RURAL WATER SUPPLY

THROUGH DEVELOPMENT OF NATURAL SPRINGS

Sponsor : Socio Economic Unit

Kerala Water Authority

THIRUVANANTHAPURAM

National Environmental Engineering Reasearch Institute
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JANUARY 1994

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1. Introduction

The International Drinking Water Supply and Sanitation Decade (IDWSSD) which started in 1981, has been the forerunner of the Health for All by 2000 AD, to which India is a signatory to the progamme. The target for IDWSSD in 1981 was 100 percent coverage of rural water supply by 1990. A mid-decade evalution by the Government of India revealed a backlog of 2.27 lakhs of problem villages in the area of water supply. These problem villages have been identified by non-availabilty of a water source at a resonable distance or depth or because of the exessive dissolved chemicals and biological contamination. The gamut of rural water supply essentially comprises identification of a perennial source of water, conveyance of water, purification and distribution to the consumers.

The water Technology Mission (WTM) was one of the five technology missions set up by the late Rajiv Gandhi Government in late 1986, in order to make mid-term correction and to achieve the goal of the IDWSSD. The WTM identified 1157 problem villages in the State of Kerala in 1987-88. In spite of the IDWSSD programme, it is estimated that 40 percent of the urban and 60 percent of the rural population in the state which is known for its advances made in the area of Public Health and Education do not have adequate supply of safe drinking water, especially in the summer months.

Kerala is a land having peculiar geographical features, with its long coastal belt, undulating midlands and hilly highlands, having a thick growth of populace and vegetation, makes it difficult for providing piped water supply to all house-holds. The sources of water in the house-holds are predominantly private wells. Each individual house having a compound of 100-200 cents or more of land will have an open well. Village tanks form the facility for bathing, washing clothes and cattle wash and cattle drink. Having two monsoons spread over a period of 6-8 months, water scarcity is felt only when the monsoon fails.

2. Natural Springs as Source of Drinking Water

However, general scarcity of water due to natural reasons - droughts, wide fluctuations of rain fall and fast run offs of rain water from mountains and highlands to the vallies is frequently observed in many parts of Kerala, resulting in hardships to the people living in the remote hilly tracts. Probably, because of the non-accessability to the hamlets, that protected water supply has not been possible in the hilly tracts in many districts of the State. The source of water to the people living in the hilly tracts is either small streams or sub-surface water collected in the depressions of rocks, locally known as "Kulam" (See the Photograph of an undeveloped spring - Figure. 1). These are natural springs. Several thousands of these springs exist in the highlands stretched over the length of the western ghats. Many of them are seasonal. But there are several perennial springs which have been used by the settlers as their source of water for drinking, bathing and other daily needs ever since they migrated from the valley

2.1. Development of natural springs

2.2. Implementing agency

2.2.1. The Pazhakulam Social Service Society (PASSS)

PASSS, a non-governmental organisation (NGO), which is operating in the Pathanamthitta, Alleppey and Kollam districts of the State is active in the uplift of the weaker sections of the society. PASSS is engaged in the socio economic development of weaker sections in rural areas through implementation of agricultural animal husbundry, awareness creation, protected water supply, sanitation, health education, land manegement

The society through their "Farm Clubs" contacts, has felt the need to develop, protect and supply safe drinking water to the socio-economically deprived class of the society in the area of their activity from the perennial 'natural springs'.

2.2.2. Objectives

The objectives of the current programme were:

(1) To overcome scarcity of drinking water in dry months (January-June) in isolated/remote/hilly region through development of springs as alternate/complimentary,low cost and enviornmentally sound sources of safe drinking water;

(2) To improve health and sanitation standards of the participant families through increased availability of water and health education;

(3) To reduce the drudgery on the family, especially the women, in fetching water from long distances;

(4) To ensure participation of user-families at various stages of the programme development and enable them to shoulder the responsibility of managing and maintaining the developed springs;

2.2.3. Methodology of Implementation

In order to achive these objectives the society adopted the following strategies :

(1) Active participation of local groups, officers of rural development, agricultural and forest departments in the preliminary identification of the springs. Help from the village elders have also been sought.
(2) Organising geological investigations to ascertain the viability and sustainability of the selected sources
(3) Conduct motivation classes by qualified social workers for making rapport with the user communities.
(4) Organise the potential users for making them aware of the benefits of the progarmme and persuade them for sharing the cost (financial as well as labour).

The society, in this process, selected 77 springs for development as sources of drinking water (Figure 2 to 5) in the Pathanamthitta and Kollam districts of the Kerala State. PASSS also took into consideration of the following aspects, before the final selection of the sources:

(1) Reliability of yield to meet the demands throughout the year.
(2) Accessibility and availability of land for development of the spring and storage of spring water.
(3) The number of users to be served by the source (springs) be maximum.
(4) The per capita cost (initial) be minimum
(5) The ownership of the land and spring for development is such that it is congenial for the post developmental programmes (maintenance).
(6) The proximity of the source to the user community.

PASSS had identified amongst the users a few members to function as members of the Water Ward Committee (WWC) who will be responsible for maintenanace of the springs.

The development of springs involved civil construction works, fixing suitable water drawing systems and disinfection before it is supplied. For the developmental activities, the society required financial inputs as well as human resources for construction work

2.2.4. Financial Supports

PASSS has been receiving financial assistance from various State, Central and International agencies for their social uplift activities in the rural villages.

The Royal Dutch Government through the Socio-Economic Unit (SEU) of the Kerala Water Authority (KWA) has supported this scheme.

