week is about 590 to 980 litres. A one cubic meter volume of volt privy is therefore adequate to accomodate the night soil produced by an average family upto 1 month production.

SIZE OF COLLECTION TANK TRUCK

The side of tank trucks for night soil collection varies. In Japan, the tank truck usually has a capacity of 1.8 m^3 and staffed by two person. In Taiwan and m^3 and 6 m^3 vacuum tankers are used. They are also using 20 m^3 tanker-trailer pulled by a farm tractor and employing collectors with small tank carts for house to house collection, while in Bangkok 6 and 8 m^3 tank trucks are being used to carry sludges from septic tanks.

The use of 20-m^3 tanker trailor would need smaller tank cars for house to house collection and is suitable to areas where narrow lanes and backhouse collection arecommon . For more recently developed towns, whereback-house have to night soil pipe extended near the roadway, the 8 m^3 tank truck equipped with vacuum pump and, 100-150 m length of hose will be adequate for all collection and delivery

COLLECTION OPERATION AND TRANSPORTATION

The flow chart showing the different sequences of a collection operation and the time needed is shown in Fig.2. Since there is no available accurate data on the time spent on each activity of the collection operation, basic assumptions have to be made in order to determine the number of, tank trucks required. The other parameters that are considered are:

i) Distance between treatment plant and collection area

ii) Capacity of tank truck = 8 m^3

iii) No. of crew per tank truck = 2 collectors plut driver
volume of night soil per service unit = 0.5 m^3
Vacuum pump capacity = 110 litre/min.
Collection frequency = 2 weeks
Tank truck speed loaded = 20 kmph
Empty = 20 kmph

Based on these basic assumptions using the expected value for each activity; the time spent per trip is about 300 mni. For an eight hour working day, the tank truck can make 2 trips per day, tank truck being full during the first trip and only about 5 m^3 of night soil collected on the 2nd trip. A management policy may be adopted such that each tank truck will have to take 2 trips daily, each trip taking on a full load. By removing thetime constraint on the length of working period, the crew would strive to fill the 8 m^3 tank truck twice and call it a day instead of working 8 hours every day. This policy will serve as an intensive for the crew who are being paid on hourly basis. An 8 m^3 tank truck therefore can service on the average 30 service units per day working 10 hours continuously with an average volume of night soil collected equal to 16 m^3. For a town, with 50,000 population, total number of service units work out to be 7150 considering 7 persons per household. The number of service units to be served daily at a collection frequency of a 2 week is therefore 7150/14 = 510 service units/day. The number of tank truck required for a 50,000 population works out to be 510/30 = 17 tank tracks.

If two-shift collection operation is adopted working continuously every day, the number of tank-trucks required will be reduced to half the normal number but the cost of labour and truck operation are doubled. To give added reliability on the collection operation, additional 2 to 3 units of collection tank truck may be provided so that servicing and repairs may be carried out without interrupting the collection operation.

CONCLUSIONS

The cost of night soil collection under basic assumption made, vary with the size of tank truck, distance of treatment plant to collection area and the amount of flushing water usage. The use of larger collection tank truck and transfer station (tank trailer) will greatly reduce the unit cost of night soil collection.

The overall cost of night soil collection and treatment is reported as 21 per capita per year (i.e. About Rs. 10/= per capita per year) considering the fertilizer value of night soil may be sold at 50 to 78 m^3 (i.e. Rs.25 to 40 per m^3). It is therefore concluded that night soil collection and treatment is feasible provided that a market exists for the utilization of the treated human waste.

ACKNOWLEDGEMENT

The author is very much greatful to Prof. R.N.Shelat, Prof. of Civil Engg. Deptt. of S.V. Regional College of Engg. & Tech., Surat, for the purposeful discussion while preparing this paper.

QUALITY CONTROL OF BOMBAY WATER SUPPLY

SHRI V.M. SHIDHAYE* AND SRI N.W. MIRCHANDANI**

1. Introduction:

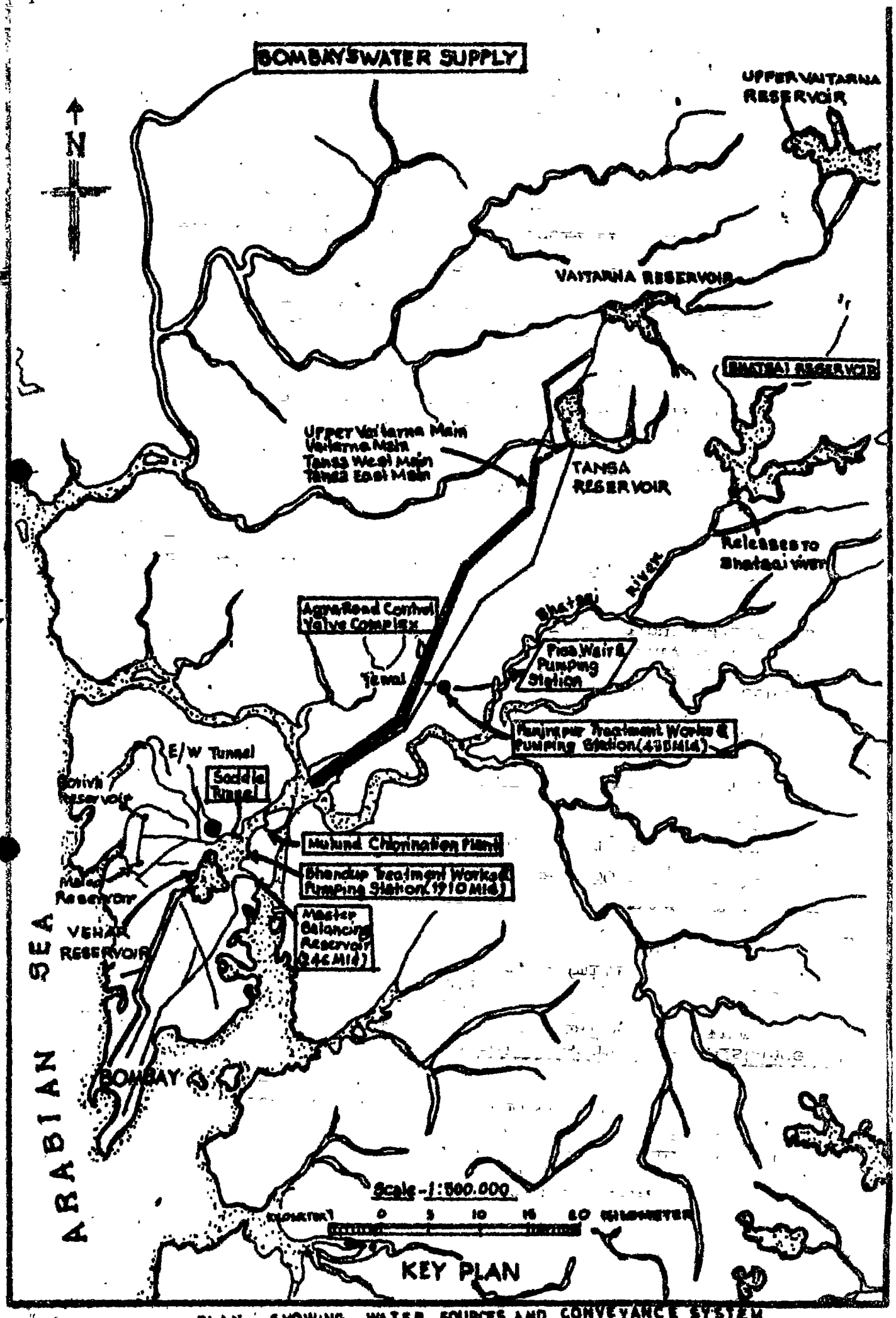
Bombay's water is both unique and complex. The city of Greater Bombay received at present about 2,000 mega litres of water daily for a population of about 8.5 million. The major sources of water supply are impounded reservoirs situated at distances of about 100-125 K.Ms. from the city which are indicated in the table below :

Lakes	Year of construction.	Fully supply level. Metre T.H.D.*	Lowest Drawable Level. Metre T.H.D.	Useful contents in million litres.	Normal daily withdrawal (million Ltrs.)	Distance from Bombay K.Ms.	Remarks
1.Vehar	1860	80.64	73.93	41404.08	50	29	
2.Tulsi	1979	139.18	131.10	11350	18	35	
3.Tansa	1892	128.66	114.33	184596	318	106	
4.Vaitarana	1955	163.11	126.83	270856	490	119	
5.Ulhas	1970	-	-	-	91	45	*** This was constructed as an emergency scheme when the Govt. allowed the waters to the extent of overflows from the river at Kalyan to be picked up, treated and pumped into the system.
6.Upper Vaitarana	1972	603.65	582.32	295100	544	106	
7. Bhatsa	1980	103.05	75.00	241364.6	454	109	*** The river extends over a distance of about 48 K.Ms. downstream of Bhatsadam before its waters are picked up at Pise and pumped into the system.

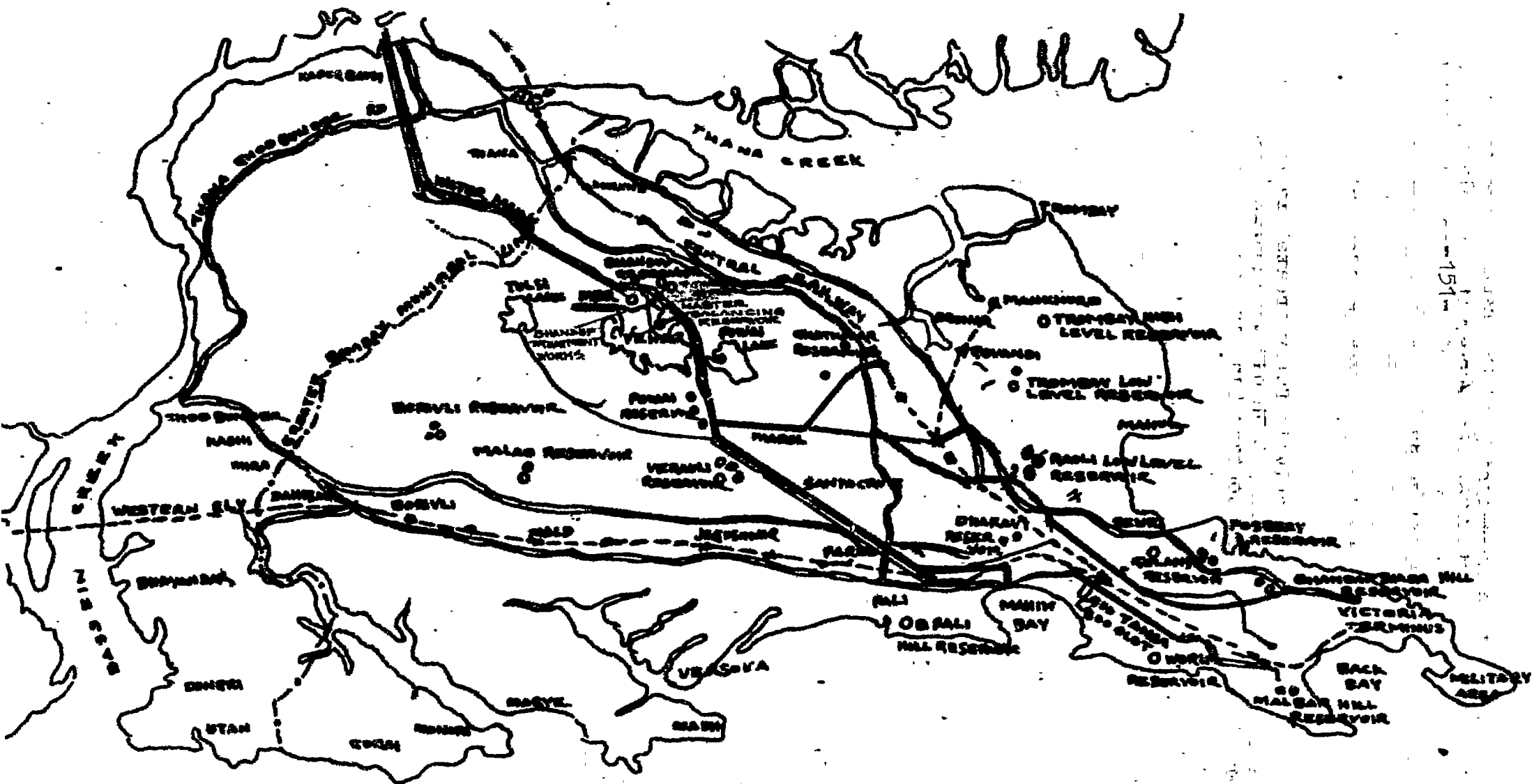
* T.H.D. = Town Hall Datum = M.S.L + 24.46 metres.

* Chief Engineer, Water Supply Projects.

** Deputy Chief Engineer, Water Supply Projects.



PLAN SHOWING WATER SOURCES AND CONVEYANCE SYSTEM



PLAN SHOWING THE LOCATION OF SERVICE RESERVOIRS

Prior to commissioning of the first stage of Bhatsa water supply scheme in 1981, Bombay's water supply was mainly disinfected by injecting the doses of Chlorine. Two major changes in the Bombay water supply system have occured after the World Bank aided Bhatsa Project.

1. All the water supply which was formerly conveyed fro from the sources by gravity, is now pumped.

2. The water supply is fully treated in the central two stages Treatment Plant at Bhandup. The filtered water before leaving Chlorine Contact Tank is produced to the exacting standards as under :-

i) Turbidity not exceeding 0.4 J.T.U.
ii) Suspended solids not more than 1 mg/l.
iii) Absence of Coliform organism and residual Chlorine of 0.4 mg/l.

From the Chlorine contact Tank the water is pumped to the Master Balancing Reservoir from where it is fed to the existing Service Reservoirs. The outlets from the various service Reservoirs feed the different distributory zones. For supply to the individual consumer, separate connections from thedistributory mains ar granted to the individual premises.

2. Existing Status :-

For distribution purposes, the City of Greater Bombay is divided into 79 zones. Each zone is fed by an independent outlet from the Service Reservoir. At present there are 19 Service Reservoirs in the City and 16 reservoirs are proposed to be constructed in the near future. The supply to the individual zone is intermittent one for a period of about 4.5 hours in a day. During the supply hours the mains are charged and remain under pressure, while during the rest of the hours the mains are empty. The Sewerage system in most of the areas, particularly in the congested areas in the heart of the City, is grossly inadequate with the result that most of the time the sewers are surcharged. In the monsoon season the prbblem is aggravated further and the overflow from the sewers and sub-soil water gets sucked in the water mains during non-supply hours. Many of these mains have been laid 40 to 50 years back and have developed leaks. Thus, contamination of drinking water takes place and in many cases, water borne diseases such as Typhoid, Jaundice and Dysentory are reported year after year from these areas.

There is an independentagency of Municipal Analyst who collects water samples every day from the various points in the distribution system. About 600 samples are collected in a month from different points spread throughout the City. Apart from that, whenever complaints are received from the consumers, extra water samples are taken by the Hydraulic Engineers' Department. These are analysed for bacteriological, quality as well as for the residual Chlorine and in case of unfit samples, corrective action like flushing of water mains, locating and repairing the source of contamination and re-chlorination of the mains by protable chlorinators is taken. In extreme cases, mechanical scraping of the pipe line by using mechanical scrapers is also done. The samples are collected again till they are found fit.

At the service reservoirs, rechlorination is done by admitting chlorine solution into the inlet mains. The chlorine dose is adjusted in such a way as to maintain a free residual chlorine of about 0.2 mg/l. at the farthest end of the distributory mains to take care of the chance contamination.

In addition to regular samples, periodic samples are collected from different lakes and complete physical, Chemical and bacteriological analysis is carried out. Epidemicological studies are also carried out particularly, in areas where the incidance of water borne diseases is high. Samples are collected from the areas and premises occupied by various strata of society such as from individual flats, chawls, slums etc. These studies will also help in determining the effectiveness of supply of filtered water to the consumers and the reduction of incidence of water borne diseases in different strata of society.

3. Constraints :-

For almost a century, Bombay received unfiltered water supply with chlorination as the only treatment. It is only in 1982 that fully filtered water is being supplied. Many of the distributory mains laid are old. The supply is intermittent, the sewerage system is undersized. Many of the buildings are also old and connections to these have been granted more than 50 years back. With introduction of filtered water supply in the system, there is a need for careful monitoring and study of the quality of water received by the consumers. Even though, a rigorous leak detection and prevention programme is embarked by the Municipal Corporation of Greater Bombay, yet there remains a number of leaky joints in the pipe lines, corroded service pipe lines etc. which need renewal, reconditioning or repair. There are about 2,000 K.M. of distributory mains in the City and about 2 lakhs connections are granted to individual buildings and con-sumers. To replace, repair or condition these mains and pipelines will :

1) require a huge financial investment,
2) require a large increase in the trained supervisory staff,
3) Certain types of the materials like cast iron pipes and galvanised iron service ipies and sanitary fittings are in short supply. Thus, finance materials and trained man power particularly at the foreman level are the various constraints in effectively controlling the quality of Bombay's water supply.

4. Need for improvement and need for a master plan :-

It will thus be seen that for effective quality control of Bombay's water supply so that the consumers may get the full benefit of the improved water quality produced at the Treatment Plant, there is a need for improvement in the following areas :-

1) Corrective action needed at the sources of water supply.
2) Effective control needed at the Treatment Plant to produce the water of the required quality.
3) Strengthening the water sampling programme in the distribution system.

4) Need for rigorous leak detection and prevention programme.

5) Replacement of corroded pipes and fittings.

6) Need for supply of water on continuous system rather than on a intermittent one.

7) Need for improvement and augmentation of Sewage Collection and disposal system on a priority basis.

8) Adequate and effective steps to prevent contamination in the consumers premises.

9) Establishment of additional laboratories.

10) Training to be given to the various categories of staff particularly at the foreman's skilled workers level.

11) Need for establishing effective public relations.

5. Estimated Cost :-

It is difficult to state or estimate the cost of all the improvements needed, as the cost is bound to run in astronomical figures. However, a beginning can be made by allocating certain amounts towards the quality control of water supply every year. To start with, it is suggested that an amount of at least 10 crores per annum be earmarked for the works towards replacement or renovation of distributory pipes, and replacement of service pipes and fittings, establishment of laboratories, purchase of portable chlorinators, purchase of modern leak detection equipment and training of staff. This amount is in addition to the cost of establishment and operation of the existing additional treatment plants.