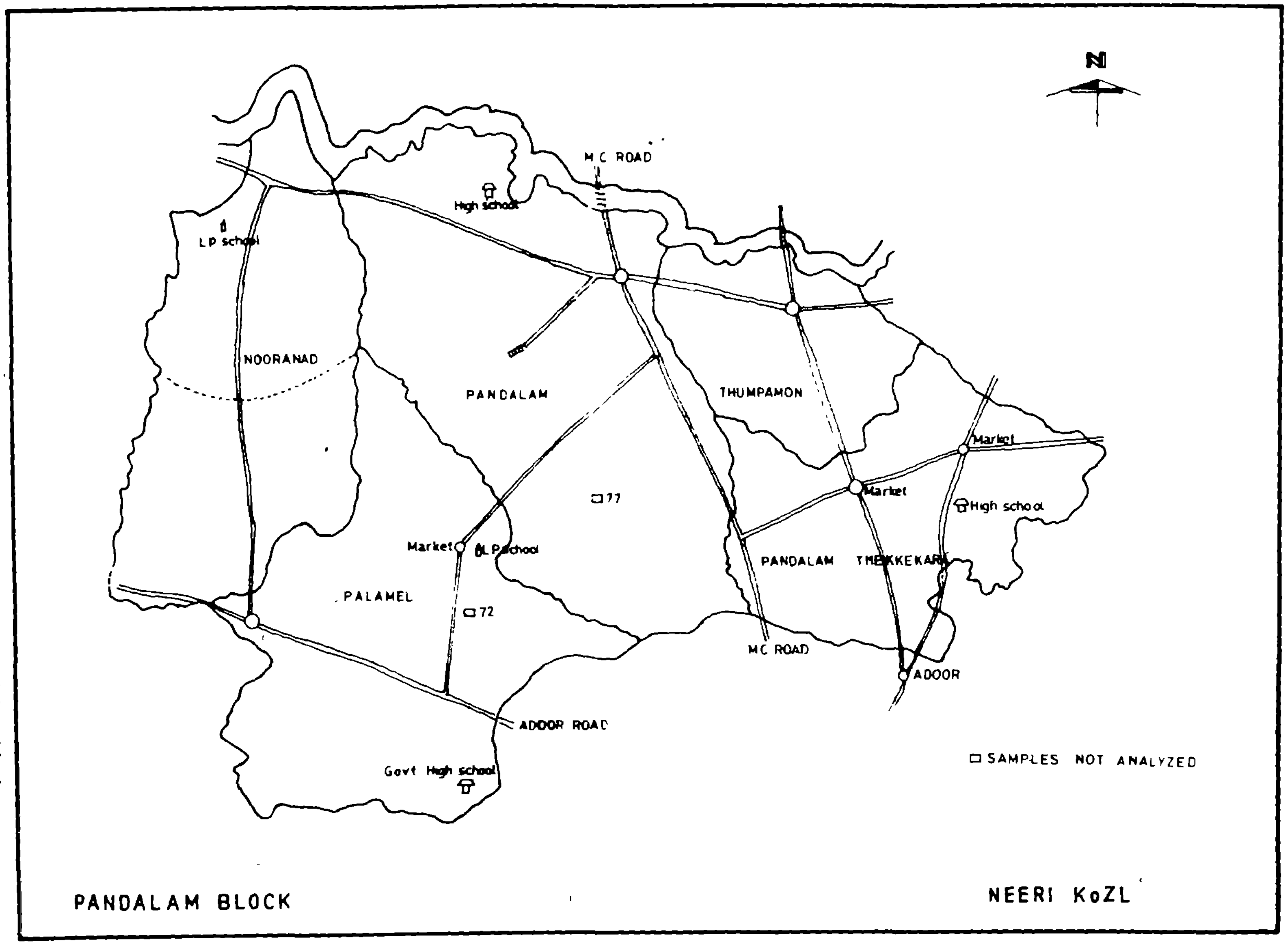


Figure.2. Location map of developed springs in Pandalam block

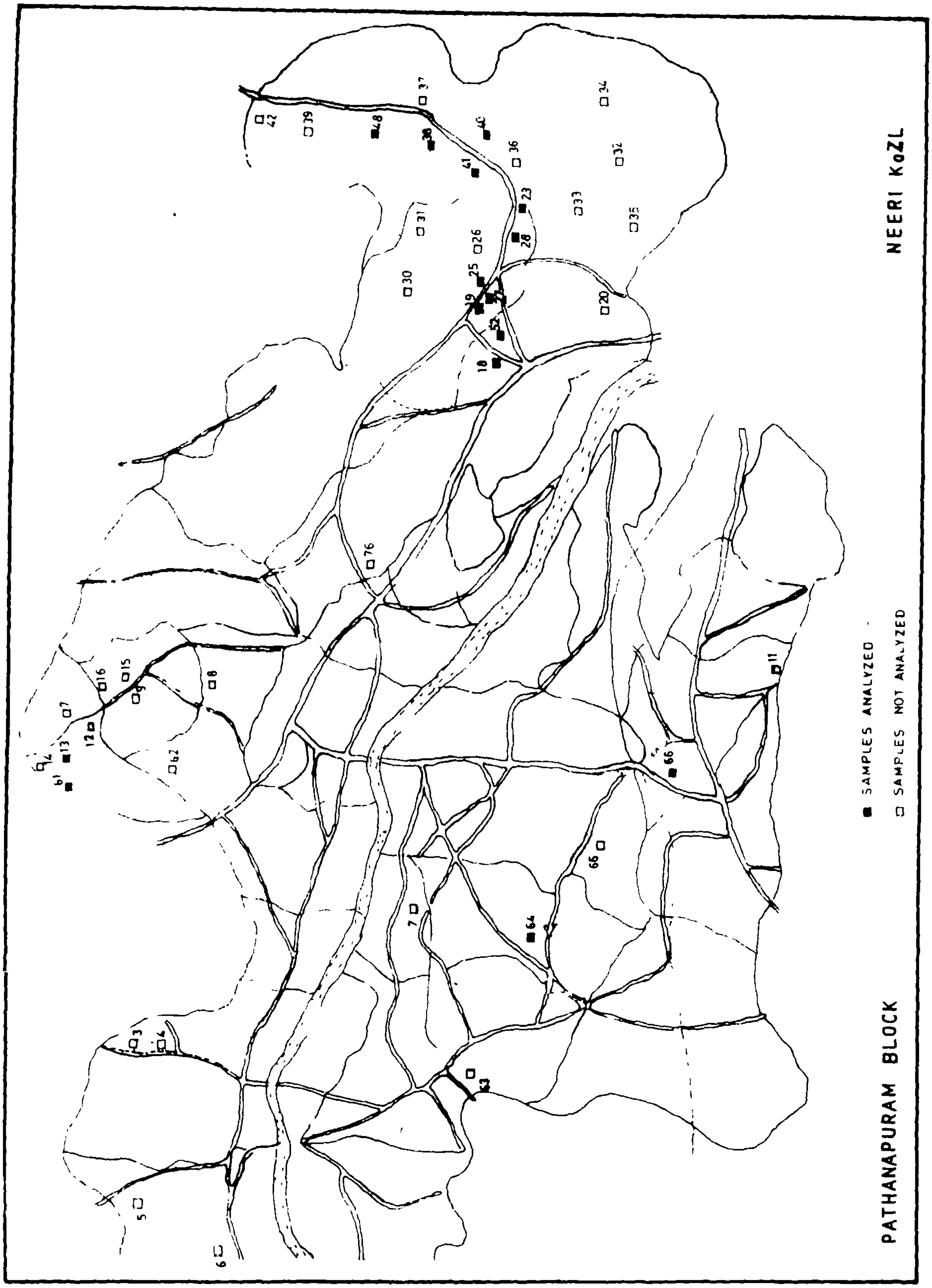


Figure.3. Location map of developed springs in Pathanapuram block

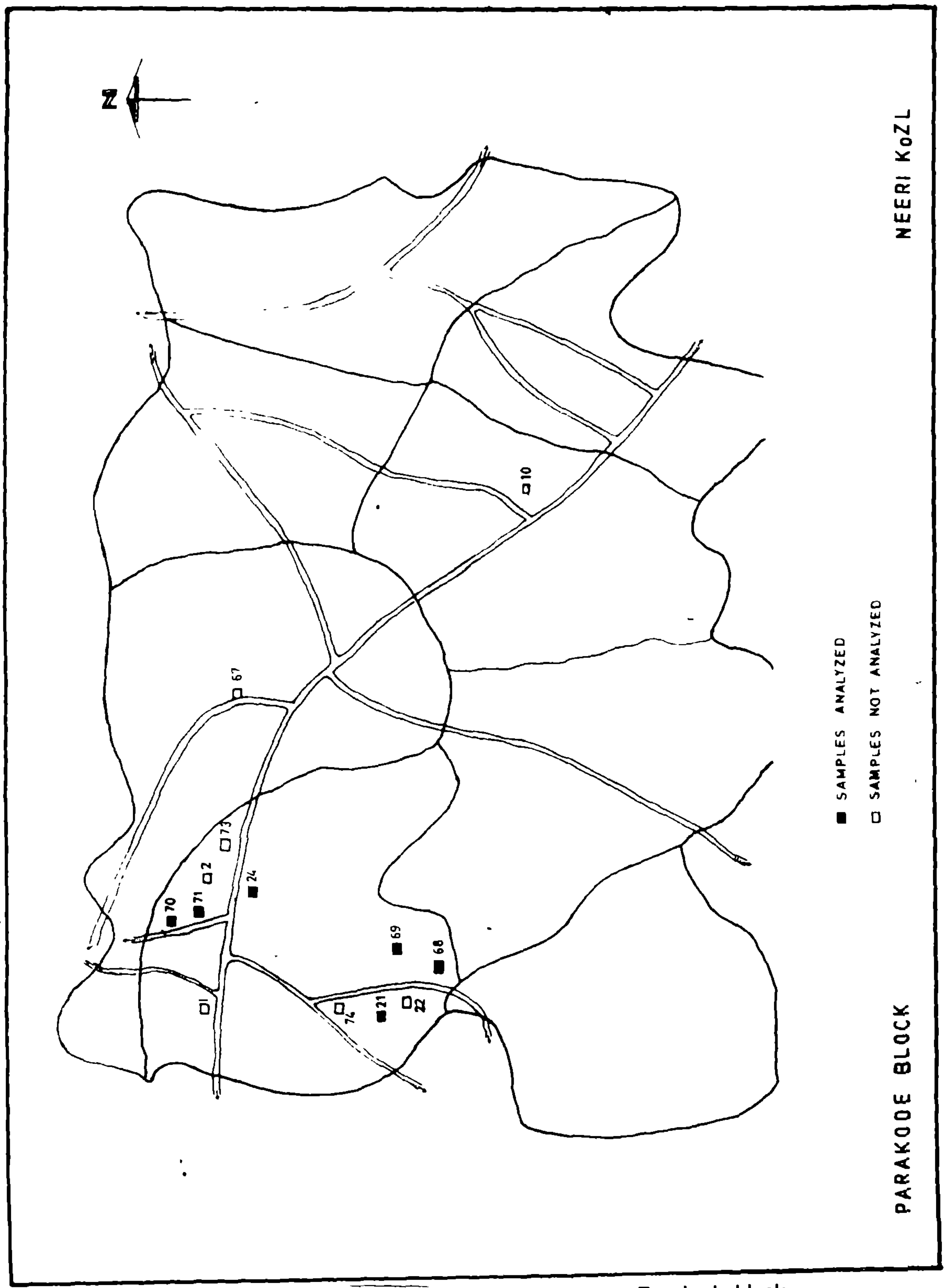


Figure.4. Location map of developed springs in Parakode block

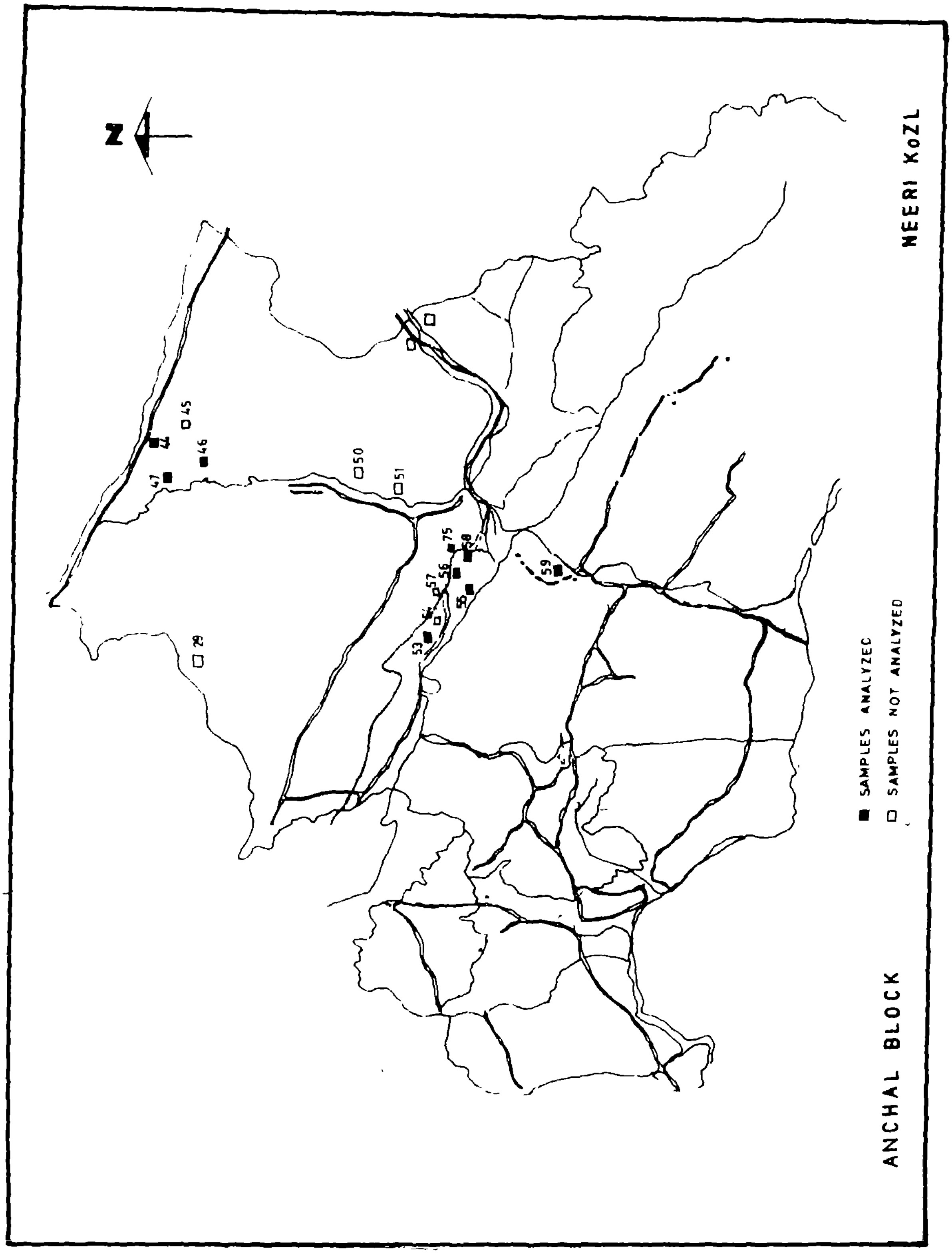


Figure.5. Location map of developed springs in Anchal block

2.2.5. Socio-Economic Unit

The SEU having objectives behind their activities as mentioned below has actively participated in this programme:

Integrate socio-economic activities and methods into the KWA's current programme for water supply (activities are improving population coverage, site selection in the community, monitoring/maintenance/ drainage around standpost, fault reporting).

Develop sustainable strategies which will, within the community and household contribute to improved hygiene/health practices related to safe handling and use of water, enhance sanitation practices and essential sanitary facilities (includes household and institutional latrines with education, environmental activities of local relevance).

Strengthen/establish mechanisms which enable people and their local institutions to plan and participate in activities related to water supply, sanitation and hygiene education. Particular emphasis is being paid to women's involvement. (includes Ward Water Committees, Standpost Attendant, networking with other agencies/NGOs, improving open wells and springs, monitoring activities, school health clubs, women's programmes)

The user community contributed about 8 per cent of the construction cost. In addition the community involvement has been through contribution of the labour force to the construction work.

2.3. Civil Construction Works

The development of the spring involved construction of the side retaining walls, erection of platforms, R.C.C. slabs with man holes. Plans showing the details of the construction is given in Figures 6 and 7.

The water withdrawal arrangement in the case of the springs are; hand pumps, where enough slope is not avilable as is seen in photographs (Figures 8 and 9). The spring in figure 8 is located on the backyards of an individual family land, while that in figure 9 on the side of a National Highway.

The spring developed and as shown in Figure 10 is situated on the slopes of a farm land and is provided with a tap to draw water from the stored tank. Figure 11 shows a developed spring situated in the low lying area between two ridges of hillocks.

For the developmental activities, PASSS has received support from the community, as is evidenced from the labour support from the women (Figure 12), as helpers by the men (Figure 13).

2.3.1. Collection and Storage of Water

The community collects water from the springs through hand pumps or taps in aluminium or plastic buckets or in aluminium vessels as can be seen in photographs - Figures 14 and 15

2.4. Water Quality Assessment

2.4.1. National Environmental Engineering Research Institute

The developmental agencies retained National Environmental Engineering Research Institute (NEERI), to assess the water quality with specific reference to chemical and bacteriological quality and socio-economic impact of the programme on the communities that participated in the development process.

This report presents the water quality of 30 selected springs in terms of the chemical constituents of essential parameters and faecal coliform concentrations. Also, a socio-economic survey and the incidence of water-associated diseases has been conducted to evaluate the impact of the community water supply in unaccessible, remote, rural, hilly areas of the districts of Pathanamthitta and Kollam in the Kerala State.