6. Mode of Finance :-

The capital works should be through public borrowing or by getting loan from L.I.C. etc. or with the aid from international agencies such as World Bank, UNICEF, WHO etc. The cost towards maintenance and operation can be met from the revenue grant of the Corporation.

7. Action needed :-

A constant vigil is needed in monitoring the quality of water at various stages from the different sources to the consumers. Some of the actions needed are enumerated below :

(1) Corrective action needed atthe sources of water supply :

(a) Sampling Programme :

Sources at Vaitarana, Upper Vaitarana, Tansa Vehar and Tulsi are the impounded reservoirs while the supply from the Bhatsa source travels through a distance of about 48 KM in open river downstream of Bhatsa dam till the Pick-up Weir at Pise. During this stretch there is possibility of contamination occuring from the industries, from the agricultural wastes, and township situated within the catchment area.

Action is therefore needed to organise the sampling programme for regular monitoring of the various sources of water supply from different points and at different depths. This need is particularly great in the open stretch of 3 48 KM between the portion downstream of the Bhatsa dam and Pise Pick-up weir. In the Tansa catchment area, there are certain villages some of them quite large as at Khardi, whose wastes are being washed in the Tansa lake during the monsoon season with the result that the NPN count of Tansa waters during the monsoon season, particularly after the first floods, is considerably high. Similarly, after the commissioning of the Bhandup Treatment Plant, the water treatment plant wastes are discharged into the Vehar lake. Some hutment colonies have also sprung up in the Vehar catchment area. Vaitarana lake is a deep lake and the characteristics of the waters at different depths are dissimilar. To draw the water of the acceptable quality requires a need for effective sampling programme at various depths. From the above it will be seen that it is very necessary to organise and pursue a sampling programme with regular monitoring of the various sources of water supply so as to pin-point the points and nature of the contamination and to take effective corrective action.

Physical parameters such as turbidity, colour, PH and temperature should be monitored daily while a complete physical, chemical, bacteriological and biological analysis with special reference to the determination of nitrates, phosphates, sulphates, chlorides and algal count should be carried out once a week.

b) To carry out sanitary survey of the catchment areas.

c) To determine the industries and villages and townships etc. whose wastes are likely to drain into the sources.

ii) <u>At the treatment plant</u> :-

To study the characteristics of the incoming of raw water and effluent filtered water and also to study the methods of disposal of the sludge and its adequacy.

iii) <u>Sampling programme in the distribution system</u> :-

The reorganise of the sampling programme in the distribution system so as to covdr :

a) All the distribution zones.

b) Areas where there are incidence of water-borne diseases.

c) Areas served by distributory mains with dead ends.

d) To increase the number of samples to confirm with WHO standards of one sample per 10,000 population per month.

e) To establish extra laboratories for testing water samples in the city as well as in the subarban areas;

f) To purchase adequate number of portable chlorinators modern laboratory equipment etc.

Iv) Leak detection and prevention :

For the purpose of leak detection and waste prevention the 79 water distribution zones are subdivided into 525 leak detection zones each comprising of 250-300 consumers' connections. Even then there is a need to strength of the leak detection programme as the distribution system is fairly old and due to the intermittent supply coupled with granting of unmetered connections to slum areas, the taps are either kept open or removed in certain areas. The anti-social elements even damage the pipes todraw unsuthorised water. This results in waste of water.

Some of the steps that can be taken to make the leak detection programme more effective are as follows :-

a) To organise and pursue a vigorous leak detection and waste prevention programme throughout the city.

b) To organise periodic surprise checks during the supply hours in different areas of the city and thus arrest visible leaks.

c) To select certain smaller zones where 24 hours supply should be given at a low pressure, so as to evaluate the effect of continous supply vis-a-vis intermittent supply with respect to contamination complaints.

d) To chalk our programme of replacement of leaky pipes and fittings and re-aligning them particularly in the house gullies.

e) To investigate effectiveness of galvanising vis-a-vis pipe coatings with tapping etc.

f) To insist on the use of I.S.I. Marked pipes and fittings to ensure use of proper materials and thereby reduce chances of frequent leaks.

g) To commission newly laid water mains only after proper leak and pressure testing.

v) Corrosion Control :

To corrosion problems in the city of Bombay are of two folds viz: Galvanic corrosion and stray current corrosion Galvanic corrosion is due to nearness of sea and stray current corrosion is due to D.C. traction used for Suparban Railways. Corrosion by both these reasons is of higher magnitude. However, the effect of stray current corrosion is of serious nature due to high fluctuation in the voltage of the corrosion currents. Various remedial measures suggested to combat the evil effects of corrosion are impressed current cathodic protection system, providing insulated flanges on the pipelines where there are more chances of corrosion and effective external coatings for underground pipelines.

vi) Prevention of contamination in consumers' premises :-

In a recent study carried out by NEERI, it was noticed that in 80% of the cases the contamination takes places within the private premises due to the leaky pipes and fittings, stoping water in unhygienic tanks and con

Action needed in this regard can be as follows :-

a) To educate the people regarding accurance of contamination within the private premises.

b) To issue notices regarding periodical cleaning of suction and overhead storage tanks of the owners/tenants of the private premises.

c) To issue notices and follow up action for replacement of corroded pipes and fittings in the private premises.

d) To maintain public relations to contribute through articles, Press releases and exhibiting cinema slides and short films in educating people regarding leakage, waste of water and contamination.

viii) Establishment of quality control cell :

There is need for establishing a centralised quality control cell in the water department of the Municipal Corporation of Greater Bombay. The cell will monitor the quality of water at different sources, organise collection of samples and water analysis. It will also be responsible for establishment of various laboratories. It will establish co-ordination with thevarious statutory authorities, with the press and various departments of the Corporation. It will give directions to the leak detection and prevention staff and prescribe standards for discharge of waste in the various sources of water supply. It will also train the various staff in their respective specialised fields.

viii) Improvement of Sewerage System :-

The Water supply System cannot be looked into isolation from the waste carrying system. The existing sewerage system is undersized and old and in many areas, it is not existing. This leads to many problems of contamination occuring in the pipelines. There is, therefore, a need for immediate renovation and strengthening of sewage collection and disposal system. The Municipal Corporation of Greater Bombay has created a unified authority known as Water Supply and Sewerage Department which is co-ordinating and carrying out the various improvement and augmentation schemes both as regards to Water Supply & Sewerage Collection and Disposal System.

8. Recommendation and Conclusion :-

Bombay's problems in controlling the quality of water supply are unique and stupendous. There is a back log of decades to be overcome. In other places the treatment plants and the other facilities are generally existing and only augmentation is done, the staff is already trained, which has to be increased. But in case of Bombay at one stroke, we have started giving filtered water to the consumers. It needs training of staff at all stages in the operation and maintenance of treatment plants, water sample collection and testing, leak detection and waste prevention and to carry out the various tasks in the most effective way. Huge sums of money are involved in operating one of the World's largest Water Treatment Plant at Bhandup. It is estimated that the quantities of chemicals used in the treatment plant will be about 12,000 tonnes of alum and 2,500 tonnes of

chlorine per annum. It is very necessary to ensure that adequate and regular periodic supplies are insured as any lapse on this count will affect the treatment processes and thereby the quantity of the water produced at the treatment plants. Considerable savings in economy can be affected by the trained, conscientious staff in operating and main taining the water supply system. Training course have been organised and staff has been trained both within the country and by deputing them abroad. There is a need for large investments in future towards carrying outw works of repairs, renovations, and replacement of hundreds of KM of pipelines of various sizes and materials. The contamination can be greatly reduced by bringing down the leakage figure which at present is about 15% to 10% or so. There is also need for establishing centralised seperate cell for quality control of Bombay's water supply. The task is indeed a challenging one, but the satisfaction drived from the knowledge of supplying this vital health giver water to the citizen of Bombay is even more.

"ROLE OF COMMUNICATION AND HEALTH EDUCATION IN WATER SUPPLY AND SANITATION PROGRAMME"

A.C. Johri* and Dr. A. Rahman**

The attainment of the targets of health for all by the year 2000 A.D. through primary health care is gaining momentum in all the countries of the world. It was in the response to the United Nations Declaration and programme of action on the establishment of a new international economic order, adopted by the United Nation's General Assembly in the spring of 1974. Subsequently the World Health Assemnly decided on the target of health for all by the year 2000 A.D., and the Alma Ata Declaration adopted by the International Conference on Primary Health Care.

One of the basic component of primary health care is sanitation which has seven areas:

1. Drinking water supply
2. Housing
3. Disposal of refuse and garbage
4. Disposal of human and animal excreta
5. Prevention of air pollution
6. Sewerage and drainage
7. Environmental restoration and beautification

The United Nation's Conference on Human Settlement (Habitat) set 1990 as the date for community water supply and sanitation to include all urban and rural areas. The United Nation's Water Conference repeated the Habitat Conference Commitments ad considered that :

(A) All people have the right to have access to drinking water in quantities and of a quality equal to their basic needs.

(B) It was universally recognised that availability of water resources to man is essential for life and his full development, both as an individual and as an integral part of society.

(C) Similar consideration apply to all that concerns the disposal of waste water, including sewage, industrial and agriculture waste and harmful sources, which are the main task of public sanitation system of each country.

The attainment of the target for the International Drinking Water Supply and Sanitation Decade, 1981-1990, i.e. safe water supply and sanitation for all by 1990, will require new joint sectoral approach both in national and local strategies.

Planning Commission has constituted a high powered "Working Group On Health", with Secretary, Ministry of Health and Family Welfare as its Chairman in July 1980. The water supply and Sanitation was assigned to one of the subgroups of working Groups on "Health For All". According to a rough assessment of the Ministry of Works and Housing,

---

*Audio-Visual Officer, All India Inst. of Hyg. & Pub.Hlth., Calcutta.

** Assoc. Prof. of Health Education, All India Inst. of Hyg. & Pub. Hlth., Calcutta.

Govt. of India, the projected requirements of funds for the decade would be that of Rs. 15,000 crores to provide the minimum basic services to all the people in the country(both urban and rural).

The Draft Sixth Five Year Plan (1978-83) provides for about Rs.2,700 crores for the water supply and sanitation sector. It further suggests that the outlay for these programmes for the period 1978-83, 1980-85 and 1985-90, should be as follows:

1978-83	..	Rs. 2,700 crores
1980-85	..	Rs. 4,000 "
1985-90	..	Rs. 6,000/Rs.9,000 crores

(Source Report of Working Group on Health for All By 2,000 A.D., Ministry of Health and Family Welfare, pages 67,68, March 1981).

Before planning a communication and health education programme for water supply and sanitation, we must have an idea of the hazards of water pollution which may be classified as (1) Biological hazards and (2) Chemical Hazards.

Biological hazards include water borne diseases caused by the presence of an infective agent or an acquatic host in the water.

Chemical hazards are due to chemical pollutants which are increasing day by day. These pollutant include detergents, solvents, cyanides, heavy metals, minerals and organic acids, nitrogenous substances, bleaching agents, sulphides etc., toxic and bio-cidal organic compounds etc.

Communication and Health Education have very important roles to play in these areas. Before we go into further details of Plan of Action, we must know:

What are the natural, regional and local problems in these areas of water supply, sanitation and health delivery case.

The process of communication and Health education has to take problem-solving approach which passes through three different stages:

(1) Awareness stage - That the problem exists.
(2) Analysis of the problem to identify its root causes which is a continuous process.
(3) To develop strategies to correct the problem and to prevent future occurrence.

However, complete health hazards and problems created by hiological and chemical hazards cannot be solved by Problem-Solving approach alone. These environmental problems are the conditions on the biophysical environment which hinders the satisfaction of man's needs for health and happinness. Therefore, communication and health education in this area has to be future oriented for the protection of quality and quantity of environment which could not exist, unless we have succeeded in creating a society which has succeeded in satisfying basic human needs for a major segment of society.

To develop citizens who have a knowledge about the biophysical environment and its associated problems, and are aware of how to become effective in working towards a more livable future and is motivated to do so.

(1) Communication and Health Education concerns with "Man, and The Educated People", not the environments.

In developing an educational programme we must be specially concerned with those aspects of human behaviour which are related to man's interaction with the biophysical environment and his ability to resolve biophysical environmental problems.

The magnitude of these problems will require a Mass Environmental Information explosion on issue including air and water pollution, over population, sanitation, urbanization, chemical additives and pesticides, energy resources including problems of human ecosphere such as housing, health and welfare etc., racism, numbers and their increases etc.

In relation to communication and education people have to be motivated at an early stage to help achieve the objectives of the water supply and sanitation decade by the carefully planned use of communications media. It should be a permanent feature of training and support programme for community participation and health education on these unmanageable areas.

What Communication Can Do ?

(1) Motivate the people at early stages to help achieve the objectives of the decade of water supply and sanitation.

(2) It should be a permanent feature in the training programme.

(3) It should support community involvement and participation.

(4) It should support in the health education aspects of the problems.

(5) It should highlight the close relationship between safe water, good sanitation, food hygiene, adequate nutrition, restoration of natural environment beautification and health.

According to differences in programme areas and local customs, traditions and behaviour different Health Education and Communication strategies may be planned with pretesting of communication methods and media for each target group is most essential. As we are well aware that these problems of water supply and sanitation is Local Municipalities and Panchayats functions while we have not yet involved these agencies and institutions more than four years have lapsed.

These programmes will consist of projects and activities according to the needs and practical feasibilities in a country in a local area and they should have -

- set specific targets for a specified period in total number of 5,70,000 villages;
- identify projects and plan the schedule for their implementation on a year-to-year basis;
- should specify institutional arrangements for planning, implementation, operation and maintenance;
- establishment of staff and their training and logistics;

PROGRAMMES COVERAGE:

The water supply and sanitation programmes should cover from every household, locality, community, village, block, squattes settlements, slums town areas, cantonments, small and medium sized towns and regions of water catchment areas.

PROGRAMME DESIGN:

Programme design should include financial support and management of municipalities and panchayats, study of ground water and new resources, assessment of sanitation and training programmes for muncilpalities staff.

COMMUNICATION AND HEALTH EDUCATION PROGRAMME PLANNING CONSIDERATIONS:

Communication and health education can be taken up in two major areas : (1) Preparation of Audio-Visual media, pretesting and distribution and supply of manuals, flash cards slides, films and other audio-visual aids for staff training support, including community health volunteers, and other auxiliaries.

(2) To organize health education programmes in each area of water supply and sanitation programmes.

Each programme will need different messages, media and communication skills for the success of the programme.

The task would be to assist lower-level workers and community auxiliaries to learn new tasks and accept responsibilities. Further appropriate method of communication should be used suited to each level of workers and activity for specific target communities.

Package of water supply and sanitation teaching aids should provide relevant information to different programmes in a single package of information.

Health Education programmes have to be developed in schools, non-formal education, in Clinics, in the places of work and in the community.

Mass media should also be used in a general way to supply the required information on health and hygiene and other items.

Media must be responsive to public interest which is critical factor in understanding news coverage. We have to keep in view the news worthyness of the items, area to be covered and the public demand etc. No doubt Environment and Sanitation problems are news worthy issues. When the environmental news coverage will increase, automatically public environmental interest will increase and the public interest will decrease as the novelty of the programme wears off. The perpetual crisis wears thin, the media coverage will decrease also.

Media must have entertainment and persuasive communication. Massmedia and folk media has a very important role to play in sanitation and environmental education. Even the mere exposure of sanitation problems can be our most effidient education.

In designing communication and health education strategies we should not forget how an average Indian spends time. We must cater to the needs of village farmers, village women, urban women, children, school-going and non-school going, youths and the elderly population.

Children's literature, cartoons, folk tales, stores, puppet shows, radio and television can do a lot in educating the community about the sanitation and environmental hazards, which will go a long way in attaining the goal of health for all through primary health care.

STATUS OF LOW COST SANITATION IN GUJARAT.

Y.N. Nanjundiah* and B.J. Vasavada**

1.0 The State at a glance

The state of Gujarat covers an area of 187091 sq.kms. which is 5.7% of the total Indian Terriotory. The population of the State as per the first Census report of 1981 census is 33.96 millions. The breakup of urban and rural population is as under Rural 23,404,474

Urban 10,550,431.

The average population density works out to 173 persons per sq.km. The ratio of urban and rural population is 28.72 living in 255 towns and 18275 villages respectively.

1.1 The climate is sub-humid to arid with maximum temperature of 46°c and minimum temperature of 4°c. The annual average rainfall over the past 10 years is in the rangge of 33 mm. in the driest district of Kutch to 1520 mm. in the district of Dangs. However, extreme years can reduce the rainfall to 20% of the above figures as in the 1972 or can double it as in the year 1976.

1.2 The Geohydrological features of the State are Tabulated in Table 1 below:

Table : 1

Sr. No.	Nature of site	Area in sq. Kms.	Percentage of State areas
1.	Rocky areas	93,302	47.6
2.	Re-charge Areas (Probable)	3,815	1.9
3.	Suitable Zone for Tubewell construction.	25,488	13
4.	Over developed areas	6,160	3.1
5.	Saline Zone (lime Stone)	1,550	0.8
6.	Saline Zone sea	43,095	21.98
7.	Low discharge shallow tubewell areas	12,942	27

Kutch district is an arid zone and it occupies about 25 percent areas of Gujarat State. Banaskantha and part of Mehsana District, in north Gujarat and all districts of Saurashtra are scarcity Prone. There is a problem of salinity ingress along the coastal areas.

2.0 Present status of water supply and Sewerage sector in the State.

2.1 Urban Water Supply:

There are 255 towns in the State of Gujarat with a total population of 10,556, 431 lacs as per 1981 census. Out of these 255 towns, 168 towns have organised piped water supply with a comparatively high coverage of population.

* Member Secretary, GWSSB, Gandhinagar.

** Dy. Executive Engineer, GWSSB, Gandhinagar.

2.2 Rural Water Supply:

Out of the 18275 villages 11550 villages have been declared as problem area villages. 4826 problem villages have been covered with water supply as on 1.4.82 and the 4212 villages are proposed to be completed during the Sixth Plan.