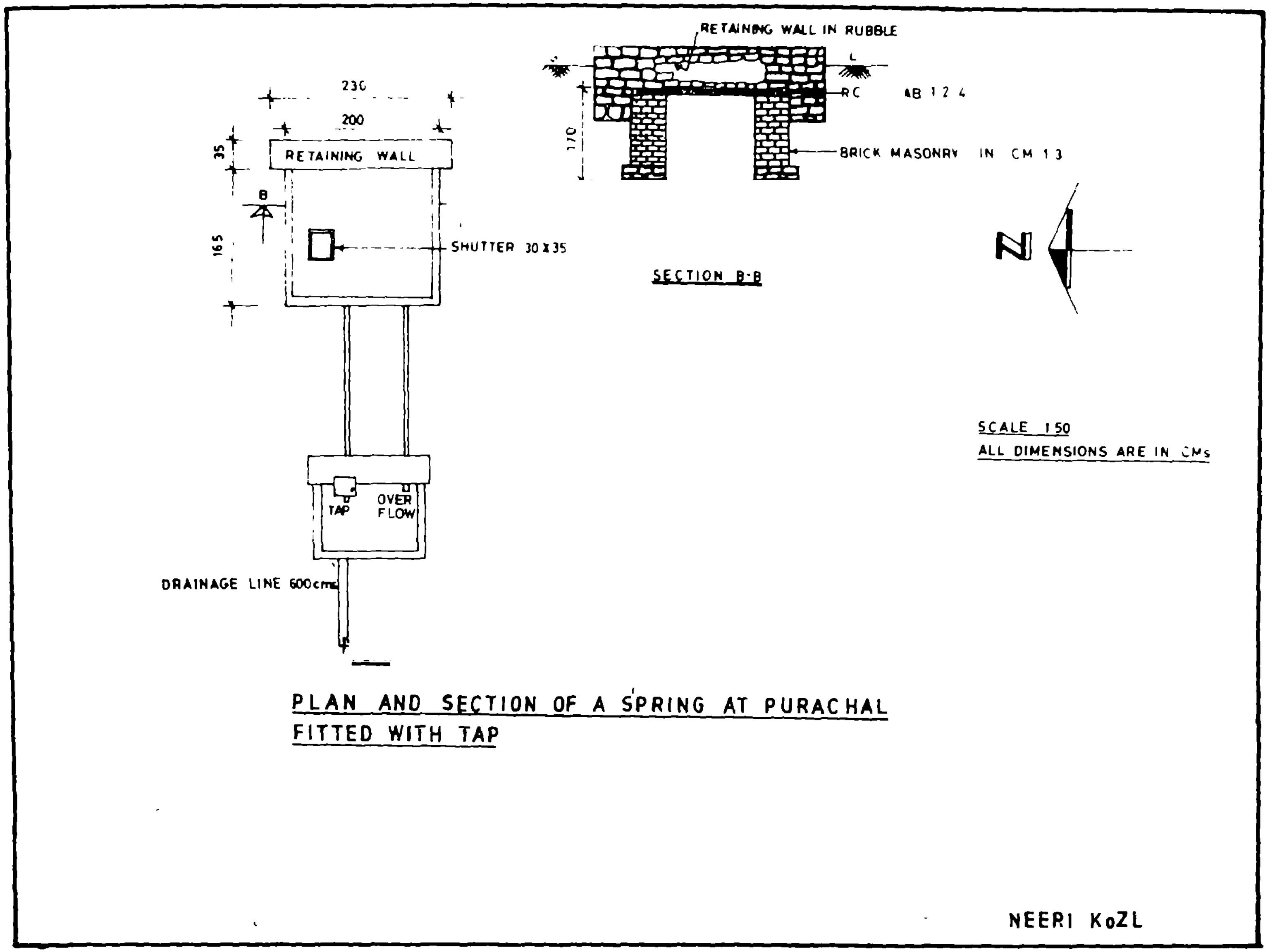


Figure.6. Plan for civil construction of a spring with fixture for hand pump

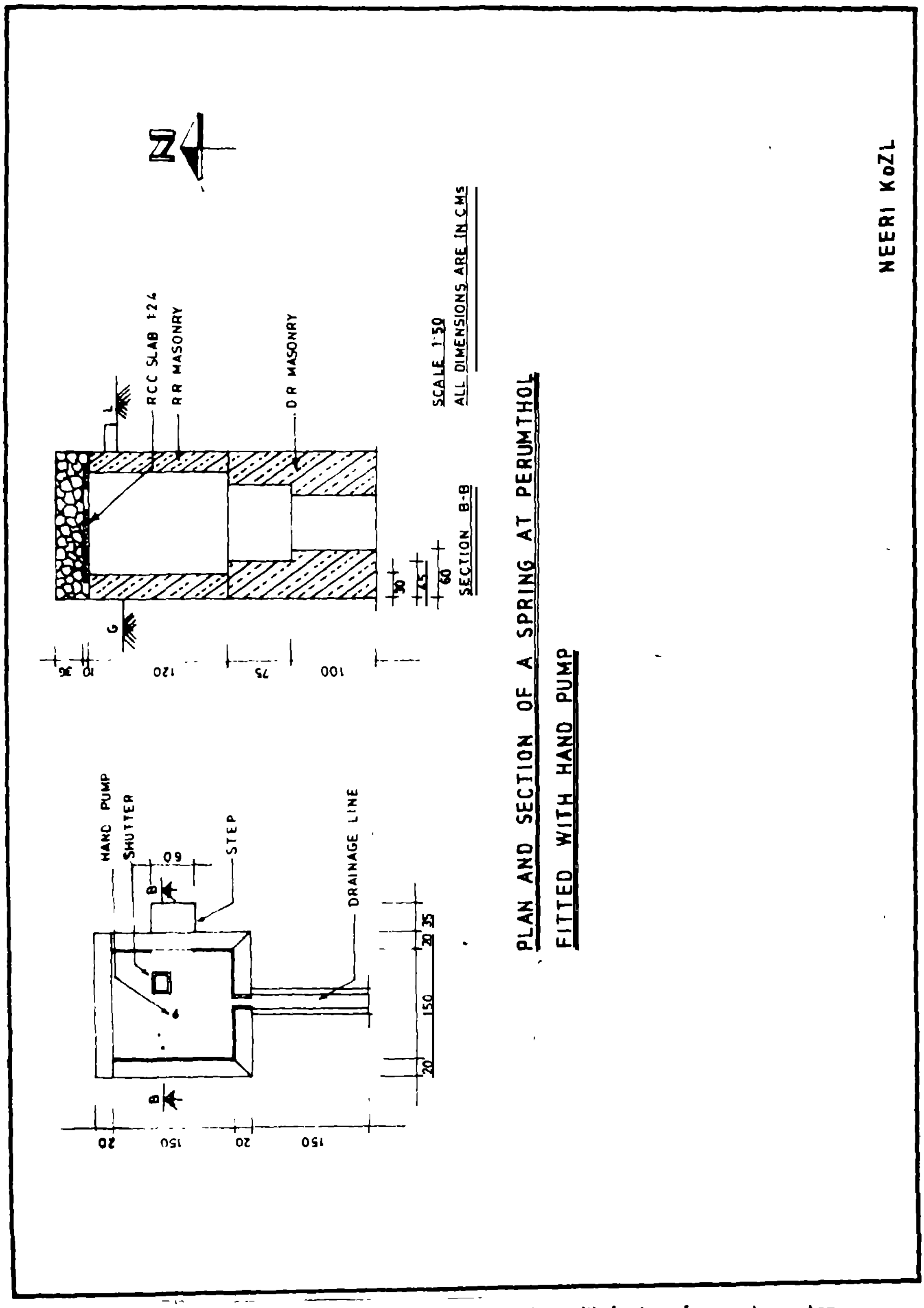


Figure.7. Plan for civil construction of a spring with feature for waste-no-tap

Selection of the springs for this evaluation has been made on the basis of random easy access basis by PASSS/SEU. The location of the springs are shown in Figures 2 - 5. These springs are located in three blocks (Pathanapuram, Parakode and Anchal) of the districts of Pathanamthitta and Kollam. The details of the springs, location, status, water yield, storage capacity of the constructed tanks, construcion cost, water utility pattern and the type of beneficiary group is given in Table 1. These informations have been collected from PASSS on the data sheet 1 (Annexure I). On the basis of the water yeild from the springs, the construction cost and the utilising pattern, has been ranked, assuming an average 40 LPCD as the resonable water requirement as against the national goal of 70 LPCD. These ranking shows that 23 out of the 30 springs are optimally utilized. 5 of the springs are underutilized. (more families can be added to these sources) Two springs have been developed for single family use, because of their poor socio-economic status.

The quality of the water has been assessed, with referece to the chemical and bacteriological contaminants during the two seasons of the year 1993. Samples were collected during pre-monsoon season, when it is expected to be the lean period of water yield and in the post-monsoon season, when it is expected to have high pollutional load due to flooding, sub-surface water recharge and runoffs, into the springs. The method of collection of samples at sight can be seen in the photograph (Figure 16). Details of the samples have been collected on Data sheet 2 (Annexure II).

Samples collection was spread over a perid of one month in each season (May/June and September/ October 1993). After collection, the samples have been preserved as suggested in the standard methods of water and waste water analysis. The samples were analysed in the laboratory as early as possible by the procedures described in the Standard Methods. Results of analysis of these samples are given in Table 2 and 3, while Table 4 provides the values for drinking water as per the Indian Standards. An assessment of the water quality on the basis of the results presented in the tables and to that of the prescribed permissible/ desired levels, indicates that the sources have acidic water, as the pH of the water is much below the desired levels. The possible reason for the acidity is the dissolved Carbon dioxide in the water. Carbon dioxide is a natural component of all natural waters. It is produced by microbial oxidation of organic matter in the soil with which the water has been in contact and under such conditions the gas is not free to escape to the atmosphere and gets dissolved in the ground water. It is particularly true to encounter acidity as high as 30-50 mg/l, when the water percolates through soil that do not contain Calcium or Magnasium Carbonate to neutralise the Carbon dioxide through formation of bicarbonates.

Acidity is of little concern from a sanitary or public health viewpoint. Carbondioxide is present in carbonated beverages in concentrations greatly in excess of any concentrations in any natural water and no deleterious effect has so far been recognized except its corrosive nature.

Corrossion: Hydrogen Sulphide, dissolved Carbondioxide and dissolved Oxygen which causes acidity are responsible for corrossion. Carbondioxide, which is often found in water passing through heavily wooded areas is responsible for corrossion of unprotected pipes. Natural water containing Carbondioxide will dissolve carbonates from rocks in the ground thus producing soluble bicarbonates. Depending upon the relationship between the bicarbonate alkalinity and the pH of the water on the one hand and between the free Carbondioxide and the alkalinity on the other hand the water will be corrosive or will deposit a film on the inner surface of the pipe line. However, it has been observed that when the water is kept open for some time, the pH value increses to reach the neutral range. Some of the spring water has white hazyness due to suspended particulates but is being accepted by the user community without any hesitation. Enquiries amongst the user community reveal that the taste is acceptable to them. Total dissolved solids in all except 1 spring (spring No. 46) are well within the prescribed limits.

2.4.2. Chemical Quality

The chemical quality assessment shows that the hardness is practically negligible, with carbonates, chlorides and sulphates of Calcium and Magnesium which are very low. Fluorides are not even in traces, which can lead to dental carries in children. Ten springs have iron content within the permissible concentrations. The reason for high iron content can be due to corrosion of hand pumps due to the acidity of the water.

Nitrates in some of the samples has increased concentration in the post-monsoon period. This can be due to leaching of nitrate which has been formed by nitrification by soil bacteria.

Table 1 Details of the Natural Springs, developed under Rural Water Supply Scheme									
Spring No & Name	Location	Status Public/ Private	Yield in Peak Summer (l/min)	Storage Capacity (m^3)	Cost of Constr-ction (Rs)	Per Capita Unit Cost (Rs)	Water Utility (LPCD)	Type of Benifi-ciary	Remarks
13 Santhi Bhavan	Chandra Babu S Santhi Bhavan IX, Pathanapuram Kollam Dt	Private	3	1 9	6522	60.46	45	Low Income Group (LIG)	
18 Purachal	Kochu Podiyan Roadarikathu Veedu W-V, Piravanthoor Kollam Dt	Private	1	1 95	3869	773.8	288	Sigle Family	Under-Utilized
19 Sanyasikon	Santhamma Raji Bhavan W-V, Sanyasikon Piravantoor Pathanapuram Kollam Dt	Private	1 7	1 6	4344	149.8	23	Single family	
21 Kavullathil	Damodaran Thekkemolil Kavullathil W-V, Palliacal Paracod, Adoor Pathanamthitta Dt	Private	0 9	0 8	4129	137 06	54	LIG	
23 Micamine	Panchayath W-VI, Micamine Piravanthoor Pathanapuram Kollam Dt	Public	4 0	2 8	4252 75	84 27	95	LIG	
24 Thengum-tharakkulam	Purushothaman Mulakuvila Thekkethil Thengumthara Paracod Pazakulam East Adoor, Kollam Dt	Private	1 4	1 55	4700	327 46	101	LIG	
25 Perumthol	N Valsan Nellimootil W-VII, Perumthol Piravanthoor Pathanapuram Kollam Dt	Private	3	4	4136	101 27	86 4	LIG	

Table 1 Details of the Natural Springs, developed under Rural Water Supply Scheme(Contd)									
Spring No. & Name	Location	Status Public/ Private	Yeild in Peak Summer (l/min)	Storage Capacity (m^3)	Cost of Constr-uction (Rs)	Per Capita Unit Cost (Rs)	Water Utility (LPCD)	Type of Benefi-ciary	Remarks
27 Kala Bhavan	Sdananthan Kala Bhavan Perumthol W-VI Piravanthoor Pathanapuram Kollam Dt	Private	5	3	8508	109 07	47 4	LIG	
28 Thalappa-kkettil	Aihsa Beevi Thalappakkethil Perumthol Piravanthoor Pathanapuram Kollam Dt	Private	4	2 88	8923	147 63	87.3	LIG	
38 Orekkar	Nabeesa Beevi Thadathilankath Champanaruvi W-X, Orekkar Piravanthoor Pathanapuram Kollam Dt	Private	3 5	2 52	8191	143 7	84	LIG	
40 Parayil	Alexander Moolamuriyil Chambanaruvi W-X Piravathoor Pathanapuram Kollam Dt	Private	2 5	1 8	8175	103 48	40 1	LIG	
41 Vijaya Mandiram	Achuthan Pillai Vijayamandiram W-X Piravathoor Pathanpuram Kollam Dt	Private	5 5	4	8883	108 33	93 2	LIG	
44 Depot Kulam	Forest Land Achenkoil W-VII, Aryankavu Pathanapuram Kollam Dt	Public	3	2 16	11415	93 56	32 5	LIG	
46 Block No 66	Rukmani Amma Block 66 Harijan Colony, Achenkoil Anchal, Aryankavu Pathanapuram Kollam Dt	Private	4	3	11230	138 64	64	LIG	

Spring No & Name	Location	Status Public/ Private	Yield in Peak Summer (l/min)	Storage Capacity (m^3)	Cost of Construction (Rs)	Per Capita Unit Cost (Rs)	Water Utility (LPCD)	Type of Beneficiary	Remarks
Table 1 Details of the Natural Springs, developed under Rural Water Supply Scheme(Contd)									
47 Block No 82	Kunju Pennu Block 82, W-VII Harijan Colony Achenkoil, Anchal Aryankavu Pathanapuram Kollam Dt	Private	3 5	2 252	11163	126.22	49.4	LIG	
48 Kotta-vasal well	Panchayath Property W-VIII, Aryankavu Kottavasal Well Pathanapuram Kollam Dt	Public	8	6	11284	61 66	25 2	LIG & Others	
52 Vanmala	Sunderesan Sundaresa Bhavan Vettithula P O W-VI, Piravanthoor Pathanapuram Kollam Dt	Private	4	2 88	8110	86 55	72	LIG	
53 Look Out	Panchatath Property W-VII. Thenmala Anchal Pathanapuram Kollam Dt	Public	3 5	2 5	7445	140.47	84	LIG	
55 Erappan chall	K.O Madhava Panicker Pushpavilasam W-IX, Thenmala Ottakkal Anchal Pathanapuram Kollam Dt	Private	6	4 32	10230	114 93	96	LIG	Under Utilized
56 Nalpatha-mile	Panchyath Property W-IX, Thenmala Anchal Pathanapuram Kollam Dt	Public	6 5	4.5	10265	97.57	64.55	LIG	
58 Theatre Kulam	Harrison Malayalam Plantations W-VII,Thenmala Anchal Pathanapuram Kollam Dt	Private	4 5	3 25	8206	45 33	40 5	LIG	
59 Nedumanoor Kadavu	Abdul Azeez Purampokku Land Nedumanoorkadavu W-X, Kolathupuzha Anchal Pathanapuram Kollam Dt	Public	4	2.98	9357	158 59	88 6	LIG	

Table 1 Details of the Natural Springs, developed under Rural Water Supply Scheme(Contd.)									
Spring No & Name	Location	Status Public/ Private	Yield in Peak Summer (l/min)	Storage Capacity (m^3)	Cost of Constr-ction (Rs)	Per Capita Unit Cost (Rs)	Water Utility (LPCD)	Type of Benefi-ciary	Remarks
61 Kuttan-kulam	Rajukuttan Resmi Bhavan W-IX, Mangode Pathanapuram Kollam Dt	Private	3 7	2 665	9340	133 42	71	LIG	
64 Thalavoor	Sankaran Elanji Velil W-X, Thalavoor Pathanapuram Kollam Dt	Private	1 7	1 324	10295	138 13	27.2	LIG	
66 Kundothu-moola	Ismail Kunju Charuvile Thekkethil W-I, Avaneeswaram Vilakudy Pathanapuram Kollam Dt	Private	5 5	3 96	9035	96 12	82 5	LIG	Under Utilized
68 Chakkan-chira-kkulam	Panchayath Property W-V, Pallickal Parakode Adur, Kollam Dt	Public	5	5	9230	98.19	72	LIG	Under Utilized
69 Uppini-thara	Kochu Chekkan Thadathil Velayil W-V, Nooranadu Pallickal Parakod Kollam Dt	Private	2	2 1	8139	96 89	35	LIG	
70 Thenna-kkanna	Georgekutty C C Charauvilla Puthen Veedu W-VII Pazhakulam Adur Pathanamthitta Dt	Private	2 8	2 016	8144	110 05	40	LIG	
71 Thanni-kodu-kulam	Janardan Vijush Bhavan W-XII, Thannikkode Pazhakulam Pathanamthitta Dt	Private	2 5	1 8	8218	124.52	37 5	LIG	
75 Charuvu-kalakkulam	Thankamma Rajani Charivukala Puthen Veedu W-X, Ottakal Thanmala, Anchal Kollam Dt		3 8	3 8	7232	118 45	91.2	LIG	Under Utilized

Table 2 Physico-Chemical and Bacteriological Quality of Water from Natural Springs

Sl No	Parameters	13	18	19	21	23	24	25	27	28	38	40	41	44	46	47	48	52	53	55	56	58	59	61	64	66	68	69	70	71	75
	Spring Numbers																														
(A)PHYSICAL																															
1	Colour (VISUAL)	CL	CL	Hz	CL	Hz	CL	CL	CL	Hz	Hz	CL	CL	CL	CL	CL	CL	Hz	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	C
2	Odour	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB
3	Tastes	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	Turbidity-NTU	2 0	1 0	61 0	1 0	36 0	1 0	6 0	5 0	56 0	25 0	5 0	15 0	3 0	15 0	7 0	1 0	24 0	1 0	1 0	2 0	1 0	1 0	1 0	5 0	1 0	1 0	5 0	5 0	4 0	2
5	Total Diss Solids(mg/l)	182	156	197	232	460	102	211	205	358	208	202	568	90	159	297	199	230	63	177	27	101	130	164	208	179	189	130	193	293	14
6	pH	4 4	5 4	5 8	5 9	5 3	5 2	5 3	4 8	5 9	5 5	5 4	6 3	6 3	6 3	6 6	6 2	5 6	6 0	5 7	5 7	5 9	5 8	5 8	5 3	4 2	4 4	4 6	4 2	4 0	5
(B)CHEMICAL																															
7	Alkalinity as $CaCO_3$ (mg/l)	12	12	60	12	40	4	54	20	90	6C	44	60	18	70	34	76	47	6	26	10	26	14	14	36	20	22	14	8	10	20
8	Hardness (Total) as $CaCO_3$ (mg/l)	4	14	68	10	64	2	52	28	70	60	36	84	20	60	20	60	60	4	14	8	30	10	10	30	6	8	6	6	4	10
9	Calcium as Ca (mg/l)	2	4	12	3	12	1	19	10	27	22	11	30	5	16	5	14	20	1	4	1 5	10	3	3	10	2	2	2	2	2	3
10	Magnesium as Mg (mg/l)	NIL	1	9	0 5	8	NIL	1	1	0 5	1 5	2	2	2	5	2	6	2 5	0 5	1 5	1	1 5	0 5	0 5	1 5	0 5	1	0 5	0 5	NIL	0 5
11	Chlorides as Cl (mg/l)	4	5	7	10	7	5	13	5	45	10	10	20	12	15	5	15	13	3	4	5	10	8	4	44	20	8	6	4	8	1'
12	Sulphates as SO_4 (mg/l)	NIL	NIL	11	0 3	153	5	45	117	78	9	23	58	0 5	3 8	1	6	180	0 5	NIL	0 5	4 5	4 3	NIL	4 5	0 3	NIL	NIL	1 3	NIL	NI
13	Fluorides as F (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NI
14	Nitrates as NO_3 (mg/l)	6	NIL	13	3	13	1	18	1	9	9	18	13	22	16	7	5	6	5	5	5	5	5	7	36	6	1	1	1	1	16
15	Sulphides as S (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NI
16	Iron as Fe (mg/l)	0 6	1 2	0 9	0 5	0 8	0 3	0 5	1 4	3 2	0 9	0 9	1 0	0 2	1 1	1 3	2.0	1 6	2.0	1 8	2 0	0 4	0 4	0.3	0 9	0 3	1 1	1 1	0 7	3 2	0 :
17	Free Res Chlorine as Cl (mg/l)	0 2	0 2	NIL	NIL	0 2	NIL	4 5	1 0	0 2	3 5	0 2	5 0	NIL	NIL	NIL	NIL	4 0	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NI
(C) BACTERIOLOGICAL																															
18	Faecal coliforms(CFU/100ml)	13	0	500	9	0	1	0	0	0	0	0	0	110	0	190	0	0	0	14	0	0	34	1	340	39	140	1	5	0	0

PRE-MONSOON

Cl = Clear Hz = Hazy, UB = Unobjectionable A = Agreeable Diss = Dissolved, Res = Residual