2.3 Urban Sewerage:

22 Towns in the State have sewerage facilities. These facilities are also partial. Table No. 2 below gives the coverage of population under the sewerage system in the State.

TABLE NO. 2

Sanitation Service Coverage - Population Served as on 31.3.1982

Sr. No.	No. of Towns	Population served in millions. Total	%	Population unserved in millions. Total	%
1.	3 Corporation Towns (Ahmedabad, Vadodara, Surat).	2.04	68%	0.95	32%
2.	19 Towns	0.71	70%	0.30	30%
3.	233 Towns	-	-	5.924	100%
Total:	255 Towns	2.75	-	7.174	-

2.4 Rural Sanitation:

The total rural population of the State is 2,34,04,474. Out of this population, only a population of 53000 has been provided with rural sanitation schemes. Thus only 0.23% of the total rural population has been covered under this service.

3.0 Decade targets for the State:

The following targers have been accepted for the Gujarat State to be achieved during the International Water Supply and Sanitation Decade 1981-1990.

(a) 100% population of the Class-I cities to be covered with sewerage and sewage treatment facilities.

(b) The other urban communities will be provided with low cost sanitation facilities such as conversion of bucket latrines into sanitary latrines, construction of new private and community sanitary latrines.

(c) The overall coverage targets in all these urban communities would be 80% including Class-I cities.

(d) The 25% of the rural population to be covered with simple sanitary latrines. The physical targets to be achieved in the field of sanitation during the Decade (1981-1990) has been estimated as under :

(a)	Urban population to be covered with new facilities.	57,76,000
(b)	Urban population to be covered by way of aggmentation of existing facilities.	43,68,000
(c)	Rural population to be covered with sanitation.	1,05,35,000
	Total:	2,06,79,000

4.0 The existing and planned service level concerning urban and rural sanitation in the State of Gujarat is given in Table No. 3 below :

TABLE- 3

Sr. No.	Particulars	Population served in thousands. 1981	1991
1.	Urban population	4368	5776
2.	Rural population	53	6645
		4421	12421

5.0 At the end of the year 1979-80 there were 170249 nos. of bucket latrines. Out of this a total number of 142373 nos. of bucket latrines have been converted into waterseal latrines. 27876 latrines are yet to be converted as they are of bucket type. It is proposed to convert these latrines into Sanitary latrines during the Sixth Plan period (1980-85) for which a provision of Rs. 80 lacs is made in the Sixth Plan.

5.1 A scheme for progressive conversion of dry latrines in Gujarat into flush type of latrines was introduced in the Fourth Five Year Plan. It provided sharing of cost of such conversion by the owner, the local body and the State Govt. in the ratio of 2:1:1. Under this scheme to-day the owner gets 25% of the conversion of Rs.200/- whichever is less from local body as well as from the State Government. The remaining amount has to be borne by the owner himself. This subsidy is granted only to the private latrine owners for dry latrines constructed before 31st March 1970. There is a provision of granting loans to local bodies on request for the following purposes :

(a) 50% loan of the total conversion cost of public latrines of local bodies. In 1979 Government has decided to raise this to 100 per cent of the total conversion cost.

(b) 100% loan for giving subsidy amount to be paid by the local bodies to private latrine owners, if they are unable to provide funds for giving subsidy.

Loans are provided to local bodies through Social Welfare Department for purchase of wheel burrows hand-carts and other mechanical equipment. The scheme is operative still in all those Municipal and Panchayat Areas where dry latrines exist.

5.2 A sample survey has indicated that the percentage of household without latrines is as under :

(a)	Urban	..	27.52%
(b)	Rural	..	93.70%

324974 houses, out of the 13,65,079 houses in the urban area are provided with latrines that means there is only one latrine per 23 persons. As mentioned above in rural areas 93.70% houses are without latrines.

6.0 Five Year Plan Coverage:

TABLE- 4

Plan Coverage Proposals

(Rs.in Millions)

Sr. No.	Sub-Sector	1966 - 76	1974 - 78	1978 - 79	80-85
1.	Urban sewerage	14.00	11.05	5.049	27.0
2.	Rural Sanitation	2.00	1.78	0.009	2.6
3.	Latrine converstion programme.	-	3.37	-	8.00

7.0 Existing financial pattern:

The financing pattern prescribed by the State Govt. for the sanitation schemes are as under :

A. For Sewerage Scheme:

The state Govt. provides grant-in-aid to local bodies for the implementation of their sewerage schemes as per the norms mentioned below in Table No. 5.

TABLE- 5

Grant-in-aid for Sewerage Schemes

Sr. No.	Class of Town	Population range.	GIA for sewerage project (%cost)
1.	A	Above one lac.	35%
2.	B	50,000 to one lac.	45%
3.	C	10,000 to 50,000	55%
4.	D	Below 10,000	60%
5.	For Surface Drainage.	Below 10,000	50%

B. The State Government has finalised the financing pattern for the low cost sanitation project to be implemented in the State as under :

(cost of private latrines is estimated as Rs. 2,000.00)

(i) For the Harijan areas:

(a) 75% State Government grant.

(b) 25% to be provided by the local body to be provided by the local body for which the State Government will provide loan at 6% interest. There will be Government subsidy to the extent of 50% towards the interest charges.

(c) No contribution is to be obtained from Harijan beneficiaries.

This pattern is subject to the condition that 30% of the expenditure is incurred in Harijan areas.

(ii) Non-Harijan areas:

(a) 50% State Government's grant-in-aid.

(b) 30% to be provided by the local bodies.

(c) 20% contribution from the beneficiaries.

The burden of interest as well as repayment of loan will not be levied on the beneficiary house-owner.

(d) The beneficiary house-owner having a monthly income less than Rs. 500/- will be provided with a soft loadn at 6% interest to be repaid in 24 monthly instalments to meet with his share of 20% of the cost of latrines.

The Government will provide necessary loans to the local body at an interest rate of 6% and to be repaid within a period of 15 years.

8. The existing organisation for the latrine conversion programme:

The programme of conversion of dry latrines into water seal latrines is being implemented by the concerned local body and is being continuously monitoried and controlled by the Directorate of Municipalities under the control of the State Department of Panchayat, Housing and Urban Development. The local bodies have been permitted to give their part of the subsidy for the conversion programme in kind instead of cash, for example pans, traps, pipes, slabs, cement, etc. to private latrine owner if they so desire and as a means to promote the programme. The programme is being implemented with the help of Sanitary Inspectors under the control of Municipality.

9. Impmenting Agencies:

9.1 An innovative step was taken by the Goverrment to involve the Safai Vidyalaya established by the Harijan Sevak Sangh at Gandhi Ashram, Ahmedabad. The principal of Safai Vidyalaya was appointed as Honorary Advisor to the Govt. to ensure effective and speedy implementation of the latrine conversion programme by promotional work and lias on with the local body, and guiding and monitoring the programme activity. The close association and active involvement of a non-official social agency has added a special dimension to the programme.

9.2 The Safai Vidhyalaya has been equiped with a mobile education van which moves through out the State for taking up health education programme by way of arranging latrines, documentary fils, charts and posters. The Films Division of the Government of Gujarat has also prepared a film showing various social and health aspects of the latrines conversion programme being taken up in the State.

10. TrainingProgrammes:

The Training and motivation programme are being conducted in Gujarat under the auspices of the Safai Vidalaya at Gandhi Ashram, Ahmedabad. Short-term courses are conducted to train the Chief Officers of the Municipalities, Sanitary Inspectors, Taluka Development Officers, Presidents of the Village Panchayat etc.

11.0 Studies Undertaken:

11.1 Pollution Studies:

To study the effect of pollution due to the low cost waterseal latrines with two pits system, a latrine so constructed at Kheda (a town of Kheda District) was selecyed and 1w numbers of bores were drilled around latrines at varying distances. On completion of these bores, the samples of soil as well as water as water met with in the bores were examined by the Gujarat Water Pollution Control Board and Gujarat Engineering Research Institute. After examination of the soil and water samples, it has been concluded that there was no pollution effect observed either in the soil or in the underground water table.

It has been experienced and observed based on this study that extend of pollution flow in most of the soils is very low. Leachpits can be located in a soil partly saturated/fully saturated, the extend of pollution depends on

(a) Nature of soil.

(b) Velocity of ground water flow.

If the soil has suitable filtration conditions, and if there is a distance of 2 metres from the bottan of pit to the water table, water source can be as close as 3 metres, otherwise 10 metres away from the leach pit.

If there are cracks etc. in the rocky strata, this design of soak pits cannot be adopted. This would need other alternatives like Aquaprivies, Septic tanks etc.

Systematic monitoring of ground water in the towns where such pits are located would provide further data to examine the problem in more details.

11.2 Evaluation Studies:

The evaluation studies in the Gujarat State envisaged to evaluate on-going programme of conversion of dry latrines into pour flush water-seal latrines in urban areas in Gujarat from the State and the local body levels to the level of individual household. Six tows as under with a total population of 1,97,021 were selected for State as representative of the State as a whole. They represent a range on different geological, hydrological, social and economic condition and civil and other amenities existing in Gujarat.

Sl. No.	Town	Taluka	District	Population (Census 1971)
1.	Patan	Patan	Mehsana	64,519
2.	Palanpur	Palanpur	Banaskantha	42,114
3.	Mangrol	Mangrol	Junagadh	28,443
4.	Chhota-udepur.	Chhota-udepur.	Vadodara	14,312
5.	Sahijpur Bogha	Ahmedabad	Ahmedabad	32,300
6.	Kheda	Memhedabad	Kheda	15,333
			Total:	1,97,021

After completion of evaluation studies a detailed report has been prepared as regards the socio-economic and legal aspects to be taken into consideration during the preparation of the low cost sanitation project in the State. This report has been of extensive use during the feasibility studies.

In the course of the project preparation, a number of special studies were undertaken, including evaluation of the on-going latrine conversion programme an assessment of pollution hazards of ground water and water distribution system, optimization of alternative technical solutions, and the social implications of scavengers rendered redundant by new practices. The feasibility studies were completed prior to project appraisal least cost solutions were presented and the suitability of using these in the project areas was established. The populations in the target towns range between 9,000 and 120,000 totalling 612,000 (Estimated 1980). At present about two-thirds of the population have no house latrine facilities. The objective of the first stage of the programme (1982-86) is to reduce the backlog by half, individual household latrines, and the remainder community latrines.

The majority of latrines to be provided under the project will be pour-flush, waterseal latrines discharging into underground leaching pits. There are certain areas within the project towns where other alternatives will have to be considered. These are the areas where soil conditions are poor or where there is a danger of contamination of drinking water sources. Such areas will be investigated during the first stage programme. However, for maximum impact the project will concentrate in the first stage on the widespread application of technology.

12. Low Cost Sanitation Project in 15 Towns of the State:

The Gujarat Water Supply and Sewerage Board has already prepared the feasibility report for implementing the low cost sanitation project in the 15 selected towns of the State. In March 1981, the World Bank pre-appraisal mission visited the State. Prior to this Mr. John Calbermatten of the World Bank had also visited Gujarat in November 1981. During the visit the World Bank appraisal were very much impressed of the work and latrine conversion programme in the State and also they were satisfied with the project preparation and implemented capabilities of the GWSSB and Hence they dedided to include a component of low cost sanitation in the Guharat Water Supply and Sewerage Project for IDA assistance.

12.1 Gujarat Water Supply and Sewerage Board had presented a project package costing Rs. 137.54 crores to the International Development Association of the World Bank for Development of the Water Supply and Sanitation Sector in the State of Gujarat. The project was appraised in the month of June 1981. The project was been negotiated by the Indian Delegation which visited Washington in the month of May 1982. The Board of Directors of the International Development Association of the World Bank have approved a credit of Rs. 72 million U.S. Dollars (Rs. 61.2 crores) for the project.

The Government of Gujarat is fully committed to the Internationnal Drinking Water Supply and Sanitation Decade and intends to bring about very substantial improvements in water supply and sanitation services both in urban and rural areas. As part of its Decade objectives, Govt. of India intends to ensure that 80% of the population of smaller towns have access to sanitary latrines, connected to safe disposal system.

The UNDP Global project GLOp 18/806 executed by World Bank, was established to assit Government in achieving their Decade objectives in particular through development projects employing low-cost water supply and sanitation techniques. GOI requested assistance undertaking low cost water seal latrine feasibility studies in 7 States, of which Govt. was one, and requested the Government of Gujarat to nominate 15 towns to be covered under the studies.

The Government of Gujarat selected 15 towns ranging in population from 7,600 to 92000 (total 490,800). The town have been selected by the State Government agreed to the following criteria.

(a) Population generally be below one lac.

(b) The towns should have no sewers at present and unlikely to be sewered during theDecade.

(c) In order to permit extrapolation of the feasibility studies to other towns in the State, the towns initially selected should represent a variety of socio-economic and socio-cultural conditions as well as the various geological, hydrogeological and physical conditions in urban areas in the State.

Government of Gujarat accordingly selected following towns to be included in the Feasibility Studies.

TOWNS SELECTED FOR PROJECT

Classification	Towns	Population (1971 Census)
Class- II	Bharuch	91,589
	Dhorajil	69,973
	Godhra	66,403
Class- III	Amreli	39,520
	Deesa	20,324
	Dhrangadhra	40,791
	Mandvi	27,849
	Magrol	27,183
	Wadhwan	30,584

Class - IV	Harij	11,073
	Prantij	14,502
	Radhanpur	18,360
	Vijapur	15,571
	Vyara	18,910
Class - V	Bansada	7,108
	Total:	4,97,740

For preparing feasibility report, the GWSSB organised and carried out a number of special investigations as mentioned below :

(A) A house-to house survey in each of the project town.

(B) Evaluation of on-going latrines conversion programme in Gujarat.

(C) Pollution Studes.

(D) Organisation, financial and management studies of the local authorities in the 15 Project towns.

The total population of these 15 towns as per 1981 Census is 6,11,930 souls.

The Project envisages to construct new private latrines, community latrines and conversion of existing dry latrines into pour flush waterseal latrines in the above mentioned towns.

12.2 Existing facilities in Project-area Towns.

The existing toilet facilities in these towns is given under Table No. 6 below:

TABLE- 6

Sr. No.	Name of town	Population for 1980.	Population served through Private Water seal latrines.	Percentage of total population
1.	2.	3.	4.	5.
1.	Amreli	51,459	11,671	22.46
2.	Bansada	9,242	2,843	30.76
3.	Baruch	1,20,690	54,608	45.24
4.	Deesa	35,200	10,192	14.13
5.	Dhorji	72,123	8,186	16.95
6.	Dhrangadhra	48,280	7,280	20.65
7.	Godhra	83,840	24,728	30.69
8.	Harij	11,644	2,728	23.51
9.	Mandvi	29,847	8,994	30.14
10.	Mangrol	39,357	13,117	33.32
11.	Prantij	15,360	2.031	13.23
12.	Radhanpur	20,521	4,850	23.63
13.	Vijapur	16,603	5,077	30.58
14.	Vyara	20,966	9,358	44.64
15.	Wadhwan	36,276	7,659	21.13
	Total:		1,73,332	

The Master P lan Report on low cost sanitation waterseal programme in the above 15 towns of the Gujarat State has been prepared by the Gujarat Water Supply and Sewerage Board with the help of the Technology Advisory Group of the UNDP Global project. This master plan was presented to the World Bank and has been accepted. Under this programme the facilities proposed is given in Table No. 7 below :

TABLE- 7

Proposals as per Report

Sl. No.	Name of Town	No. of private latrine proposed.	Population proposed to be served.	Percentage of total population.	No. of sets of community latrine.
1.	2.	3.	4.	5.	6.
1.	Amreli	1,362	8,897(800)	17.29	60
2.	Bansada	293	1,617(16)	17.49	
3.	Bharuch	3,163	25,719(4000)	21.31	220
4.	Bhoraji	5,005	27,850(1100)	38.61	-
5.	Deesa	1,779	10,641(3500)	30.23	100
6.	Dhrangadhra	1,665	12,089(1200)	25.04	60
7.	Godhra	4,449	22,215(700)	26.49	
8.	Harij	640	3,466(350)	29.87	
9.	Mandvi	1,720	8,174(1800)	27,39	
10.	Mangrol	1,245	9,697(700)	24.64	
11.	Prantij	1,173	7,567(550)	49.26	
12.	Radhanpur	1,163	7,430(330)	15.71	
13.	Vijapur	584	3,294(330)	15.71	
14.	Vyara	725	3,655(1430)	17.43	
15.	Wadhwan	1,814	10,137(950)	27.94	
	Total:	26,780	1,62,448 (177)		440

12.3 Technology:

The type of waterseal latrine to be constructed under the project is a simple low cost pour flush latrine with 2 Nos. of leaching pits. The first leaching pit will be utilised for the disposal of the night soil by anaerobic de-composition and second will work as a standbye when the first leaching pit gets filled up the second will be put to commission and the composed sludge from leaching pit will be taken out after 2 to 3 years and will be used for manure. The design of the latrine is such that there would not be any bad smell as well as no fly nuisance. The latrine pan will have 20 mm. water seal and will be either of china clay or Fibreglass.

12.4 Experience:

All the 15 towns covered under the project are already having large number of "PRAI" type latrines with single pit constructed as a part of the conversion of the bucket latrines into the Sanitary latrines. While discussing with the local bodies and also the people, who are actually using such latrines, it has been observed that no complaints have come up so far. The pit gets filled up within a period of about 5 to 7 years depending upon the size of the family using the latrine. The "PRAI" latrine system is in operation in all these towns and also many other towns in the State and has proved to be a better alternative as far as the collection and disposal of the night soil is concerned. In towns like Dhrangadhra Mangrol where underground strata consists of rock, an alternative of

constructing single pit acqaprivies have been adopted in place of leaching pits. Where the space is short, the house owners have constructed the pits within the premises of their buildings in the courtyard or just below the entrance etc. and have reported that absolutely no difficulty has been experienced so far.

However, the UNDP design of two pit system would be more suitable as the night soil in the first filled up pit will get enough time for anawrobic digestion, while the other is in use.