TABLE 3 PHYSICO-CHEMICAL AND BACTERIOLOGICAL QUALITY OF WATER FROM NATURAL SPRINGS

Sl No	Parameters	Spring Numbers														
		13	18	19	21	23	24	25	27	28	38	40	41	44	46	47
(A)	**PHYSICAL**															
1	Colour (VISUAL)	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
2	Odour	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB
3	Tastes	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	Turbidity-NTU	2.0	2.0	6.0	1.0	4.0	6.0	NIL	NIL	4.0	6.0	NIL	NIL	9.0	5.0	8.0
5	Total Diss Solids (mg/l)	114	89	123	66	49	92	45	92	83	139	142	151	482	514	161
6	pH	4.5	5.2	6.0	5.5	5.3	6.2	5.3	5.3	5.5	5.6	5.7	5.9	5.4	5.7	6.5
(B)	**CHEMICAL**															
7	Alkalinity as CaCo3 (mg/l)	6.0	6.0	5.0	8.0	20.0	4.0	28.0	20.0	34.0	30.0	14.0	26.0	20.0	30.0	50.0
8	Hardness (Total) as CaCo3 (mg/l)	6.0	4.0	4.4	6.0	18.0	2.0	16.0	18.0	54.0	24.0	12.0	30.0	14.0	20.0	38.0
9	Calcium as Ca (mg/l)	2.5	2.0	9.0	2.0	7.0	1.0	6.0	6.0	18.0	10.0	3.0	8.0	4.0	6.5	12.0
10	Magnesium as Mg (mg/l)	NIL	NIL	5.5	0.5	NIL	NIL	NIL	1.0	2.0	NIL	1.0	2.0	1.0	1.0	2.0
11	Chlorides as Cl (mg/l)	12.0	3.0	7.0	8.0	6.0	6.0	8.0	8.0	38.0	6.0	6.0	6.0	9.0	9.0	5.0
12	Sulphates as SO4 (mg/l)	NIL	NIL	NIL	NIL	6.5	NIL	2.5	2.2	5.0	2.2	NIL	2.0	NIL	NIL	NIL
13	Fluorides as F (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
14	Nitrates as NO3 (mg/l)	4.0	NIL	NIL	NIL	1.0	1.0	2.5	0.5	17.0	2.0	1.0	0.4	2.0	2.5	4.5
15	Sulphides as S (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
16	Iron as Fe (mg/l)	0.6	0.2	0.9	1.0	0.2	0.2	0.4	0.4	0.2	0.9	0.2	1.1	0.6	0.2	0.3
17	Free Res Chlorine as Cl (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
(C)	**BACTERIOLOGICAL**															
18	Faecalcoliforms (CFU 100 ml)	10	36	30	300	212	68	28	20	132	0	30	70	66	72	280

Sl No	Parameters	Spring Numbers														
		48	52	53	55	56	58	59	61	64	66	68	69	70	71	75
(A)	**PHYSICAL**															
1	Colour (VISUAL)	CL	CL	CL	CL	CL	CL	CL	CL	Hz	Hz	CL	CL	Hz	CL	CL
2	Odour	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB
3	Tastes	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	Turbidity-NTU	2.0	6.0	2.0	2.0	2.0	NIL	2.0	15.0	80.0	42.0	2.0	5.0	2.5	5.0	6.0
5	Total Diss Solids (mg/l)	229	143	350	226	49	310	49	310	178	46	124	169	109	134	56
6	pH	6.3	6.5	6.6	6.6	5.3	5.1	6.5	5.5	5.5	4.8	4.8	5.4	5.4	5.8	5.0
(B)	**CHEMICAL**															
7	Alkalinity as CaCo3 (mg/l)	80.0	20.0	8.0	38.0	14.0	14.0	20.0	14.0	18.0	12.0	8.0	18.0	8.0	10.0	14.0
8	Hardness (Total) as CaCo3 (mg/l)	72.0	6.0	NIL	18.0	6.0	10.0	36.0	8.0	20.0	8.0	4.0	20.0	2.0	2.0	14.0
9	Calcium as Ca (mg/l)	16.0	2.0	NIL	4.0	2.5	4.0	8.0	3.0	5.0	3.0	2.0	8.0	1.0	1.0	2.5
10	Magnesium as Mg (mg/l)	7.5	NIL	NIL	2.0	NIL	NIL	4.0	NIL	2.0	NIL	NIL	NIL	NIL	NIL	2.0
11	Chlorides as Cl (mg/l)	10.0	4.0	21.0	17.0	7.0	4.0	7.0	9.0	7.0	19.0	8.0	16.0	3.0	6.0	23.0
12	Sulphates as SO4 (mg/l)	NIL	3.0	NIL	NIL	NIL	NIL	8.0	NIL	NIL	NIL	NIL	6.5	1.9	2.6	NIL
13	Fluorides as F (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
14	Nitrates as NO3 (mg/l)	4.5	NIL	1.0	1.0	1.0	3.0	8.5	4.0	8.0	4.0	1.0	1.0	1.0	NIL	6.0
15	Sulphides as S (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
16	Iron as Fe (mg/l)	0.3	2.8	0.3	0.5	0.6	0.1	0.4	3.3	2.0	0.7	0.2	2.2	0.9	0.2	0.5
17	Free Res Chlorine as Cl (mg/l)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
(C)	**BACTERIOLOGICAL**															
18	Faecalcoliforms (CFU 100 ml)	3500	2900	60	60	160	4	32	4	*	480	0	160	0	0	36

POST - MONSOON

* = Not in use, hence not done, Cl = Clear; Hz = Hazy, UB = Unobjectionable, A = Agreeable, Diss = Dissolved, Res = Residual

TABLE 4 Specific Indian Standards for Drinking Water

No	Parameters	IS#10500(1983) (MAX)
	Physical	
1	Colour (Hazen Unit)	10
2	Odour	Unobjectionable
3	Taste	Agreeable
4	Turbidity (NTU)	10
5	Total dissolved Solids (mg/l)	500
	Chemical	
1	Alkanity as $CaCo_3$ (mg/l)	None
2	Hardness (Total) as $CaCO_3$(mg/l)	300
3	Calcium as Ca (mg/l)	25
4	Magnesium as Mg (mg/l)	30
5	Chlorides as Cl (mg/l)	250
6	Sulphates as So_4 (mg/l)	150
7	Fluorides as F (mg/l)	0.6 to 1.2
8	Nitrates as NO_3 (mg/l)	45
9	Sulphides as S (mg/l)	None
10	Iron as Fe (mg/l)	0.3
11	Residual free chlorine (mg/l)	0.2
	Bacteriological	
1	Faecal coliform bacteria (Colony forming units per 100 ml)	None in 100 ml

2.4.3. Bacteriological Quality

Bacteriological quality of the spring samples tested indicate that faecal coliforms are present in the water in spite of disinfection practised by pot chlorination method. Only two springs showed the absence of faecal coliforms during consecutive sampling (Springs 38 and 71). Bacterial load in the post-monsoon season showed an increasing trend. This suggests that run off water contaminates the subsurface water.

2.4.4. Disinfection of Water

PASSS adopted pot chlorination as a method for disinfection of the spring water, for which they provided manholes in the slabs to suspend the pot chlorinator. Typical arrangements of the disinfection system can be seen in figure 17 with the open manhole and the lid kept at the side.

The effeciency of the disinfection system has been evaluated. The procedure followed for charging the pots with bleaching powder and sand mixture, the quality of the disinfectant, the frequency at which the pot is replaced and the free residual chlorine in the treated water has been assesed.

The observations are:

(1) The pots are of uniform size, irrespective of the yield from the springs and the size of the reservoir;
(2) The quantity of bleaching powder and sand suggested to the user community is 150-200 gm each in a pot of average size of 0.5 litres;
(3) Residual chlorine in the spring water ranged from 0.0 to 5.0 mg/l;
(4) The frequency of the change of the disinfectant varied between 15 days to 1 month. This resulted in the varying concentrations of free residual chlorine in the water.

The purpose of chlorination is for disinfection of biologically contaminated water, when it is used for drinking purposes. Biological contamination of water bodies by faecal material is of significance, when the pathogenic, disease producing micro-organisams are passed on from infected population of the community to susceptible individuals. The rectal-oral-route for transmission of the diseases are caused by enteropathogenic bacteria, viruses, protozoans and nematodes. A classification of the water associated diseases and their remedy is given in table 5, while the causetive organisms are shown in table 6.

Disinfection is necessary to kill these pathogenic microorganisms, so as to provide a safe quality of water to the community. Several chemical and physical agents have been used for disinfection of potable water. The requirement for a suitable disinfectant is that it should be ·

(1) Effective in killing the pathogenic organisms,
(2) Readily soluble in water;
(3) Not to impart taste and odour;
(4) Non-toxic;
(5) Easy to detect;
(6) Easy to handle and
(7) Readily available.

Halogens are used as chemical agents for disinfection of drinking water. Bleaching powder or liquid chlorine, sodium hypochlorite solution, iodine, potassium permanganate and ozone are the chemical agents employed for disinfection of water that is used for human consumption. Radiation by UV light is also being employed in a limited scale.

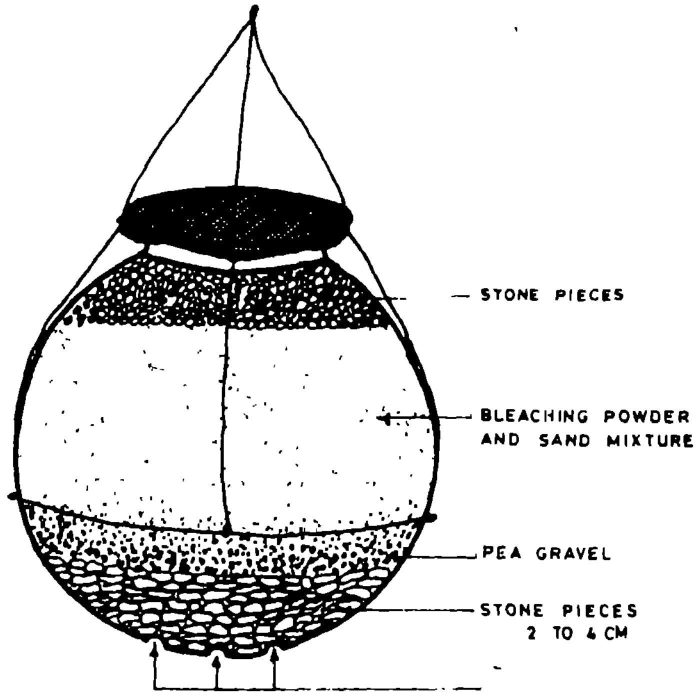
Application of bleaching powder in solid form, filled in pots or plastic containers or in solution has been developed at NEERI and propagated as a cost-effective practicable method for disinfection of well water Disinfection tablets have also been developed with NEERI know-how and marketed, using NEERI Technology NEERI has developed single pot as well as double pot chlorinators, the details of which are given in figures 18 and 19. These pots have been experimented in open well disinfection. The frequency of replacing the bleaching powder-sand mixture, according to the methods prescribed by NEERI is once a week while the PASSS procedure of change is after 15 days. Enquiries during field visits reveal that the bleaching powder sand mixture in the pot is being replaced once a month. In several cases, the pots are broken because of

TABLE 5 Classification of water associated diseases

Category	Disease	Remedy
Water borne infections Jaundice,	Typhoid, Cholera,	Microbiological improvement in water quality
Water washed infection (skin, eyes)	Scabis, Trachoma	Greater volume of water for use
Water based infection	Schistoso-miasis,	Protection of user and source Guinea worm
Water related insect Vectors breeding in water	Sleping sickness, Yellow Fever, Malaria	Water piped from sources

TABLE 6 Pathogenic microorganisms causing diseases

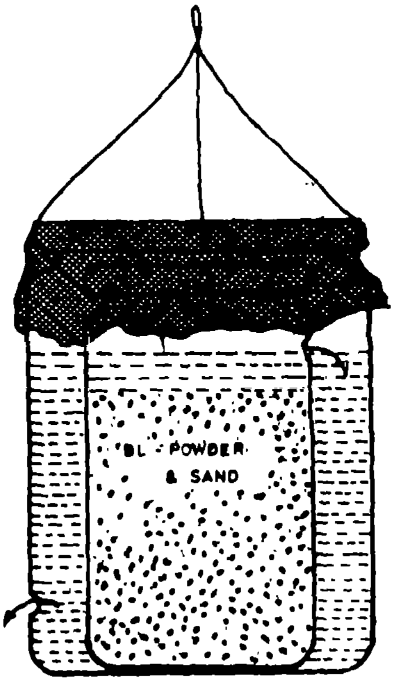
	Organism	Disease
Bacteria	Salmonella (Typhoid, Paratyphoid) Gastroenteritis	Enferic fevers
	Shigella	Dysentery
	E coli (enteropathogenic)	Dysentery
	Vibrio Cholerae	Cholera
Viruses	Infectious hepatitis B	Jaundice
	Polio virus	Poliomyeletis
	ECHO, Coxackie	Gastroenteritis
Protozoa	E. histolytica	Amoebic dysentery
	Giardia	Giardiasis
	Endamoeba coli	Gastroenteritis
Helminths	Tape worm	Gastroenteritis
	Round worm	Gasteroenteritis



- An earthern pot of 12.15 litre with two 0.6 cm diameter holes in bottom middle
- Fill with a layer of stone pieces of 2-4 cm
- Mix 1.5 kg bleaching powder and 3 kg of coarse sand - a moist mixture
- Place pea size gravels as shown in the figure
- Fill with small stone pieces
- Cover with poly ethylene paper
- Lower in well 2 ft below the surface water
- Chlorinate well of 9000-13000 litres water content having withdrawal of 900-1300 litres per day
- Work for a period of at least one week
- Residual chlorine 0.2 to 0.8 ppm

NEERI KoZL

Figure.18. Single pot chlorinator developed by NEERI



- Two cylindrical pots one inside the other
- Moist mixture of 1 kg bleaching powder and 2 kg of coarse sand in innerpot little below the level of holes
- Outer pot covered with polyethylene paper
- Outer pot has a hole at bottom
- Lower in well with the help of rope 1 metre below the level of water
- Work for a period of 2-3 weeks
- Residual chlorine in the range of 0.15 to 0.5 ppm

NEERI KoZL

Figure.19. Double pot chlorinator developed by NEERI

which no disinfection is practised or bleaching powder is directly added into the reservoir The net result is reflected on the bateriological quality of water in these springs. Bacteriological contamination is pronounced in post-monsoon season, when the free residual chlorine is not traced in any of the spring water samples Moderate to heavy load of faecal coliforms has been recorded in all but four sources.

3. Socio-economic Aspects

During the course of investigations, attempts have been made to conduct a socio-economic survey to study the health status of the community, the sanitation practices and other related aspects. Data has been collected during pre and post implementation stages in the data sheet 3 (Annexure III). The information collected is summarised in Table 7. The study covered 482 houses for which the 30 springs served as the sources of drinking water. The population covered is 2033, out of which 31.9 percent is adult males; 35.52 percent adult females and 32.90 percent is children below the age of 18. Educational status of the population reveal that almost all are literate. 87.5 percent of the population belong to the low Income group and 12.5 percent to the middle income group. There is not a single family belonging to the high income group. As for land holdings in the community, 40.25 percent has less than 10 cents of land, just having a house constructed in the land . while 59.75 percent has more than 10 cents but less than 500 cents. The population belongs to agricultural labourers, living in thatched huts (72.8 percent). 26.6 percent has houses with tiled roofs and only 0 6 percent has terraced building They cook food in traditional chulahs with fire wood(93 percent), in smokeless Chulahs (0.6 percent), while chimneys are fixed in 6.4 percent houses. 84 percent of the population defecate on the open land while 12 percent has permanent latrines and 4 percent has temporary latrines. 80 percent has no cattles. 13 percent has permanent cattle sheds while 7 percent has temporary cattle sheds in their houses

They consume on an average of 3-4 litres of water for drinking, 25-30 litres for bathing, 30-40 litres for washing clothes (per capita). The community has natural springs as the main source of water for all purposes. Where the land holdings are more than 100 cents, they have separate springs as sources of drinking, bathing and washing (one as drinking water and other for bathing). Water for cattle is generally from open streams or village tanks 5 communities have private or public wells as alternative source of water, while three communities are served with piped water supply and the springs serve as supplimentary source in the case of failure of piped water They draw water from the drinking sources 3 to 4 times daily. Most of the developed springs are fitted with hand pump which, quite often are not functioning, and then the rope and bucket method is being adopted for water withdrawal The failure of the hand pumps is due to non-availability of good quality washers for the plungers. They store water in aluminium or plastic vessels. Normally, women in the family bring water for domestic use as can be seen from the photograph (figure 15). The community has high hygeinic consciousness. They take bath atleast once a day, wash hands before and after taking food. They are free from water associated diseases, except in one community. Cases of diarrhoea, typhoid, jaundice has been reported during pre-project implementation stage. One jaundice case has been reported in another community in which an individual contracted the disease from Bombay, while he went on a job hunt The health care system consists of Primary Health Centres (PHCs) at village level and District Hospital. The nearest hospital serving the community is 0.5 Kms while the farthest is, 18 Kms. The pre and post-project implementation survey reveal that the health status of the community is satisfactory. Providing drinking water in the hilly and remote areas of the high lands in the Kerala State through development of perennial natural springs has been one of the activities of SEU/PASSS. A programme aimed to cover more than 8000 families having a population of 50,000, spread in Pathanapuram, Adoor and Kozhenchery thaluks of Pathanamthitta and Kollam districts has been implemented by PASSS with partial financial assistance from SEU of KWA Natural springs (77 numbers) have been developed at an average per capita cost of Rs 60/- as against the estimateed Rs. 900/- per capita for piped water supply. Considering the population distribution, topography and hydrogeology of the area, providing drinking water through the development of natural springs has been thought to be in conformity with the environment against the conventional system of dam-pipes-water-taps and contractors

The community has been using natural springs as a source of water for drinking and their other necessities. Increasing population growth and pressure on the natural resources, protection, safe and equitable supply against demand is one of the ideal propositions as the case with the present experiment.

TABLE 7 SOCIO ECONOMIC ASPECTS on Rural Water Supply through Development of Natural Springs