The low cost sanitation system envisaged by the UNDP will deal with the problem of disposal of night soil. The disposal of sullage water coming from the Bathrooms, kitchen and other household uses still remain a problem. It would be necessary to provide surface drains to dispose the sullage water. The mode of disposal can be land disposal for irrigation. If this is not done, the aim of providing sanitation to these towns will not fulfilled and further problems of health. The sullagewater will flow into the streats etc. and the pronlems of mosquito breeding, foulsmell etc. would come up. It is therefore, very essential to take up composite projects so as to deal with both night soil and sullage as well.

The Gujarat Water Supply and Sewerage Board had posed this issue to the Technology Advisory Group of UNDP in January 1981 and had desired to include the disposal of sullage water in the project alongwith the night soil disposal so as to provide better sanitation to the people.

"The Technology Advisory Group of UNDP had opined that the component of sullage water disposal is important, but, where resources are limited and institutional competance is being duit up, these other components should yield precedence to latrine programme UNDP has further opined that in terms of public health and social priorities, and taking due ceynizance of the institutional and financial constraints safe means of excreta disposal must take first priority".

The opinon is still debatable. If we go according the social priorities, the above opinion may sound reasonable. If we mean to provide improved sanitation to 80 percent of urban population, during the decade leaving aside the problem of sullage water disposal, we would not be doing justice to the word sanitation, and also allow the health hazards due to non-disposal of sullage water, to continue. In this our goal ? Why not to face the problem of limited financial resources by finding out some way out and provide people better sanitation.

We still poser the issue to the Administrators and Technocrats attending the conference with a view to think of the solution at least to think for making a beginning in this direction.

12.5 Cost

As per the project report accepted by the IDA of the World Bank the cost break-up off of the project is given vide Table No. 8 below :

TABLE- 8

Summary cost Estimate

Fiscal Year	Cost Estimate in Rs. '00
1982-83	8000
1983-84	10769
1984-85	17862
1985-86	23789
Total:	60000

After appraisal of the project by the World Bank a meeting of 15 project area local bodies was held at State level wherein the Secretary, Health and Family Welfare Deptt., the Secretary Panchayat, Housing and Urban Development Department, the Director of Municipalities, Development Commissioner and the officials of the GWSSB also participated. This meeting was held on 16th September 1981. During this meeting the contents of the project were explained to the local bodies in details and the actions to be taken by the various municipalities and panchayats step-by-step were also identified and discussed. The legal requirements like passing byelaws etc., were also discussed at length. This meeting has helped a lot in educating the local bodies for taking up the project and has also initiated the way towards speedy and smooth implementation of the project.

12.6 Bye-laws:

During negotiations of the project with the IDA at Washington it was jointly agreed that all the project area local bodies will pass necessary bye-laws for implementation of the law cost sanitation programme in their town. A format of the bye laws has already been prescribed in the master plan report prepared by the Technological Advisory Group of UNDP. All the project area local bodies had resolved the passed bye-laws prior to negotiation the IDA had insisted on actual adoption of the bye-laws and had made a condition that if the bye-laws are passed to the specification of the IDA, before the legal agreements are finally provided at Washington, the condition restricted the disbursement of IDA for this sub-project would be deleted.

In order to achieve, this GWSSB had deputed an officer to visit the project area local bodies and explained to them the needs and urgency of passing the bye-laws. Due to this drive, 14 towns out of the 15 Municipalities have already adopted the bye-laws as per the format prescribed by the UNDP. The Govt. of India has already been informed accordingly with a request to get in touch with the IDA and get the condition of disbursement deleted.

12.7 Legislation:

The existing legislations in the form of Gujarat Municipalities Act, Gujarat Panchayat Act and the Gujarat Water Supply and Sewerage Board Act are sufficient enough for implementation of the project.

12.8 Resolutions from the Local Bodies:

The Project area local bodies have already passed necessary resolutions as per the draft enclosed under Annexure-I-Accepting the low cost Sanitation project and confirming the responsibilities of the local body for implementation of the project. For getting the resolutions, GWSSB had deputed its officers to each of the project area local bodies to explain the details of the project, its requirements and the socio-economic benefits of the project to the elected members and officers of the local body. This has paved the way ahead for the local bodies to get the resolutions smoothly passed in the meetings of their general board.

The GWSSB officials had also contacted the District Development Officers, the Director of Municipalities and the Collectors concerned for each of the project area town and had impressed upon them the requirement of the passing of the bye-laws and its importance. This kxd has expedited the process of passing the bye-laws under the provision of the Municipal Act.

12.9 Project Implementation:

The Gujarat Water Supply and Sewerage Board will be the implementing agency for the project. The functions of GWSSB as far as this project is concerned are detailed below :

The functions of GWSSB would be as under :

1. Provide funds for project implementation.

2. Procure all materials (such as cement, steel, pans, and traps)not readily available locally)

3. Responsible for getting the house-hold latrines constructed through local bodies.

4. Provide technical guidance, supervision and monitoring.

5. Approve contractors' work of construction of private latrines where needed.

6. Arrange publicity, promotion and health education activities.

7. Establish a project management cell to undertake these responsibilities.

The Local Authorities will be responsible for :

1. Construction of Private and Public latrines.

2. Channellising loans and grants to housseholds and repayment of the loans to GWSSB.

3. Operation and maintenance of community latrines and emptying of leaching pits.

The Gujarat Water Supply and Sewerage Board has also proposed to the Government to constitute a State Direction Committee at the State level and District Implementation Committee at each project area district for necessary advise in the implementation of the project.

12.10 Motivation of the Programme:

(a) The programme in each of the town is a very importance aspect for making programme-population and to achieve the target within the time-bound programme agreed to with the IDA.

The programme of latrine construction also involves an element of education. The GWSSB decided to take up these of vital aspects on hand immediately so that the necessary atmosphere for making the programme successfully can be created in each of the project town. With this view GWSSB has deputed one officer from the Board and Shri Ishwarbhai Patel, Safai Vidyalaya Sabarmati, Ahmedabad to visit each of the town and motivated the programme. This team has so far as visited 8 towns and had conducted meetings with the Municipal authorities, local leaders, social workers and explained the technical, financial and administrative aspects of the programme. The GWSSB is considering to provide necessary materials like the latrine pan, trap, and cement to the local bodies for supplying the same to the beneficiary house-holders as part of Govt. GIA so that the programme go a head at a rate and also in smooth manner. The Town impression that had developed during the visit of the motivating team to the project area towns is that the people have now become health conscious and there would not be any difficulty in taking by the programme and achieve the set targets.

All the local bodies are keen to take up the programme from 2nd October,1982.

(b) The programme of constructing PRAI type water flush latrines in Gujarat-State has been very popular amongst all the local bodies. The people in the State have now accepted the need of having hygiene latrine and are coming forward to adopt the low cost sanitation system as a health improvement scheme. Thus the general assessment is that the programe would go very smooth in the State and the set directives would be achieved at a faster rate.

To accelerate the progress of the project and its acceptance by the people the local bodies have been advised by the GWSSB official who visited all the towns, to publicise and motivate the programme by adopting following modes of publicity.

1. Posters containing the details of the low cost latrine along with a brief and attractive write up for the advantages involved is under preparation. These posters will be exhibited on to the public places like schools, hospitals, public buildings, markets etc. with a view to adopt the people to expedite the programme.

2. Local bodies will prepare cinema slides and the same will be exhibited in the Cinema Theateres of the town so that a large group of people gets acquainted with the benefits of the project.

3. Radio talks on the Low cost sanitation technique will be given so as to cover the entire State under the motivation programme. The seminars and group discussions will be arranged at the district head quarters where in the authorities of the local bodies will be invited to participate and thereby get acquainted with the benefits of the system.

The Project management cell and the State Direction Committee will carefully manage the rate of acceptance of the programme in order to ensure that programme gets momentum.

13. Demonstration:

Each Local Body has constructed one or two low cost design latrines for demonstration of the Project design.

BIO-MONITORING TESTS FOR DETERMINING INDUSTRIAL EFFLUENT TOXICITY OF WATER

Prof. J.J. Ghosh* & A. Manna*

INTRODUCTION

The organic chemicals, arising from industries as well as from the runoff waters of agricultural lands and soils, constitute the major hazardous constituents of the water. One inherent characteristic features of these organic compounds is their residue forming potential in different biotic systems. These residue forming potential or bioconcentration factors give an approximate measure of the hazard potential of these compounds.

Since it is not economically feasible to determine the toxicity of each of these potentially harmful compounds, direct approach towards assessing the comparative toxicity of these different and divergent types of organic chemicals may be made by biomonitoring tests using aquatic organisms like fish or other smaller aquatic species, as indicators of pollution. From the biological response shown by these specis, one can assess the pollution status of the water.

BASIC PRINCIPLE AND METHODOLOGY

The biomonitoring tests are generally carried out to determine the acute toxic effects expressed as the median lethal concentration or LC 50, where death is the criteria of toxicity. Besides death, there may be other behavioural or biochemical criteria viz., immobilization, blood chemistry or enzyme activity inhibition etc., which are generally expressed in terms of maidan effective concentration or EC 50.

In all bio-monitoring tests, generally a 2-test sequence is followed to estimate the acute toxic effects of an organic effluent, viz., (a) range finding test and (b) definitive test.

(a) The range finding test, a preliminary, short-term test, is carried out to find out the range of effluent dilutions to be used in the subsequent tests and (b) The definitive test which is more precise and long-term, is carried out (using the range of effluent dilutions determined by the range finding tests) over a varying period lf longer time interval to arrive at the acute toxicity of the organic effluent, which is generally expressed either as LC 50 or EC 50. Both range finding and definitive tests are carried out either under static conditions or under flow through conditions. If the effluent has a higher dissolved oxygen demand or it the test organisms require flowing water, then flow-through tests are generally preferred. For the successful operation of the bio-monitoring tests, it is necessary to work out the quantative or at least the semi-quantitative relationship between the exposure effect or exposure-response relationship.

---

* Department of Biochemistry, Calcutta University.

Two approaches are generally used in the exposure-effect/response studies : the first involves the early detection of biochemical impairment in terms of changes in the activities of different marker enzymes or some non-enzymic proteins etc. Changes in the biochemical parameters due to exposure to hazardous pollutants may often be among the more quantitative indicators of the presence of pollutants in water as well as the magnitude of contamination made by the pollutants. Needless to mention that while studying all these changes in the exposed groups - side by side readings are to be taken with unexposed control groups.

BIOCHEMICAL MARKERS

Following are the list of biochemical parameters which can serve as better indices for assessing the response to different organic pollutants :

a) Sodium - Potassium ATPase } Serving as the index of Osmoregularity or nerve-activity
b) Magnesium - ATPase }

c) Acetylcholine esterase } nerve activity impairment
d) Non-specific choline esterase }

e) Lactic dehydrogenase and its various isoenzymes :-indicating muscular damage.

f) Glucuronide formation :- indicating impairment of liver function.

g) Succinic dehydrogenase and cytochrome C oxidase :-indicating impairment of oxidative metabolism.

IMPORTANCE OF BIOMONITORING TEST FROM THE STANDPOINT PREDICTIVE TOXICOLOGY

In recent years a significant effort has been made towards environmental forecasting by using different approaches. Biomonitoring tests for the assessment of pollution status of rivers, lakes and streams may have immense applications in field survey, as well as in predicting "pollution fraginity" of the aquatic environment to different types of pollutants.

EXISTING SANITATION STATUS - PROBLEMS AND PROSPECTS
-"REFUSE SANITATION" -

Shri S. Shankarappa*

I-INTRODUCTION

1.A. In the process of evolution of civilization man realised the danger of existing amidst refuse of his own creation, and began to give serious consideation to find ways to dispose of the garbage from his surrounding.

2. The population explosion and industrial revolutions, the problem of garbage collection in urban areas assumed an important position and started drawing attentions of local authorities and federal Governments for ensuring better sanitary environments.

3. In the process of evolution of various metnods for disposal of garbage, recycling of garbage became a profitable investment.

Over-riding considerations should however be one of ensuring public health keeping economic gains as subsidary.

2.0 The Corporatiom of Greater Bombay :
(ADMINISTRATIVE AREA OF BOMBAY) -

Bombay is the URBS PRIMA of India, one of the World's largest Cities, a nerve centre of trade, commerce and Industry, and with a population of 8.5 million spread over 437 sq.k.m.

Geographically, it lies bounded by sea on three sides and forming three distinct areas of old city island, W.S. and E.S. thus forming Greater Bombay.

These areas are further divided into administration wards, each ward to be managed by a ward office.

The wards are again grouped into Zones, each zone under one deputy Minicipal Commissioner.

The total road net work is 500 km. in the city and 1000 km. in the suburbs.

2.1 Municipal Solid Waste generated in Grwater Bombay

The main centres of generation of municipal solid wastes in Greater Bombay are :

(1) Housing premises
(2) shops
(3) street sweepings
(4) commercial premises
(5) markets, Hotels, Hospitals etc.

The occasional generation centres are :

(1) Social gatherings,
(2) festival fetes
(3) circuses
(4) sport venues etc.

Quantity & quality of Municipal Solid Waste in Greater Bombay :

The Quantity, quality and regional generation pattern vary place to place and season to season. They are given in tables 1, 2 & 3 appearing at page 2, 3 & 4.

T A B L E - I

PHYSICAL CHARACTERISTICS OF REFUSE

PERCENTAGE BY WEIGHT (for Indian Cities). (Reg. Indian Journal for Environmental health July 1975).

Sr. No.	ITEM	PERCENTAGE
1.	PAPER	7.07
2.	RUBBER	0.866
3.	PLASTICS	0.86
4.	METALS	1.031
5.	GLASS	0.76
6.	ASH AND BARTH	31.74
7.	OTHER MISC.	15.98
8.	COMPOSTABLE MATERIAL	41.69
	TOTAL	100.00

T A B L E - II

CHEMICAL CHARACTERISTICS OF REFUSE(for Indian Cities) (Ref. Indian Journal for environmental health July 1975).

Sr. No.	ITEM	-
1	pH	7.68
2	MOISTURE	31.138%
3	ORGANIC MATTER	21.57%
4	CARBON	15.316%
5	NITROGEN	0.584%
6	C/N - RATIO	26.22

T A B L E - 3

Localitywise characteristics of refuse (By weight)*
(for 1972)

A r e a.	Compostable matter **	Combustible Matter	Inert organic Matter	Metal	Moisture
Residential High Income Group	56.06	28.79	13.28	1.87	56.68
Residential Middle Income Group	36.37	43.47	18.05	2.11	42.49
Residential Mixed Income Group	43.57	42.17	10.40	3.36	53.75
Market Waste					
Veg. Market	63.00	27.30	4.93	4.77	53.30
Meat Market	62.00	38.00	-	-	71.00
Hospital Waste	53.63	45.66	0.71	-	69.60
Commercial Area	40.69	36.51	22.48	0.32	43.60

* - Percentage by weight

** - Fruit, flower, food waste etc.

*** - Paper, wood, baggasse, plastics etc.

2.2. Management of Solid Waste in Greater Bombay :

The task of collection, handling and disposal of Solid Wastes of Greater Bombay is rendered by Solid Waste Management Department of Municipal Corporation of Greater Bombay and discharges its function as laid down under section 61 of the B.M.C. Act No.III of 1888.

The functions of Solid Waste Management Department consist of

1. Public road cleaning and collection of sweepings at temporary collection places (dust bins, sheds on road).

2. Collection transportation and disposal of refuse generated from road sweeping, from domestic and commercial premises all over Greater Bombay including slums,

3. Removal of night soil and sludge from unsewered areas and maintenance of public sanitary conveniences.

4. Removal of dead animals.

Finance of the Solid Waste Management Department comes under 'A' Budget of the Corporation. Per capita cost for five years upto 1980-81 are tabulated below :-

TABLE - 4

Item	1976-77 Rs.P.	1977-78 Rs.P.	1978-79 Rs.P.	1979-80 Rs.p.	1980-81 Rs.P.
Collection	50.08	54.70	56.00	60.26	55.33
Transportation	37.16	38.12	36.75	39.74	59.62
Disposal	3.41	2.50	2.75	1.50	3.32
Total	90.65	95.32	95.50	101.50	118.27

Administrative Set-Up :

The Department of Solid Waste Management as described above including the Transport Deptt. to cater municipal vehicles for various services work under the direction and control of the Director (Solid Waste Management). He is assisted by the Deputy Engineer (Solid Waste Management), Head Supervisors, Deputy Head Supervisors and Assistant Head Supervisors and by two Executive Engineers of the Transport Wing. The transport wings provide vehicles for transportation of refuse and cesspool, for wards maintenance, Health service, encroachment services etc. The Greater Bombay Map showing ward boundaries appear next page.

Working System :-

In order to adequately render the services broadly outlined above, the administrative wards area under each

ward Officer is sub-divided into 44 conservancy wards. Each ward is under the control of a Supervisor. The work of three to four supervisors is looked after by an Assistant Head Supervisor. Besides there are 6 chawl supervisors and 3 dumping ground supervisors.

Under each Supervisor, there are four to five section Junior Overseers and one Motor Loading Junior Oversoor in each shift. Each section Junior Overseer has two Mukadams and sixty scavengers.

Collection of Refuse :-

All the public roads, footpaths and house gullies are cleaned daily.

Municipal Road areas are divided into beats for sweeping with two sweepers per beat. Per pair the sweeping area is about 3000 to 5000 sq. mts. for city roads and for suburban area it is about 5000 to 10000 sq. mts. The work of about 15 beats is supervised by one Section Mukadam. The work of two mukadams is supervised by one Junior Overseer.

Conservancy sweepers work in broken shifts in the City from 6.30 a.m. to 10.30 a.m. in the morning and 1.45 p.m. to 4.45 p.m. in the afternoon. In suburb sweeping is done in straight duty shift i.e. from 6.30 a.m. to 1.30 p.m. Labour staff is mustered by Junior Overseer at the commencement and the end of the shifts.

The refuse so collected is stored at the nearest point of temporary dump comprising of either refuse shed or refuse bin. At present there are about 4000 such temporary collection points. Refuse generated at private premises, commercial institutions, hotels, hospitals, dispensaries etc. is also deposited at these points.

Transportation :-

The motor loading work for garbage transportation is organised by one junior overseer under each supervisor by indenting required municipal & contractors vehicles. One Asst. Mukddam with six motor loaders are allotted per vehicle to attend a decided given programme. According to the intensity of deposits, clearance is given once or twice a day, at there temporary dump points.

This transportation demands use of about 750 vehicle shifts per day. Municipal fleet is of the order of 240 vehicles shifts. Balance demand is met indents lorry hire contractors appointed for this work on yearly basis.

Municipal vehicles are with steel closed body and tipping type. Recently about 20 compactor refuse vans are also introduced. Municipal vehicles are mostly used for house to house collection.

Disposal :-

Final disposal of municipal solid waste is by land fill method.

Refuse carrying vehicles are sent to notified dumping grounds for tipping into low lying marshy creek areas set aside for this. The Bulldozers are used to level the heaps tipped at there places. Any debris brought to these sites is used to provide cover.

The land filling is the principal method of disposal adopted for Municipal Solid Waste of Greater Bombay since last 100 years, experiment is being made to try incineration and composting. It is found that the refuse is rich in organic matter which can be used for manufacturing of compost and as such a compost plant having a capacity of 300 M. tonnes per day has been set up in 1979 at Deonar.

The incineration is not suitable method for Municipal Waste of Greater Bombay due to less combustible material and high percentage of moisture. However it is being applied on small scale in such areas like Hospitals. A small plant 2 T/D capacity has been set up at Group of T.B. Hospitals, seweree and another of 1.2 M. tonnes per day capacity is to enter commission shortly for combustion of dead rats. This is a very costly method of disposal as large quantity of oil is required to be used.

Quantity and quality of refuse :

A population of about 8.2 million generate about 3200 to 3500 tonnes of refuse per day giving per capita figures 425/450 gms.

Table 1 : Gives the characteristics of refuse of Greater Bombay.

Table 2 : Gives the chemical characteristics of refuse of Greater Bombay.

Table 3 : Gives the localitywise characteristics of refuse of Greater Bombay.

Widespread practice of totting reflects in the fact that refuse deposited in dust bins or at storage points is not the refuse arriving at dumping grounds.

A study of the tables reveal that :

1. The higher income group residential areas and commercial areas show a high paper, metal and plastic content.

2. In general, the refuse has high moisture content even in dry seasons because the City's refuse comes mostly from house gullies in the City and from open drains in the suburbs where it comes into contact with water or sullage. In wet season the refuse is almost drenched.

3. The market areas show a large percentage of garbage, leaves etc.

4. Due to large amount of totting of paper, glass, metal and plastics, their quantities are low in the refuse arriving at dumping grounds.

5. The calorific value is between 1100 Kcal/Kg. to 4000 Kcal/Kg. but is generally less than 2000 Kcal/Kg. This does not give a self sustaining temperature in the incinerator.

6. The refuse has an average compostable portion of less than 50%.

CONSTRAINTS :

Collection and disposal of Solid Wastes have become serious problems for the Corporation due to the following major reasons :

1) The erratic and un-predictable population increase.

2) Proliferation of slum colonies, constituting 40% of the total population.

3) General awareness for better and adequate service demands without any improvement in civic-sense.

4) Spurt in education levels, which poses serious threat from Monopolistic Labour system for this work, having to face the threat of shortage or abrupt stoppage of works.

5) Phenomental rise in cost of operations and the need for management systems of highest order to bridge the gap between revenue and services.

The operational problems crop up in every quarter of the solid waste management services, namely, collection transportation and disposal. They are listed below :

(a) Road Sweeping :

1) Unauthorised parking of vehicles on public roads.

2) Heavy traffic round the clock on some roads.

3) Encroachment of footpaths and roads by hawkers and fruit sellers.

4) Shops are open after the roads are swept. The owners throw away the refuse on swept road.

5) Using of footpaths for squatting, urinating, washing cloths, bathing, etc.

6) Heavy pedestrian traffic on footpaths.

7) Poor road surface conditions.

(b) Collection :

1) Everybody wants refuse bin away from his house.

2) Nuisance due to pickers.

3) Nuisance due to stray cattles.

4) Citizens throw away the refuse not in the bins but around the bins.

5) Squatting around the dust bin.

6) Obsolete collection implements.

2. Transportation :

a) The contractors' vehicles are open body vehicles and hence unhygienic in view of possible spill-over. This results in citizens' complaints.

b) The contractors' vehicles being very old fail frequently and services get interrupted.

c) Contractors' vehicles are manually unloading type against Municipal fleet which have hydraulic unloading facility. Hence, services of an additional loader are required.

d) Both Municipal and Contractors' vehicles have loading height most inconvenient to loaders.

e) It is not possible to utilise closed body vehicles fully when manually loaded and there is vehicle under utilisation.

f) Higher capacity vehicles are unsuited for small lane and are economically undesirable when low refuse generator is encountered.

g) With garage and workshop limitations, Municipal fleet utilisation is apparently low and needs to be raised.

h) Refuse vehicles are prone to corrosion effects and their maintenance becomes day by day costlier.

3. Disposal :

Hygienic disposal of wastes in the ultimate aim of any Solid Waste Management service. The refuse in Bombay is disposed off by land fill to reclaim low lying marshy land.

(1) The existing land fill method is one of uncontrolled dumping and emphasis is not on public hygiene. Hence from sanitation point of view it is disadvantageous regardless of apparent operational economy.

(2) The present land fill sites used for disposal are not owned by M.C.G.B. The reclaimed land does not fetch any revenue for the Corporation.

(3) It is difficult to develop the land fill sites with such facilities like roads, sanitation, drinking water, and lighting.

(4) The life of existing dumping sites is fast expiring and new fill sites are simply not available nearby. In case Corporation has to depend on far located tip sites, the transportation costs involved will be beyond its bearing ability. (This point speaks on the importance of alternate dispcsal facility).

(5) The 300-Ton Compost Plant has experienced difficulties like existence of glass content in garbage.

(6) Heterogenous garbage composition having large

(7) Rasping machine cannot work on organic matter.

(8) Incineration is extremely costly at Rs.800/- per tonne unless provided with waste Heat recovery. The high moisture content and relatively lower calorific value makes incineration not viable economically.

Need for Improvement :-

The existing system falls short of achieving the services required effectively and to the required levels. We cannot at the same time to complacent since Waste management has a dominant role to play to bring about desired levels of sanitation.

The scope for improvement is wide and exists in all three main areas namely Collection, Transportation and Disposal.

Basic for Improvement :-

Waste Management, no longer is a subject to be side tracked in deference to others. It holds the key to environmental protection and provides scope for research and development.

The necessity of sanitation apart, it is also equally important to achieve economy in every aspect. Revenue of civic bodies have limitations and here we are confronted by a conflicting predicament.

The only solution undoubtedly lies in an engineering approach to the whole problem, obsolete methods of operation needs to give way for more and more of scientific and technological methods.

The following are some of the alternatives to achieve this :

(A) Collection :-

(1) New developed storage places like refuse sheds.

(2) New developed mustering chowkies

(3) Introduction of better design implements brooms, handcarts, scavengering brush etc.

(4) Introduction of more mechanical sweeper units.

(5) Chalking out Collection routes on a scientific consideration to minimise expenditure & avoid non productive efforts etc.

(6) Expansion of House to House Collection :-

This system by far is the best, one can conceive of from a sanitation point of view as it leaves very little scope for household garbage to appear on street side.

(B) Transportation :

Transportation wing bears the brunt of the financial constrains of Solid Waste Management Operation. The substantial likes in oil, automobile and spare parts prices, plus labour have put transportation economy in jeopardy, unless most recent scientific innovations are

(1) Reorganisation of collection routes on a scientific basis - after due thinking of garbage potential and vehicle utilisation scope.

(2) Augmentation of Transport fleet with new type vehicles-like compactors, roll-off Tipper container systems etc.

(3) Development of adequate garage and workshop facilities by expanding existing facilities.

(4) Introducing latest management techniques in transport management and setting of transfer station.

(5) Introducting an R & D wing for S.W.M. in general and Transport in particular to check vehicle utilisation continuously and monitor the results, Suggest better routes, work out economics part etc.

(6) Closed body transportation with little spill over possibility.

(C) Disposal :-

Next in the list of areas where improvement is needed from a sanitation point of view, comes disposal : Perhaps, Collection and disposal are important from environmental sanitation angle of view :-

(1) Introducing sanitary land fill in place of existing uncontrolled dumping. Sanitary landfill which is landfilling in a phased manner with alternate layers of garbage and earth properly bulldozed to specified depths is better bygienically and sanitarily.

(2) Setting up more and more of compost plants. Besides avoiding sanitation complaints as with landfill, they yeild revenue, are less unhygienic for operating staff and serves the purpose of disposal of garbage.

(3) Energy Recovery systems :-

Profitable disposal of wastes is be the ultimate outcome of the relentless pursuit of alternative disposal methods. In an era of spiralling costs, large scale inflation and challenge from unvironmentallists, the solution is one ensuring max. economy in disposal at the best sanitation standards. It is here the energy recovery systems assume importance.

(i) Incineration cum Waste Heat Recovery and Utilisation :-

The waste will be incinerated and the heat generated will heat up water into steam which can either be used for in plant utility or in hospitals and such institutional utility or can work up a steam turbine and generate electricity. Incineration is the cleanest way of disposal.

(ii) Biogas Plants :-

Organic rich garbage can be converted into biogas with some bacterial treatment in digesters. The biogas produced will be utilised for heating, cooking, lighting and such institutional purposes or used for production of power.

(iii) Raw Materials Retrieval system or waste : Recyding or Resource Recovery system :-

Under this, a number of units are in operation in Japan and Western Countries. The heterogenous waste matter is segregated mechanically for valuable physical contents such as metal, rubber, paper, plastics etc.

Certain Japanese units use garbage for production of synthetic biproduct like paper, and separate systems like composting or biogas.

(iv) Pyrolysis or Waste gasification :-

(4) Sea Disposal :-

This alternate method will bring about better enviironmental sanitation.

(D) Legistation :-

The role of Solid Wastes in environmental sanitation is clear to everyone. Generation of Solid Wastes is a continuous phenomenon. Moreover the type of garbage we have in our contry gets decomposed too soon and as such cannot be left in the open uncleared for long.

It is, therefore, absolutely essential that solid wastes shall be removed and disposed off in a most hygenic way to ensure environmental sanitation. This work is looked after by the solid waste management Authority.

The waste generation function is one of purely human dependence, that is the garbage on the streets originates from man's activities. Indiscriminate throwing of garbage, urinating in open and such acts of citizens will allow unsanitary conditions to prevail in environment. It is in this context that the need for legislation arises.

Unfortunately the existing laws are awfully inadequate to cope up with a deteriorating civic sense, public habits and population increase.

Stringent laws and regulations will be needed to arrest bad public tendencies which threaten public sa-nitation seriously. Following Deterrent measures will be welcome proposition :-

(1) It shall be compulsory for individual household to maintain their own dustbins.

(2) Throwing of garbage or waste matter on street shall be an offence, chargeable with penalty.

(3) Urinating and such acts of making streets, public places etc. dirty shall attract penalty.

(4) There shall be fees leviable for collection, removal and disposal of garbage for Commercial and industrial wastes.

Objectives for improvement :-

The department of Solid Waste Management has well

defined objectives to bring about environmental sanitation. Following listed are some of the system changes being implemented.

1) House-to-house collection of garbage has been introduced in selected Wards and the results are extremely encouraging.

2) Improved type of adequate storage places like refuse sheds, Dust bins are being provided.

3) Better implements to Labour :-

i) Mustering chowkies are being constructed with attached storing space to keep implements well secured.

ii) New types of Hand-carts for collection have been developed and are giving good performance.

iii) Brushes are also being provided to do more thorough cleansing.

4) Transfer Station :-

Municipal Corporation of Greater Bombay has planned to set up a mechanised 1000 T P D refuse Transfer Station at Mahalaxmi to handle garbage of A, B, C, D & E wards forming almost full City area.

The site selected also has been judiciously done to get a centrally located place to give following advantages :-

1) Collection vehicles can make larger no. of trips since distance from collection centres to Transfer station will be reduced. This will result in more clearance frequency giving better environment.

2) Smaller no. collection vehicles could be deployed advantageously.

3) Idle time of collection crew will be avoided which will improve productivity, improving per tonnage cost.

4) Buck type Trailer-tractor Transportation system from Transfer station to Disposal sites will eliminate use of small vehicles going to dumping ground and will ease peak time traffic congestion substantially.

5) Development of Garages & Work-shops :-

New garages and motor repair shops with modern equipment are proposed to improve transport maintenance.

6) New Type Vehicles :-

The Solid Waste Management Department is keeping abreast i. international advances in waste handling field and assessing its utility under Indian Conditions. We have procured some Compactor Vehicles and trailers.

7) Sanitation Rules for contract supply of Transport Vehicles :-

In the specification for contract supply of vehicles

such rules are incorporated to make the whole handling upto disposal site hygienic and sanitary. For instance proper covering of was te in truck is a must to safeguard against spill over.

(b) Action against Erring Staff :-

If any collection point is left unattended or partially attended the defaulting labour are subjected to Disciplinary Action like suspension, Enquiry etc.

8) Landfill - Precautions for proper environmental Sanitation :-

The largest dumping site namely Deonar is situated far from dense inhabitant centres and Sanitation hazard which is prodominant to the neighbourhood is very little. At Deonar and all other sites, dumped matter is convered with earth and dozed in a phased manner. The operations are supervised by qualified Civil Engineers.

There is regular spraying of insecticides at dump sites and surrounding areas to eliminate insect breeding.

9) Incineration Plant :-

Incineration is a luxury for our garbage with average 45 to 50% moisture content by wt. (in rainy season 100% and more by wt.) and lower Cal. value of 1200 K can/Kg. compared with its western Counterpart. Large Scale Incinerator of our urban waste, no matter how effective and clean the system might be envkronmentally will warrant enormous capital investment and huge recurring costs. Unless backed by waste heat utilisation or power generation, it will be quite unattractive and uneconomical.

The Corporation has set up a 250 kg./hr. refuse incinerator plant to dispose off obnoxious hospital garbage at T.B. Group of Hospitals at Sewri. The Plant is in operation since 1979. It is equipped with latest air pollution control system and mechanical feeding. Another Plant for disposal of dead bodies of rats at 150 kg./hr. capacity is also installed and will be commissioned very shortly for Haffkine Institute Parel Bombay.

10) Compost Plant :-

The corporation has set up a 300 T.P.D. Mechanical Compost Plant using aerobic process.

11) Energy Recovery & Waste Based Power Projects :-

The Corporation is collecting data from national as well as international sources in these fields to assess their viability for Bombay Conditions.

Plans for setting up a pilot Biogas plant under Government auspices has been drawn up and preliminary analytical work is under process.

12) Commercial & Industrial Wastes :-

Research & Development Cell has been set up in Solid Waste Management Deptt. which monitors the functioning of all

services. Besides the cell gets garbage samples analysed for physical and chemical compositions. The R & D Cell also is to prepare rules for Collection and Disposal of Commercial & Industrial wastes including leviable charges for different categories of industrial wastes with an objective to make environment pollution-free as well as provide a source of income for corporation by booking for Trade refuse charges.

13) Staff Amenities :-

The Labour staff of S.W.M. Department enjoy many previlages like :-

i) Free service Quarters near place of work.
ii) Welfare Centres.
iii) Radio & T.V. Communication facilities.
iv) Free Medical check-up facilities.
v) Awards/Prizes for performances.
vi) Leave Travel Allowances.
vii) Uniforms, Raincoats, Gumboots etc.

These facilities will be improved upon from time-to-time to have higher productivity.

14) Legislation :-

The existing laws governing Solid Waste Management services, within the frame work of Bombay Municipal Corporation Act have become awfully inadquate to ensure proper sanitary levels, thanks to population explosion and poor civic sense of Citizens. The Corporation, therefore, propose to amend these laws and introduce more laws and regulations to achieve better sanitary conditions. Salient features of the proposed laws are :-

i) It shall be compulsory for individual household to maintain own refuse receptacle.

ii) It shall be a punishable act to throw garbage indiscriminately on roads. Offenders will be liable to pay fine.

iii) For industrial/Commercial waste removal and disposal fees will be leved.

CONCLUSION :

FUTURE OF CLEANSING SERVICES :

To-day the impact of environmental sanitation on society is stronger than ever in the past. Man has read the writing on the wall that warns him of a perilous existence if he allows the air and surface around him to be filthy and polluted and chooses to live there. The advantage of education has brought these realities to the fore of social life. Now we have vociferous hue and cry by environmentalists world over.

Survival of society, in urban areas particularly will continue to be as it is to-day unless following issues are tackled urgently and seriously.

1. Problem of footpath dwellers, l.A. Roadside caters, pavbhaji shops etc.

2. Sugarcane/coconut crushers.

3. Nuisance of hawkers.

4. Bad public habits like throwing refuse into roads, Urinating in public etc.

5. Parking of vehicles on roads.

6. One way roads.

ENVIRONMENTAL MANAGEMENT IN 1980'S

A.C. Chaturvedi*

Introduction:

Environmental Management is the major issue, that the Indian sub-continent will face in 1980's. The northern frontiers of India are rich in mineral and energy resources. But the development of the Himalayan belt is in the throes of conflict between economic growth and environmental protection.

Rivers:

The Himalyan mountain chains have made the Indian, Pakistani, Bangaladesh and Nepal rivers change direction. Today for 800 million people, another kind of stream may be changing direction. The region is the birth place of rivers that supply waters to 10 states and nations. It also has peaceful forests, mountains, valleys, and vast open spaces that an estimated 20 million people visit year in search of recreation.

Conflicting Interests:

At a time of population growth and increasing demand for natural resources, the people of the Indian Sub-continent are divided in their own minds, whether to guard the national treasures or merely continue as in the past to use them up. Through various agencies concerned with tourist resorts and land management, the states own about 80 percent of all the land. It therefore exercise considerable influence over that the people do with these resources.

The hill people have an affection and loyalty to their lands. Many who emigrated would have stayed, if they had found some work to do. The hill people are struggling on their land all their lives. Mining rights are being freely given that will turn the fields into piles of rubble. The states think it is their land and they could do what they want with it.

The people also think that jobs and opportunities can be exploited for security to their children somehow without consequences too disastrous to their towns, prominent elements in environmental conflict are energy water, urban growth and ultimately the quality of life.

Energy Resources:

The Himalayas contain a varity of energy resources that could feed the Indian sub-continent almost indefinitely. These resources have to be extracted with care. Development is being opposed by environmentalists and rightly. The continued exploitation would consume large quantities of regions scarce water and leave heaps of wreckage on the land, the piles of residue would be larger than the holes from which they would come.

---

* Chief Engineer (Retd.), Minor Irrigation Deptt., U.P.

Standards:

The ultimate goal for pollution management in 1980's is likely to be the ultimate exclusion of the Indian waters for the disposal of pollutants. The knowledge of actual toxicity limits is restricted. In absence of accurate analytical methods the pollution control standards tend to be conservative. These requirements with unrealistic design and construction deadlines leaves little scope for ingenuity. Thus the designs tend to be conservative and in many cases leaves negative environmental effects. The energy use to have higher pollution standards naturally often leads to a poorer overall land, air and water environment. It is of considerable importance that research be carried out in this area to assure environmental improvement dependent upon scientifically valid affluent and receiving water standards.

Sewer Overflow Control

The national extent of the combined sewer overflow problem was investigated in terms of (1) Regional populations and hectares served and (2) a range of potential. Costs for the control of overflow combined sewers in the Indian sub continent serve approximate 40,000,000 people and 10.9×10^9 m^2 of urban land. Cost estimates were prepared for the control of runoff from combined sewer service areas were based on a single design storm and six hypothetical control strategies. Capital costs varied from .5 billion 75 billion and varied with the amount of operation and maintenance expanses provided. Annual value ranged from 50,00,000 - 500,000,000.

Strip Mining

Salt loading of waters receiving drainage from lands discripted by mining was estimated by 4 years of field data on a strip ruimed watershed, near Durg. Onserved Salt loading was separated into approximate contribution from mined land, undisturbed land, ground water runoff and overland runoff. The inorganic composition of mine drainage was found to be very similar to that obtained in saturation and extracts prepared from the disturbed material. Calcium Magnesium and sulfate were found to dominate the dissolved solid contents of the water. During the years 1977 to 1979, the loading was found to be 2.97 tons/hectare (8000 kg/ha) and 3.2 tons/hectare (880 kg/ha) respectively. It was estimated that 46% of the total observed salt loadi g was attributed to mined lands that comprised 15% of the contributing watershed area. It was found that different technologies were suitable for different environmental conditions, different stages of urbanisation and industrial development and different institutional constraints.

Housing

The housing in 1980's shall tend towards high rise buildings. New methodologies are called for fitting such structures into the social and physical environment. One basic strategy is to account for the variety of high rise impacts, Impact review methods should range from qualitative assessments gaging the fit of a project with community values, to relatively objective valuations based on the measurement of the actual conditions including open space effects, air and water quality.

Cost Effective Sewage Systems:

The increasing need to provide adequate sewage disposal systems to meet housing needs of the 80's should include the evaluation and acceptance of alternate sewage disposal methods. Alternative methods such as pressure and vacuum sewers and home aerobic units for primary treatments and mounds and evapotranspiration beds. For effluent disposal should meet environmental standards as well as technical regulations.

Optional Design:

Non linear design equations were used to model an activated sludge tank, final settling tank, gravity thickner, an aerobic digester, vacuum filter, pumping and aeration in terms of the design variables, activated sludge solids retention, time, hydraulic retention time, recycle ratio, thickner underflow suspended solids concentration and digester solids retention time for steady state conditions. Non linear cost equations were used to model the cost of the individual unit process sizes and capacities. A numerical search technique was to determine the optimum sizes of the unit process to minimise the sum of capital and operating costs for a specified design inflow, affluent quality and equipment limitation.

Odour Control

Odour control is an important consideration in evaluating the alternatives for waste water solids sludge disposal. The unit process of air stripping and vacuum vaporisation was evaluated for determining the effective means for controlling oders generated from digested sludge. It is found that vacuum vaporisation is superior to air stripping because of (1) Effective surface odor emission rate reduction (2) mineral recorrence of increased surface odor concentration (3) greater energy efficiency in odor removal and (4) lower off gas flow rate production. The orfgas odorant stream from vacuum vaporisation can be satisfactorily controlled for acceptable odor emissions using activated carbon absorption. The odorant characteristics of the digested sludge as measured by the volatility were found to be highly variable, apparently related to the efficient biological breakdown of organic sulfides to inorganic sulfide prior to the odor stripping.

Watershed Development:

Studies were initiated on Ganges watersheds in North U.P. and methodologies were developed to predict environmental impacts using drainage characteristics of developing watersheds. The drainage density index a measure of the total length of waterways observed on serial photographs per unit area was computed for various watersheds in order to relate land use changes and drainage pattern to hydrological and water quality responses. Results indicate significant increase in drainage density over the past 2 decades in the Gange Pasin. Water quality constrations and loading rate of dissolved solids frontier watersheds indicate a significant correlation with the drainage density index. Difference in available non point source loads were found to reflect only a small fraction of the difference in measured loads.

Coastal Area:

The Indian Coastal areas were found highly polluted due to chemical effluents and energy pollutants. A coastal management plan was prepared for each region. The effect of pollutants is proposed to be covered by dredging harbour maintenance local zoning, regulating the man made structures on the coastmi. This provided for adequate recreational needs public access to the shore, protection of wetlands against erosion. This could be effectively implemented with the aid of a major mapping programme.

Impact Statements:

Impact statements should also be considered as a social enterprise where professional accountability of poor communities should be encouraged. Impact assessment communities can evolve shared boies of knowledge and they can provide recognition and affirmation of good work and those who perform such work. Reviewers of impact statements collectively perform important roles.

Hazardous wastes

Guidelines may be issued on the control of hazardous wastes. These guidelines may propose a so called manifost system for keeping control of hazardous wastes from the place they are generated through transportation to final disposal. At the present time there are 4000 to 5000 hazardous waste disposal sites landfills lagoons etc. most of these located on private plant sites. The vast majority of these sites do not now satisfactorily dispose of these wastes. Often they result in groundwater pollution, an area uptil now that has been scriously neglected under the new proposed regulations, many of these industrial sites will have to be upgraded, all will have to get permits. Some of the smaller industrial sites faced with the cost of upgrading, will opt for disposal of their hazardous wastes at permitted off site disposal facilities. To date only a few states have really good hazardous waste sites, the leader being Guharat.

Choking of Rivers

The Indian coastal rivers do not have further capacity to assimilate the increasing amounts of effluents being discharged. Urbanisation, the upsurge in industrialisation the intensification of agriculture and allied developments has placed an intolerable burden on the assimilative capacities of the receiving waters. More efforts are needed to get local authorities to process licenses for the discharge of effluents. The level of licensing at present is close to zero.

Transfer of Technology:

The Indian environmental Engineers are looking forward to Govt. approval for a new institute to enhance scientific and technological cooperation with developing countries and in particular to enhance their own capacity to developer adopt and adapt new technology. That will involve such problems as training scientists and engineers, assisting the development of technical institutions in developing countries and joint cooperative research and development projects both in India and developing countries

A simple approach was developed that focussed upon the maximum pollutant concentration issuing from an idealised area. This study extended the maximum concentration approach to the consideration of the entire urban hydrograph, runoff versus time, pollutograph, pollutant concentration versus time and loadograph, pollutant mass emission rate versus time. Probability measures were introduced into non point source evaluation.

Formulas were derived by model analysis, which related the longitudinal dispersion coefficient of natural Indian rivers to several bulk flow properties as the discharge and the hydraulic radius. It was found that the dimension less factor of the formule unlike the dimensionless despersion coefficient was independent of the size of streams..An analysis of existing data indicated that the value of the dispersion coefficient could be predicted within a factor of four from the frictional or resistant factor of the stream. This equation for longitudional dispersion was found to be quite accurate.

Direct Filtration:

The cities may meet a INTU standard for filtration and safe drinking water. Many cities and towns that preyiously did not treat their water and merely chlorinated it shyuld instal treatment plants in order to meet this turbidity standard. Rather than construct a full blow conventional water treatment plant, it should be less costly to have toinstal a so called direct filtration plant. In a conventional plant coagulation and settling precedes sand filtration. In direct filtration on the other hand, the settling step in eliminated saving the cost of settling basins, which account for 20 to 30% of the capital cost of the plant when applied to suitable raw waters direct filtration has worked well.

Mathematical Models:

Mathematical models based on filtration theory were used in plant studies of granular bed filtration. A semi analytically solution of a such a model solved the material balance and provided concentration, specific deposit and a radient variations with filtrate volume and bed depth. The solution enabled the use of filtration equation to predict filter performance and optimise designs by feeding the computor with the filtration parameters obtained by past experiemnts. This was also applied to other accumulation processes namely fixed bed adsorption which were found to have a similar conservation equation. The general agreement between model predictions and fixed bed performance confirmed the model validity.

Rainfall:

Rising industrial pollution treatens, the country's climate in 1980's. The increasing incidence of small particles in the atmosphere particularly ommonium sulphate and sulphuric acid particles generated by industries was likely to have a marked influence on the quality of clouds to rain. These particles have discovered to have a tremendous influence on clouds. This is predicted to have serious implications for the sitting of future industrial plants.

Computor Technology:

Varying user requirements exist in order to assure effective and efficient environmental planning. A mini computor based system was selected in preference to a general purpose data system was a solution to these diverse requirements. The system was available for interactive enquiries via telephone and diverse sub-systems each to ensure ease of layman usage.

Conclusion:

Management of environmental quality in 1980's shall be intimately connected with local governments. Engineering designs shall be required to consider workable feasibility and efficient economic operation. Planning is recommended to relate issues of energy, food production, resource conversation, human health, economic productivity, ecosystems population and quality of life. These concerns can best be reconciled by local governments. Yet many current environmental problems shallbe beyond the capability of local government to effiectiverly control. A master plan is recommended to preserve environmental quality through land use controls. The effect of control intervention is to be evaluated asto their environmental effects. Inter disciplinary environmental research is a difficult task that often fails to meet its potential.

Reference:

1. Chaturvedi A.C.(1976); System Analysis for Water Management, Proceedings International Conference System Science III, Technical University Wroclaw, Poland, p. 29.
2. Yound C and Beck B(1974): Modelling and Control of Water Quality, Automica Vol. 10, p. 460.
3. Chaturvedi A.C.(1978):Industrialisation and River Ecology, Jour. Environmental Engineering Division Inst. of Engineers (I), p. 38.
4. Paone J., Morning Jh and Gorgeth L(1974):Land utilisation and Reclamation, Information circular 8642, USB of Mines, p. 24.
5. Chaturvedi A.C.(1978):Structural Designs and Problems of Water Pollution Control, Proc. Int. Conf. on Water Pollution Control in Developing Countries, Asian Institute of Technology, Bangkok p. 46.
6. Standard Methods for the Exam. of Water and Waste Water, 1971, American Public Health Assn. Washington, p.12.
7. Chaturvedi A.C.(1979): India's Water Resources Ecology in 1980's Proc. Third Conference of International Water Resources Association, p. 147.
8. Whipple W,(1977):Planning of Water Qulity Systems, Lexington Books, Mass p. 101.
9. Chaturvedi A.C.(1978):Industrialisation and Ecology, Bhagirath, p. 40.
10. Stiff Draft Report, National Commission on Water Quality 1975, p. 24.
11. Chaturvedi A.C.(1978): Water Resources Planning in India in 1980's Proceedings ASCE National Speciality Conference p. 144.
12. Vesilind PA. (1974) Treatment and Disposal of Waste Water Ann Arbor Mich p: 100.
13. Chaturvedi A.C.(1978): Geotechnics and Environmental

LAND TREATMENT SYSTEM FOR SURAT CITY

M.B. GOHIL*

Introduction:

Surat is one of the major cities of Gujarat State and also happens to be the district headquarters for Surat District. On the map of India, it occupies 21° N 12' latitude and 72° E 52' longitude and is situated on the bank of the river Tapi. Topographically city can be divided into two major parts - city within the Fort wall which was constructed by Nawab Gyasuddin in the year 1667 to protect the city from outside attack and the other area which has recently developed in the last decade and has a prominent position in industrial developments.

Existing Treatment System:

As early as 1953, the then Surat Borough Municipality installed the existing Anjana Sewage Treatment Plant for the disposal of the wastewater considering the prospective population of three hundred thousand people.

The low lying areas in Nanpura and Sayedpura are served with two boosting stations. The wastewater from these two areas flow under gravity to the lowest spots located in the respective areas from where it is lifted to the high level gravitation mains so as to feed into the sumps of central pumping station at Salabatpura. The total collection at the central pumping station is again lifted by means of 1.14 m(45 inches) rising main into the sewage treatment plant at Anjana.

The treatment plant consists of a detritus tank with cleansing mechanism from where the effluent flows in a channel at the end of which there is a sump and 76 cm(30 inches) hume pipe leading into the central column of the circular primary sedimentation tank. In the clarifier, the sewage rises from bottom of the central column and flows out through the vertical slits provided near the top and enters the circular channel by passing over the outlet weir constructed at the periphery of the clarifier. The effluent thereafter flows to the effluent chamber from where it is applied to various parts of the sewage farm. The levels of the clarifier are so arranged that the wastewater can travel in all direction upto a distance of about 300m (100 ft) beyond the limits of the sewage farm. The sludge accumulated at the bottom of the clarifier is pumped into the primary digester tank and the secondary digester tank provided in a series. Here anaerobic digestion takes place and the gas generated is used for producing electricity which in turn is used for driving motors installed on the plant. The sludge which has also high manurial ingredients, from the digester is spread on the sludge drying beds to recover sludge cakes.

The plant was put in operation in the year 1957 and since then the wastewater after only primary treatment is applied on land for the purpose of irrigation. The ridge and furrow method is employed for applying wastewater. The total irrigable area of the Anjana Sewage Farm at present is only 8.1 hactres(20 acres). It was however 9.7 hactres

(24 acres) upto the year 1974. The loss of 1.6 hacters (4 acres) is due to the construction of the buildings on the farm.

The sewage farm is under the administrative control of Municipal Corporation. The corporation authorities not only apply the wastewater on the sewage farm but also sell it to the farmers. The total command is approximately 101.2 hactres(250 acres). The surplus wastewater the quantity of which has considerably increased now-a-days is allowed to flow in the Kankara Khadi (Surface water course) without any treatment. This surface water course ultimately meets the river Tapi.

The revenue earned by the Municipal Corporation from the wastewater consists of the income from selling:

(i) Sludge cakes as fertilizer
(ii) Wastewater to farmers and
(iii) Crop raised on the sewage farm.

The revenue from these sources amounts to approximately Rs. 2 lacs per annum. The crops grown on the sewage farm and other command area consist of mainly sugarcane and vegetables. Fodder crop and horticulture are also common on some agricultural plots. At present over irrigation is practiced and the hydraulic loading is of the order of 1.5 cm/day amounting to 150 m^3/ha/day. With this rate of loading and command area of 101.2 hactres, the plant can handle about 15 mld of sewage, assuming continuous sewage irrigation round the year which is detrimental to the efficient working.

Need for Augmentation:

The existing plant has been designed for the population of three hundred thousand people only whereas at present the population is approximately the double. With rapid industrialization, it is quite possible that the rate of increase in population figure may be as high as seven to eight hundred thousand.

The quantity of waste water depends upon the rate of water supply and the population. The average rate of water supply for the city of Surat can be setimated as 200 l pcd. Assuming that 80 percent of water consumed will turn up as wastewater, the quantity of sewage from six hundred thousand population will be 96 mld. The existing plant can handle about 15 mld of sewage only as a result the surplus quantity of sewage without any treatment is discharged into the Kankara Khadi leading to the river Tapi. Due to the flow of sewage in the Kankera Khadi it is polluted and is known as Koyali (putrified) khadi locally. The Indian Standard (3) recommendations for discharging wastewater into surface water courses are stringent and not met with by this type of waste disposal. Moreover disposal by diputon is fallacy (1). Major augmentation is therefore necessary.

Possible Augmentation:

The augmentation may require additional treatment facilities in the form of secondary treatment units like trickling filter or activated sludge process to be designed for the prospective population of about eight hundred

thousand people. The augmentation can also be achieved by utilising the wastewater vor the purpose of irrigation. The results of sewage irrigation farm at Anjana are very encouraging and will attract the farmers to use the effluent for irrigation. This type of scheme will not only add to the revenue of the corporation but also have the capital which will otherwise be necessary for providing secondary treatment units and their subsequent operation and maintennce.

The city of Surat is developed on the bank of the river Tapi and can be conveniently divided into different zones. Instead of expanding the sewage farm at Anjana, land disposal schemes can be designed for different zones. On an average the recommended level of irrigation can be about 5 cm/wk requiring 14 hactres of land for disposal of 1 mld of sewage. Additional area of same magnitude will be required for alternate drying and irrigation. Thus for efficient land disposal, area required will be 28 hactres for 1 mld of sewage. This will give the hydraulic loading og 71.43 m^3 ha/day which is recommended for clay loam type of soil of Surat region (4).

In India three systems of sewage farm management are in vogue (2)

(i) Land is owned and cultivated by the local authorities.
(ii) Land is owned by the local authority but is given on lease on contract basis for a period of 1 to 5 years for cultigation.
(iii) Land is owned by the cultivators.

The municipal authorities should not acquire the land for the the wastewater disposal but manage only small demonstration farms to encourage the farmers to use the wastewater for the purpose of irrigation. Primary treatment plants like detritus tank and clarifier can be located on these demonstration farms.

Conclusion:

The sewage irrigation farm at Anjana utilizes the wastewater of Surat City after primary treatment. This plant was originally designed for only three hundred thousand population. Now the population being of the order of six hundred thousand, the quantity of wastewater has increased and as a result the plant is not capable of handling the extra volume of the wastewater which is discharged into the open surface drain.

This situation necessitates augmentation of the present treatment system. One of the potential alternatives can be in the form of land disposal by sewage irrigation. Municipal authorities instead of acquiring land for disposal can manage only some demonstrating sewage farms to attract the farmers to make use of the sewage for the purpose of irrigation.

References:

1. Gohil, M.B.; "Fallacy of Disposal by Dillution". All India Seminar on Environmental Pollution due to Industrial Growth. The Institution of Engineers (India) ,Calcutta, April 6-8, 1980.

2. Moduk, N.V., "Sewage and Wastewater Treatment" Somaiya Publications Pvt. Ltd., Bombay, 1971, pp.405.

3. "Tolerance Limits for Sewage Effluents Discharged into Inland surface waters" IS : 4764:1973.

4. "Tolerance Limits for Industrial Effluents Discharged on Land for Irrigation Purpose", IS: 3307: 1977.

LOW COST SANITATION BY AN AEROBIC(UPFLOW) FILTER SYSTEM.

V. Raman*; (Mrs.)S.A. Patkie* & A.N. Khan*

Various constraints stand in the way of providing conventional sewerage and sewage treatment systems in the urban and semi-urban areas in India. These are exhorbitant cost, finance and time factor. The demeaning practice of the scavenging system need to be abolished from social angle. Low cost simple sanitation systems which can also be considered as hygienic and appropriate to the local conditions, could be alternative sanitation options.

Sanitary pour flush water seal pit latrine form one such option for immediate solution to the problem in small and medium size conditions. In water logged and flooded areas, fissured racks, unfavourable terrain and impervious soil formations, these may become unsuitable from the points of view of construction, function and underground pollution travel. Adoption of simple alternative systems (may be constlier) need to be given consideration. Septic tanks with anaerobic (upflow) filter for secondary treatment followed by grass plots for polishing or composite anaerobic (upflow) filter systems following by polishing by grass plots, are some of the unconventional simple treatment systems to treat domestic sewage in individual, households, small communities, institutions and urban fringe areas.

Observations on laboratory pilot and field scale anaerobic filter systems over a period of eight years have shown conclusively the feasibility of adopting such a system and have enabled the evolution of design criteria.

The anaerobic (upflow) filter is an upflow submerged contact bed reactor where the wastewater is introduced from the bottom, unlike a conventional trickling filter. The anaerobic microbial growth is retained on the stone media making possible proper contact of sewage with biological solids and proper digestion anaerobically.

The process design parameters for the upflow filter can be briefly stated as (based on laboratory and field studies):

Type & shape	:	Circular, rectangular or square box of water tight masonry construction(Fig.2A)
Media	:	Gravel,broken stone,overburnt, brick bats.
Size of media	:	1.9 cms. to 2.5 cms.
Optimum depth of media	:	115 cms. to 125 cms(can be more, if need be)
Hydraulic loading rate	:	1.5 to 3.4 m^3 per m^2(of plan surface) are per day.
Temperature of sewage	:	21°C to 33°C

---

*National Environmental Engineering Research Institute, Nagpur

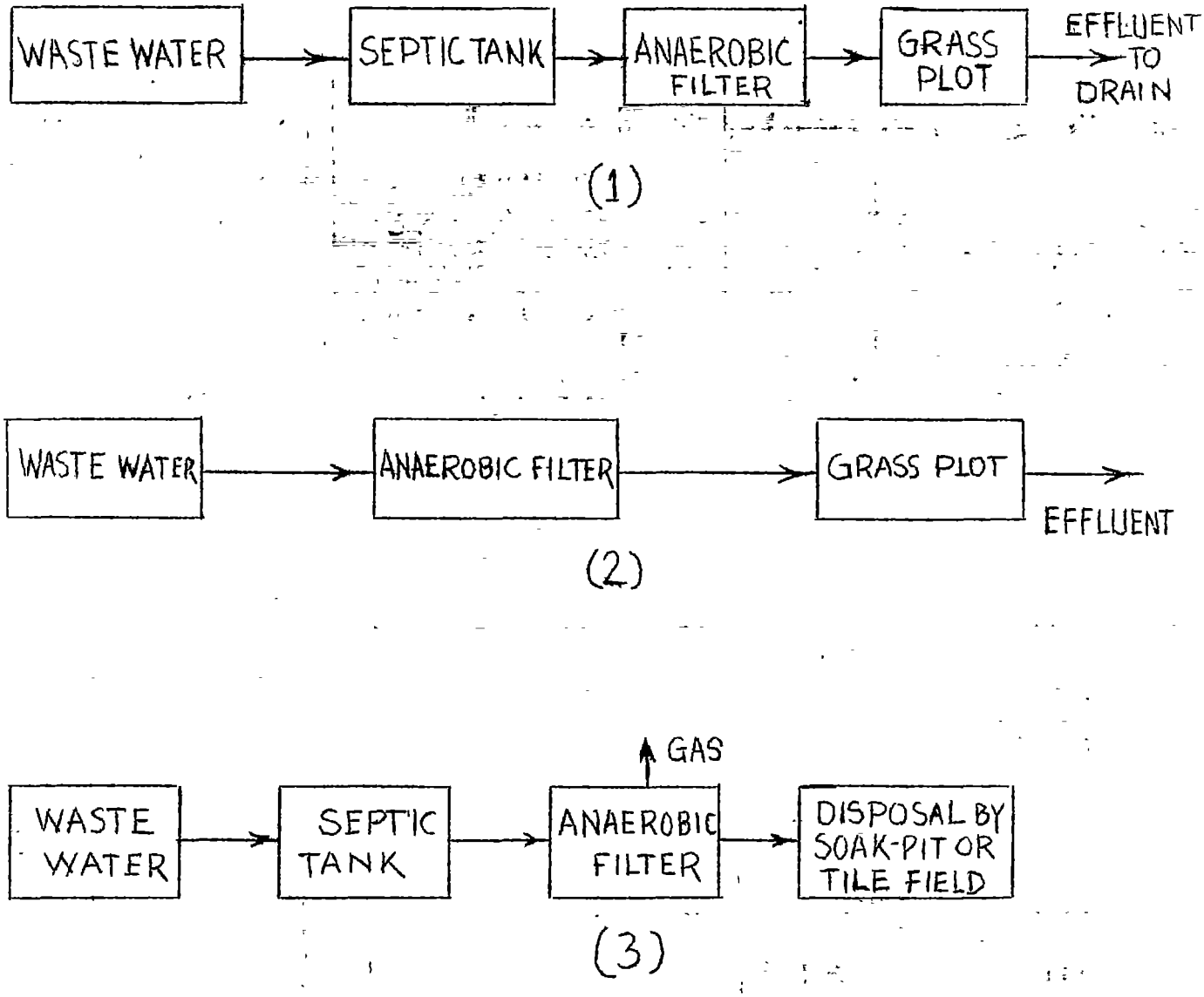


FIG.1 ANAEROBIC FILTER SYSTEM

15.10.82

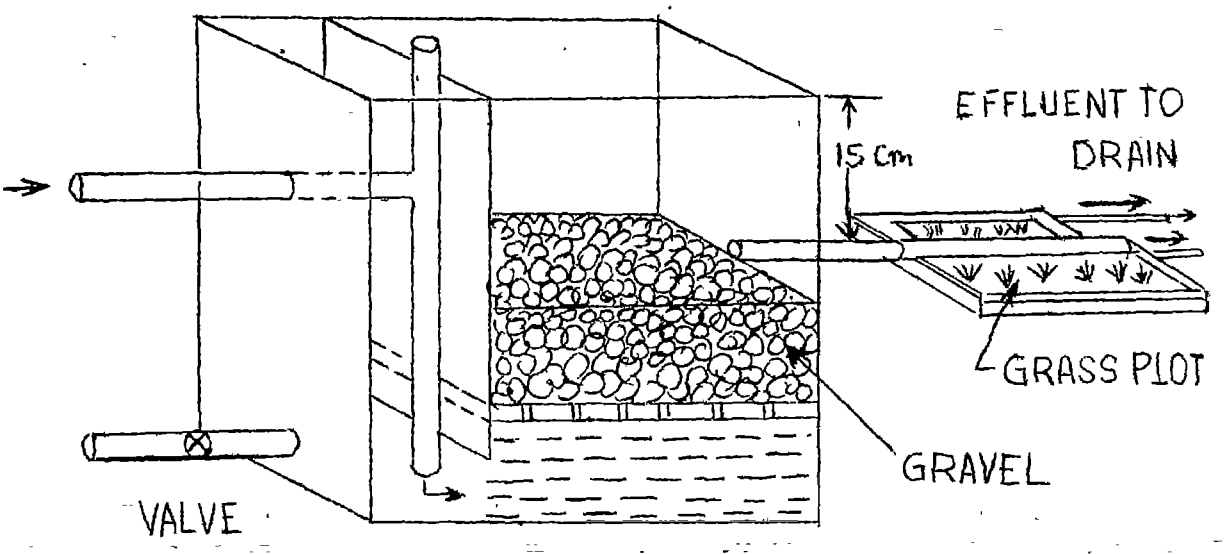


FIG. A
UPFLOW FILTER

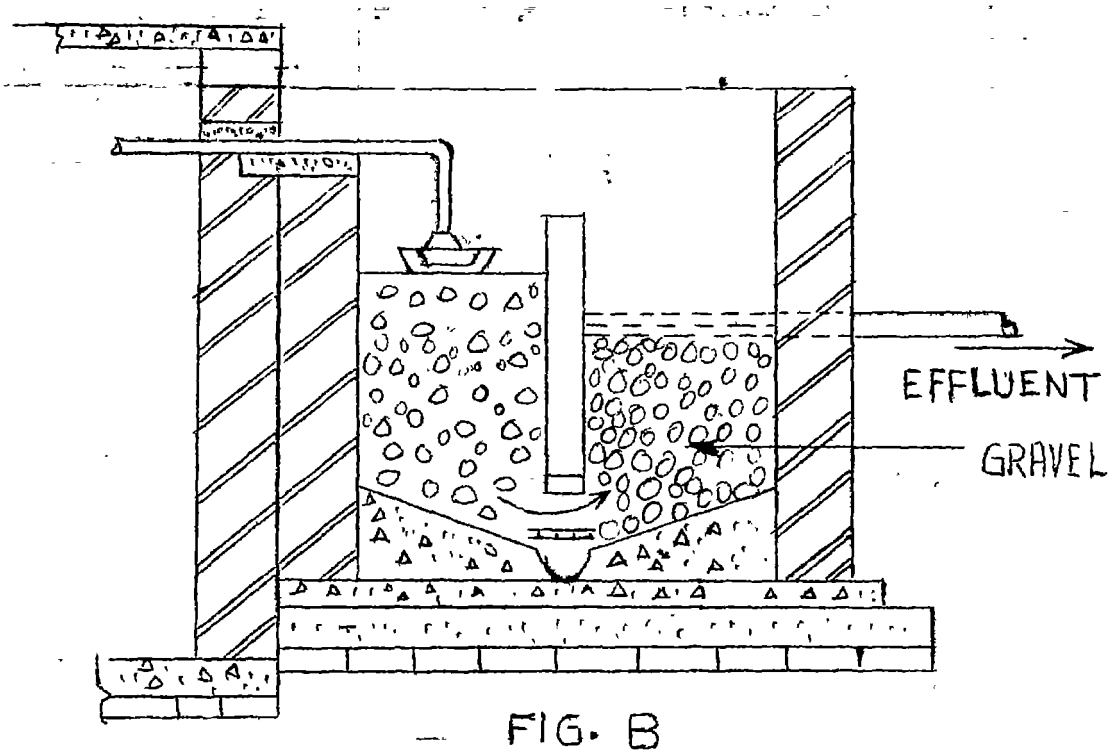


FIG. B
DOWN AND UPFLOW FILTER

FIG. 2. ANAEROBIC FILTER

Effective Detention time. : 6 to 12 hours.

BOD removal efficiency : 70 to 85%, for influent BOD concentration of 110 mg/l to 300 mg/l.

The anaerobic filter can function as a composite treatment device in which case the sewage should be free from grit and preferably homogenised. The filter can also be used as a secondary treatment device for treating effluent from septic tanks. Overland grass filtration treatment of filter effluent can be an useful adjunct for further polishing the effluent from the filter. Alternatively, the filtered effluent can be led to soak pits or soil absorption system in which case these last longer than they would be if septic tank effluents are directly applied to the system. Fig. 1 provides the flow sheets for the filter systems mentioned. Down and upflow filter(Fig. 2B) can be used where the depth of cutting has to be limited due to various constraints, keeping the detention capacity same.

Advantages of such filter systems are :

Simplicity of construction, operation and maintenance of filter, High degree of waste stabilisation, 70 to 80 percent reduction in BOD and SS, provision of methane gas collection.

Low production of waste biological sludge;

low nutrient requirements;

low capital and operating costs;

low loss of head in normal operation of filter(10 to 15 cms)

relatively clear, odour and nuisance free effluent

efficiency is not affected by intermittent flows;

can be used as compact unit along with septic tank, or complete unit by itself.

filter can operate without clogging for one to 2 years (if sewage is free from grit)

reduction in septic tank capacity of filter is used as secondary treatment device;

periodic flushing of filter once in 3 or 6 months from top can minimise clogging(as the sludge adhering to stones can be easily dislodged);

complete removal of ascaris eggs as sewage passes through the filter is obtained.

polishing in grass plots enhance the quality of effluent and adds to D.O. of effluent after grass filtration by 1 to 2 mg/l.

Limitations:

Relatively long period (15 to 30 days) is required for start up of the process.

Clogging will occur after continuous operation(over a period of one year or so), and this can be minimised by periodic flushing and keeping the sewage grit free.

Overland Grass Filtration:

Overland flow through grass plots was used for 'ploshing' of the anaerobic filter effluent. Dub grass (Cynodon SP) was grown in small plots of 3m x 1m and 7m x 1m. The filter effluent was allowed to flow over these grass plots every alternate day. There was build up of dissolved oxygen upto 1 to 2 mg/l and further reduction in BOD as the effluent flowed out of the grass plot.

Overland Grass Filtration:

Type of grass	:	Dub grass (Cynodon Sp.)
Hydraulic Loading	:	0.8 to 1.5 $m^3/m^2/day$.
Minimum number of plots	:	2 (alternate applications wetting & drying)
Slope	:	1 in 80 to 100
B.O.D. removal efficiency	:	40 to 60 percent
Increase in D.O.	:	0.8 mg/l to 1.5 mg/l.

Acknowledgements

Thanks are due to Dr. B.B. Sundaresan, Director, NEERI for his kind permission to prepare and present this paper.

References:

1. Raman V. and Chaklaudar, S.
'Upflow Filters for Septic Tank Effluents'
Jl. Water Pollution Control Federation(USA)Vol.44, Aug. 1972.

2. Raman V. and Khan A.N.
'Anaerobic(Upflow)Filter--A Simple Sewage Treatment Device'
Procs. of International Conference on 'Water Pollution Control in Development Countries, Bangkok, Feb. 1978 organised by International Association for Water Pollution Research and Asian Institute of Technology & Pub. by Asian Institute of Technology, Bangkok.

ENVIRONMENTAL SANITATION- PRESENT STATUS OF METROPOLITAN CITIES OF GUJARAT STATE.

C.C. Shah* and G.A. Gosla**

Environmental Sanitation is a very wide term in its scope. Here attention is being focussed on water sanitation in metropolitan cities of Gujarat State. An attempt has been made to discuss the present sanitary conditions of five cities viz., Ahmedabad, Baroda, Surat, Rajkot and Bhavnagar.

Except Rajkot, all other cities viz. Ahmedabad, Baroda, Surat and Bhavnagar have under ground drainage system. Rajkot has got open surface drains. Dur to rapid growth in population, simultanious urban development and industrialisation, existing drainage system of all cities are overloaded and part of area, of these cities are not yet covered under the undergound drainage system. In such area, facilities such as septic tank-soak pit system pit privy etc. are provided. Present status of metropolitan cities are tabulated in Table 'A'.

Cities like Ahmedabad, Baroda, Surat and Bhavnagar have got sewage treatment facilities. These treatment plants are also overloaded and at present all the municipal corporations are planning to provide additional treatment units under financial assistance of World Bank. Present situation of metropolitan cities considering drainage facilities and treatment are discussed as under :

Ahmedabad: Ahmedabad is the biggest city of Gujarat State haveing population of 25 lakhs. Ahmebabad has got two treatment plants (1) Pirana with capacity of 2920 lacs 1pd and Vasana with 670 lacs 1pd. Treatment plant includes sedimentation and biological trickling filters Treated effluent is discharged into river Sabarmati at a point downstream of Ahmedabad.

Baroda: Baroda is considered as one of the cleanest city in India. Total population is 7 lacs out of which 80 percent is covered with underground sewerage. Total quantity of sewage is treated in three treatment plants viz. Tarsali Treatment plant, Wadi treatment plant and Atladara treatment plant with capacity of 90 lacs 1pd, 450 lacs 1pd and 270 lacs 1pd respectively. Tarasali treatment plant has got extended aeration system and other two have conventional treatment plants. From Tarsali & Wadi treatment plants treated sewage is discharged into river Jambuva and the Atladara treatment plant treated wastewater is discharged into river Vishwamitri.

Surat: Surat is having a population of 5 lacs out of which 3 lacs is covered under sewerage system and remaining population is having septic tank-soak pit system and conservatory latrones. Total quantity of sewage is 550 lacs 1pd out of which 150 lacs 1pd is used for irrigation and 400 lass 1pd is discharged into river Mindhola through Kankara Khadi after treatment in Anjana treatment works.

Bhavnagar: Bhavnagar Municipality has been recently converted into Municipal Corporation. It has population of 3 lacs out of which 2 lacs are covered under sewerage system and one lac. is covered under septic tank-soak pit sytem. Bhavnagar has got treatments work with conventional treatmentunits and treated sewage is discharged into Bhavnagar creek.

* Dy. Env. Engineer, Guharat water pollution Control Board,

Rajkot: Rajkot is having a population of 3.5 lacs out of which 2.5 lacs are covered with open surface drains and remaining are with conservancy latrines, pit privy facilities and septic tank-soak pit system.

Rajkot has no treatment facilities and sewage is at present discharged into river Aji. Part of the sewage is used for irrigation. The work of providing underground drainage scheme is under progress and 20% work has been completed. Out of 54 municipalities, 22 cities of Gujarat have got underground drainage system with sewage treatment plant. Other cities have already planned for such schemes and work is in progress.

Urban Development Authority is planning the underground sanitation project for the surrounding areas of the Metropolitan cities in Gujarat. G.W.S.S.B. is planning to cover many Urban towns under low cost sanitation programme.

From above discussion, it can be concluded that existing treatment facilities in all metropolitan cities of Gujarat are over loaded and require major modification and alternation and additional treatment units. Gujarat Water Pollution Control Board is monitoring the treatmd sewage of all these cities and has directed all Municipal Corporation to go for additional treatment units.

TABLE-A

Environmental Sanitation status of Metropolitan cities of Gujarat State

Name of city	Population in lacs	Sewer system.	Population in lac covered under Septic tank-soak pit system.	Conservancy latrines	Open Surface drains.	Sewage treatment plant capacity	Point of disposal
Ahmedabad	25	20	5	-	-	Pirana 292 mlpd	Sabarmati river
Baroda	7	5.6	1.4	-	-	Tarsali 9 mlpd Wadi 45 mlpd Atladara 27 mlpd	River Jambuva & Vishwamitri
Surat	5	3	0.25	0.75	-	Anjana 55 mlpd	River Mindhola
Rajkot	3.5	-	0.5	0.5	2.5	-	River Aji
Bhavnagar	3	2	1	-	-	45 mlpd	Bhavnagar creek

AERATED LAGOONS AT MECON-SAIL TOWNSHIP RANCHI.

M. VIVEKANANDAN* AND D.N. BHATTACHARYA*

Introduction:

MECON-SAIL township is one of the most well planned township in Ranchi City. At present the township has 1470 residential houses for MECON and SAIL employees. The houses constructed during earlier stage development of the township are served with local septic tanks and soak pits for sewage disposal. It was observed during mansoons that the above sytem was ineffective and creating nuisance in certain places due to high water table conditions. During expension stage of the township it was felt to have a centralized sewage treatment plant for effective treatment of raw sewage to the required effluent standards. The present article describes the salient features of the sewage treatment plant constructed in the expansion area of the township. The sewage treatment plant is of aerated lagoon type and it is well designed, constructed and being maintained in good condition.

Plant Location and Capacity:

The sewage treatment plant is located on the south side of the township expansion near Bhusur river. The plant serves the entire expansion of the township and also certain portion of the existing township.

The first phase design population is 5,500 upto the year ending 1982. The ultimate design population is estimated about 9200 during the period 1982 to 1990. The proposed water supply is 365 litres/day/capita. On the basis of the above population and water supply demand and with some amount of ground water infiltration into the sewer system, the plant capacity is arrived as 84 m^3=h in the first phase and 140 m^3/h in the ultimate phase.

Selection of aerated lagoons:

After a detailed study, aerated lagoons are found to be more suitable for the township than other type of treatment plants. The main reasons for selection of aerated lagoons are : (i) Aerated lagoons require less land area than stabilization lagoons. (ii) There is no day to day sludge handling problem. (iii) There is no smell or psychoda suisance. (iv) They require less mechanical equipments than oxidation ditch and conventional plants. (v) They require less electric power and skilled operations, less capital and running expenditure, compared to oxidation ditch and conventional plants.

Process description:

Raw sewage after screening and grit removal enters the aerated lagoons in parallel. Artificial aeration is maintained on the surface of the lagoon by fixed type surface aerators. The top zone of the lagoon is under aerobic condition and solids undergo aerobic decomposition. The aeration is maintained such that there is no complete mixing of tank contents. Certain amount of solids always settles at the bottom of the lagoon and undergoes an aerobic decomposition.

* DE, MECON, RANCHI

The treated effluent passes to a polishing laggon where further purification of effluent takes place. The effluent from the polishing lagoon is discharted into natural water course after disinfection using bleaching powder solution.

Description of the warious units:

The drawing in the ANNEXURE - A indicates the layout plan of the sewage treatment plant at MECON-SAIL township (SHYAMALI) Ranchi.

The plant comprises the following units: 1. Coarse screen, 2. Raw sewage pump house, 3. Fine screen, 4. Grit channels, 5. Distribution pit, 6. Aerated lagoons. 7. Common effluent channel, 8. Polishing lagoon, 9. Bleaching powder solution tanks and chlorine contact chambers, 10. V-notches and outfall channel.

1. Coarse-screen:

The raw sewage from the sewer system of the township enters the coarse screen channel through 500 mm dia. sewer at 5.0 m. below G.L. One set of vertical screens are provided and they are operated by chainpulley mechanism. The arrange ment is such that when one screen is lifted for cleaning operations, the other will get lowered in position automatically to ensure continuous operation. The spacing between coarses screen bars is 50 mm clear.

2. Raw sewage pump house:

i) Wet well

The sewage flows into the wet/sump after passing through the coarse screen. The wet well is of annular ring shape surrounding the dry well. The wet well is provided with emergency overflow outlet and also inlet for receiving the drainage from the lagoons.

ii) Dry well

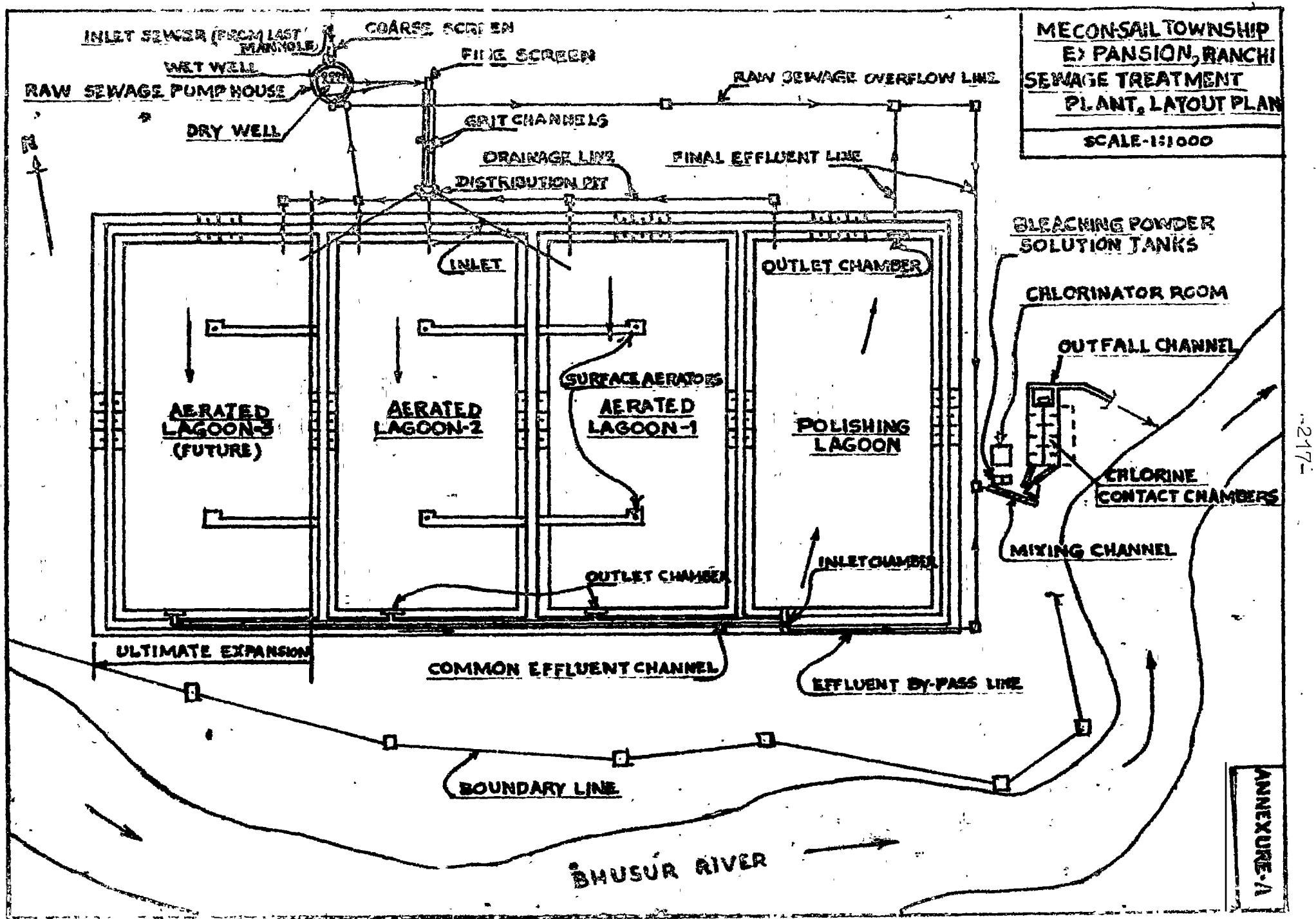
The dry well is of circular cross section of 5.83 m inner dia 7.65 overall depth below G.L. The dry well accommodates 2 Nos. electrically driven vertical pumpset and 1 no. diesel engine driven horizontal pumpset with engine. All the pumpsets are of non-clog type with 150 m^3/h capacity and 10.5 m total head each. Necessary space provision for 1 No. vertical pumpset is kept for ultimate phase expansion.

There is a drainage sump below the floor level of the dry well to receive any seepage or accidental leakages inside the dry well. 2 Nos. vertical drainage sump pumpsets are provided with 15 m^3/h capacity and 11.0 m total head each.

iii) MCC room

The MCC room over the dry well accommodates electric motors and common MCC panel for pumpsets, aerators, ventilating fan etc. Automatic liquid level controls are provided for electric pumpsets in addition to manual controls.

The sewage pumphouse is provided with forced draft ventilation facilities. A chain pulley block with monorail is provided for handling the equipments inside the pumphouse.


MECON-SAIL TOWNSHIP EXPANSION, RANCHI SEWAGE TREATMENT PLANT, LAYOUT PLAN
SCALE-1:1000
INLET SEWER (FROM LAST MANHOLE)
COARSE SCREEN
FINE SCREEN
WET WELL
RAW SEWAGE PUMP HOUSE
DRY WELL
RAW SEWAGE OVERFLOW LINE
GRIT CHANNELS
DRAINAGE LINE
FINAL EFFLUENT LINE
DISTRIBUTION PIT
INLET
OUTLET CHAMBER
BLEACHING POWDER SOLUTION TANKS
CHLORINATOR ROOM
OUTFALL CHANNEL
SURFACE AERATORS
AERATED LAGOON-3 (FUTURE)
AERATED LAGOON-2
AERATED LAGOON-1
POLISHING LAGOON
CHLORINE CONTACT CHAMBERS
MIXING CHANNEL
INLET CHAMBER
OUTLET CHAMBER
ULTIMATE EXPANSION
COMMON EFFLUENT CHANNEL
EFFLUENT BY-PASS LINE
BOUNDARY LINE
BHUSUR RIVER
ANNEXURE-A

3. Fine screen

The common header and drainage header from the raw sewage pumphouse discharge the flows into the fine screen channel. The fine screen channel is just before the pair of grit channels. The fine screen is of fixed type making 45° angle to the floor of the channel. The spacing of the screen bars is 16 mm clear.

4. Grit Channels:

A pair of grit channels with a parabolic cross section is provided and the size of each channel is 17.25 m length 0.64 m width and 1.36 m overall depth. Each channel is provided with hand operated penstock at its ends. To maintain a constant velocity a rectangular control section is provided at the down stream end of the channel During normal operation one channel will be functioning, while the other is in cleaning operation. A deep space is provided at the bottom of the channel for grit accumulation. A drain pipe with valve arrangement is provided at the bottom of each channel for draining out the grit material.

5. Distribution pit

Sewage after passing through the fine screen and grit channel enters the distribution pit of semi-circular cross section. Sewage flows from the inner to outer chamber of distribution pit through 3 Nos. of 300 mm wide rectangular notches. The outer chamber is again divided into three compartments and each compartment is connected to the respective aerated lagoons through 300 mm dia CI pipes.

6. Aerated lagoons

The aerated lagoons are located in parallel, lagoon 1, and 2 are provided in the first phase and space provision is kept for lagoon 3 which will be under ultimate expansion. The sewage flows from the distribution pit into the lagoons through 300 mm dia C.I. inlet pipes. The designed capacity of each aerated lagoon is 70 m^3/h with 5 days detention. The average surface area of the lagoon is 75.0 m length x 37.50 m width. The effective depth of the lagoon is 3.00 m and the free board is 0.60 m. The bund slopes are 1:1.5 inner and 1:2 outer. The top width of the bund is 1.50m. To prevent any infiltration or leakage, the inner surfaces of lagoon are provided with flat brick lining of 75 mm thick and 20 mm thick cement plastering over the brick lining.

2 Nos. surface aerators are provided in each lagoon. The oxygenation capacity of each surface aerator is 2 Kg/KW-h under standard conditions. The aerators are spaced such that rach aerator covers half the lagoon area. The aerator with its assembly is mounted in the aerator platform of size 2.50 m x 1.10 m. A walkway of 1.3 m width connects the aerator platform and the bund of the lagoon. The platform and walkway are supported by a system of R.C.C. columns inside the lagoon.

Each aerated lagoon is provided with a drainage pipe of 200 mm dia CI pipe at 0.50 m above the bed level. The drainage pipe is provided with valve and it is connected to drainage sewer. The drainage sewer leads the drainage from all the lagoons to the wet well of raw sewega pumphouse.

The above drainage arrangement facilitates for draining the lagoons during desludging operations.

The effluent from the aerated lagoons overflows into the common effluent channel through outlet chambers. The outlet chambers are provided sith baffle and weir arrangement.

7. Common effluent channel

The common effluent channel of rectangular cross-section leads the effluent to polishing lagoon.

8. Pâlishing lagoon

The designed capacity of polishing lagoon is 140 m^3/h with 1 day detention. The average surface area is 75-0m length x 37.5 m width. The effective depth of the lagoon is 1.20 m and 0.60m is the free board. The bund slopes, top ~~wi~~ width of bund, lining of the lagoon and drainage arrangement are similar to that for aerated lagoons. The effluent from the polishing lagoon overflows through the outlet chamber and then passes into the final effluent line of 400 mm to 450 mm dia RCC pipe.

An effluent bypass line of 400mm dia RCC pipe is provided at the end of common effluent channel and it joins the final effluent line before the mixing channel.

9. Bleaching powder solution tank and clorine contact chambers

For the purpose of disinfection of the treated effluent, the sewage treatment plant is provided with two schemes, one using liquid clorine cylinder and the other using bleaching powder. At present bleaching powder solution is used for disinfection.

There are 2 Nos. bleaching powder solution tanks of each size 2.00 m x 1.00 x x 1.60 m. The bleaching powder solution is prepared and stored in the tank itself. A 50 mm dia. pve pipe with valve arrangement is provided just above the bottom of each thank for withdrawing the solution. The solution is fed into the mixing channel where it gets mixed with the treated effluent from polishing lagoon. The solution feed is adjusted manually to maintain the required chlorine residuals in the final effluent. At the end of mixing channel there is a distribution pit which distributes the chlorinated effluent into 2 Nos. chlorine contact chambers through inlet channels. A chlorine contact time of 30 min. is maintained in each tank. The size of each tank is 12.00m length, 3.00m width and 1.88m overall depth. Baffles are provided in the chlorine contact chamber to prevent short circuiting. Also drainage pipe with valve arrangement is provided for cleaning the chambers. Necessary space for the third chlorine contact chamber is provided for ultimate phase.

10. V.notches and outfall channel

The effluent from the chlorine contact chambers passes into the individual outlet channels. At the end of each outlet channel 90°V - notch plate is provided for flow measurement. The over flow from the V-notches falls ~~xi~~ into the common outfall channel. The outfall channel leads the final effluent of the plant towards the Bhusur river.

Final effluent quality:

The final effluent quality of the sewage treatment plant conform to IS: 4764 and other limits specified by Bihar State Pollution Control and prevention Board. Recent test reports incidating characteristics of raw sewage and final effluent are given in the ANNEXURE-B.

Conclusion and Acknowledgement

The aerated lagoon and at MECON-SAIL township Ranchi xxxxxx can be a model plant for similar townships and it is a place of Environmental Engineering interest for those who would like to visit the plant. The authors are thankful to the authorities of MECON for their kind permission in presenting this paper. Authors are also thankful to Shri N.M. Saxena, EM and Shri S.G. Ambekar, AEM for their guidance and encouragement.

CHARACTERISTICS OF RAW SEWAGE AND FINAL EFFLUENT OF
THE SEWAGE TREATMENT PLANT AT MECON-SAIL TOWNSHIP, RANCHI

SL.NO.	CHARACTERISTICS	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT	RAW SEWAGE	FINAL EFFLUENT
	DATE OF SAMPLING	7.7.82		14.7.82		21.7.82		28.7.82		4.8.82		11.8.82		25.8.82		1.9.82		8.9.82		15.9.82	
1	5DAY BOD (mg/l) (AT °C)	70 (33)	16	95 (33)	25	80 (32)	15	80 (30)	20	75 (30)	12	70 (29)	12	75 (29)	12	70 (29)	12	80 (29)	11	60 (29)	9
2.	TOTAL SUSPENDED SOLIDS (mg/l)	115	30	140	35	120	20	125	30	85	15	110	20	120	30	110	10	130	15	110	10
3	pH	7.0	7.3	7.1	7.2	7.2	7.2	7.1	7.3	7.1	7.3	7.1	7.2	7.2	7.4	7.1	7.2	7.2	7.3	7.0	7.2
4.	TOTAL COLONY COUNT AT 37°C IN 48h PER ml	-	1	-	45	-	8	-	28	-	12	-	50	-	28	-	2	-	6	-	4
5	MPN-E-COLI PER 100 ml	-	1	-	250	-	4	-	1	-	4	-	1	-	5	-	1	-	1	-	6

NOTE: 1. THE ABOVE FIGURES ARE FROM THE TEST REPORTS SEND BY THE SUPERINTENDENT, WATER & SEWAGE WORKS, TISCO, JAMSHEDPUR.

2. A RESIDUAL CHLORINE OF 0.1 TO 0.2 mg/l IS ALWAYS MAINTAINED IN THE FINAL EFFLUENT.