Spring No	Family Details	Family Income	Land Area (Cents)	Type of House	Type of Chula	Facilities for defecation	Cattle Shed	Drinking Water Source	Water withdrawal system	Water Requirement (LPCD)	Drawing Frequency (Times/d)	Hygienic Habits (Ref.AnnexII)	Water associated diseases (Number of incidents reported)	General Hygienic Conditions	Acceptance	Desire for Development Pre	Desire for Development Post
	TN M FM C	Li Mi Hi	<10 >10	Th Te Tr	Tn Sm Cm	Lt Lp Opd	Pc Tc	Pi Wl Sp	Ta HP RB	D B W Ca	1 2 3 4 5	a b c d e f	Da Ty Ja Ch Di Sc Tb Po Gw Mt Dc Bb Ot	G S P	S US	Y N	Y N
13	17 24 22 25	161 0	4 12	14 3 0	17 0 0	1 6 10	1 0	0 0 1	0 1 0	2 10 10 32	N 3 Al Y N	Y Y Y Y PHC 0 5	0 0 1 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
18	1 2 1 2	1 0 0	1 0	1 0 0	1 0 0	0 0 1	0 0	N 0 1	0 1 0	5 10 20 5	N 4 Lw Y N	Y Y Y Y PHC 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0	Y -	S -	Y -	Y -
19	1 3 2 0	1 0 0	1 0	1 0 0	1 0 0	0 0 1	0 1	N 0 1	0 1 0	5 25 15 10	N 4 Al Y N	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
21	12 14 17 3	102 0	3 9	9 3 0	11 0 1	0 2 10	4 0	N 0 1	0 1 0	2 25 25 8	N 4 Al Y N	Y Y Y Y PHC 5 0	0 0 2 0 0 2 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
23	7 11 10 9	7 0 0	1 6	4 3 0	6 0 1	0 0 7	0 1	N 3 4	0 1 3	2 12 6 2	N 3 Pl Y N	Y Y Y Y PHC 10 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
24	3 5 7 4	3 0 0	2 1	2 1 0	3 0 0	1 1 1	1 0	N 0 1	0 1 0	2 25 15 0	N 4 Al Y N	Y Y Y Y PHC 5 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
25	10 14 17 18	5 2 0	1 8	6 4 0	8 0 2	0 5 5	4 6	N 0 1	0 1 0	3 25 10 10	N 3 Al Y N	Y Y Y Y PHC 6 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
27	19 27 23 26	145 0	9 10	10 9 0	16 0 3	0 6 13	1 18	N 0 1	0 1 0	2 25 30 15	N 2 Al Y N	Y Y Y Y PHC 6 0	0 0 0 0 0 3 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
28	10 15 16 22	8 2 0	4 6	7 3 0	10 0 0	0 0 10	0 0	N 0 1	0 1 0	4 20 20 0	N 6 Al Y N	Y Y Y Y PHC 1 0	8 8 8 0 0 0 0 0 0 0 0 0 0	- - Y	US -	Y -	Y -
38	11 15 19 25	8 3 0	2 9	8 3 0	9 0 2	0 0 11	0 2	N 0 1	0 1 0	2 25 25 0	N 3 Al Y N	Y Y Y Y PHC 18 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S	Y -	Y -
40	22 26 24 32	211 0	4 18	21 1 0	21 0 1	0 2 20	1 2	N 0 1	0 1 0	3 20 25 0	N 3 Al Y N	Y Y Y Y PHC 2 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
41	17 29 25 17	170 0	1 16	16 1 0	22 0 0	9 0 8	0 5	N 0 1	0 1 0	3 20 20 10	N 4 Al Y N	Y Y Y Y PHC 3 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y
44	27 36 42 46	270 0	26 2	27 0 0	27 0 0	0 0 27	0 0	N 0 1	0 1 0	2 25 30 0	N 3 Al Y N	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
46	18 22 26 29	6 12 0	6 12	15 3 0	16 0 2	1 2 15	0 2	N 0 1	0 1 0	2 30 30 5	N 3 Al Y Y	Y Y Y Y PHC 1 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -
47	17 29 26 35	170 0	10 7	17 0 0	17 0 0	0 0 17	0 1	N 0 1	0 1 0	5 25 20 10	N 3 Al Y Y	Y Y Y Y PHC 1 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y -	Y -

B - Bathing
Bb - Blue baby disease
C - Total number of male and female children
Ca - Cattle
Ch - Cholera
Cm - Chimney
D - Drinking
Da - Diarrhoea
Dc - Dental Carries
Di - Diphtheria
FM - Total number of aldut females
G - Good
Gw - Guinea worm
Hi - High income group
HP - Hand pump
Ja - Jaundice

Li - Low income group
Lp - Latrine permanent
Lt - Latrine temporary
M - Total number of adult males
Mi - Middle income group
Mt - Mottling of teeth
N - No
Opd - Open defecation
Ot - Others
Pc - Poor
P - Permanent cattle shed
PHC - Primary Health Centre
Pi - Piped water supply
Po - Polyomylities
RB - Rope and Bucket
S - Satisfactory

Sc - Scabies
Sm - Smokeless chula
Sp - Spring
Ta - Tap
Tb - Tuberculosis
Tc - Temporary cattle shed
Te - Tiled roof
Th - Thatched hut
TN - Total number of families using the spring
Tn - Traditional
Tr - Terraced building
Ty - Typhoid
US - Unsatisfactory
W - Washing
Wl - Well
Y - Yes

TABLE 7 SOCIO ECONOMIC ASPECTS on Rural Water Supply through Development of Natural Springs (Continued)

Spring No.	Family Details	Family Income	Land Area (Cents)	Type of House	Type of Chula	Facilities for defecation	Cattle Shed	Drinking Water Source	Water withdrawal system	Water Requirement (LPCD)	Drawing Frequency (Times/d)	Hygienic Habits (Ref Anex II)	Water associated diseases (Number of incidents reported)	General Hygienic Conditions	Acceptance	Desire for Development Pre Post
	TN M FM C	Li Mi Hi	<10 >10	Th Te Tr	Tn Sm Cm	Lt Lp Opd	Pc Tc	Pi Wl Sp	Ta HP RB	DB W Ca	1 2 3 4 5	a b c d e f	Da Ty Ja Ch Di Sc Tb Po Gw Mt Dc Bb Ot	G S P	S US	Y N Y N
48	39 52 54 55	39 0 0	8 30	8 31 0	39 0 0	0 0 39	0 6	N 1 1	0 1 0	4 25 20 10	N 3 Al Y Y	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
52	16 27 29 10	14 2 0	4 12	15 0 1	15 0 1	0 1 15	1 1	N 1 1	0 1 0	5 30 20 0	N 4 Al Y Y	Y Y Y Y PHC 10 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
53	13 20 16 22	13 0 0	4 8	11 2 0	13 0 0	1 0 14	1 12	N 0 1	0 1 0	3 25 25 0	N 3 Al Y Y	Y Y Y Y PHC 2 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
♦56	24 34 38 31	24 0 0	12 12	18 6 0	23 0 1	1 5 18	0 4	Y 15 1	0 1 0	3 30 25 10	N 3 Al Y Y	Y Y Y Y PHC 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
58	39 49 55 66	35 4 0	34 5	38 1 0	39 0 0	0 0 39	0 0	Y 0 1	0 1 0	4 30 30 0	N 4 Al Y Y	Y Y Y Y PHC 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0	Y -	S -	Y - Y -
59	13 14 16 26	13 0 0	10 3	13 0 0	13 0 0	0 0 13	0 0	Y 0 1	0 1 0	3 25 30 0	N 3 Pl Y Y	Y Y Y Y PHC 2 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
61	15 19 16 25	15 0 0	6 9	13 2 0	14 0 1	0 1 14	1 0	N 0 1	0 1 0	4 30 30 10	N 4 Pl Y Y	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
64	17 22 17 35	16 1 0	13 4	17 0 0	16 0 1	1 1 16	1 0	N 0 1	0 1 0	3 25 30 10	N 3 Pl Y Y	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
66	25 36 38 23	25 0 0	11 14	19 6 0	23 0 2	1 4 20	0 0	N 0 1	0 1 0	4 30 40 0	N 4 Al Y Y	Y Y Y Y PHC 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y -
68	16 34 25 38	16 0 0	2 14	6 10 0	15 0 1	0 1 15	4 0	N 0 1	0 1 0	4 35 40 0	N 4 Al Y Y	Y Y Y Y PHC 0 5	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S -	Y - Y
69	21 29 32 31	21 0 0	4 17	16 5 0	21 0 0	0 2 19	0 0	N 0 1	0 1 0	3 20 20 0	N 3 Al Y Y	Y Y Y Y PHC 3 0	0 0 0 0 0 0 0 0 0 0 0 0 0	Y -	S -	Y - Y -
70	10 25 20 18	5 5 0	0 10	0 10 0	6 2 2	1 9 1	6 0	N 0 1	0 1 0	4 30 40 30	N 3 Al Y Y	Y Y Y Y PHC 6 0	0 0 0 0 0 0 0 0 0 0 0 0 0	Y -	S -	Y - Y
71	16 32 35 15	12 4 0	0 16	5 4 0	15 0 1	4 0 12	0 1	N 0 1	0 1 0	3 30 40 30	N 3 Al Y Y	Y Y Y Y PHC 4 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S	Y - Y
75	10 24 18 16	2 8 0	0 10	2 9 1	4 0 6	0 6 4	5 0	N 0 1	0 1 0	3 30 30 30	N 3 Al Y Y	Y Y Y Y PHC 2 0	0 0 0 0 0 0 0 0 0 0 0 0 0	- Y -	S	Y - Y -

B - Bathing
Bb - Blue baby disease
C - Total number of male and female children
Ca - Cattle
Ch - Cholera
Cm - Chimney
D - Drinking
Da - Diarrhoea
Dc - Dental Caries
Di - Diphtheria
FM - Total number of aldut females
G - Good
Gw - Guinea worm
Hi - High income group
HP - Hand pump
Ja - Jaundice

Li - Low income group
Lp - Latrine permanent
Lt - Latrine temporary
M - Total number of adult males
Mi - Middle income group
Mt - Mottling of teeth
N - No
Opd - Open defecation
Ot - Others
Pc - Poor
P - Permanent cattle shed
PHC - Primary Health Centre
Pl - Piped water supply
Po - Polyomylities
RB - Rope and Bucket
S - Satisfactory

Sc - Scabies
Sm - Smokeless chula
Sp - Spring
Ta - Tap
Tb - Tuberculosis
Tc - Temporary cattle shed
Te - Tiled roof
Th - Thatched hut
TN - Total number of families using the spring
Tn - Traditional
Tr - Terraced building
Ty - Typhoid
US - Unsatisfactory
W - Washing
Wl - Well
Y - Yes

Keeping in view the aims and objectives of the programme in conformity with the financial implications, the assessment reveals that the society has accepted the outcome of the venture. An overall improvement in the health status has been observed in the community. However, a note of caution is necessary with post-project implementation programme. The springs have been developed by protecting them by unnatural barriers. Handling of water with mechanical systems such as hand pumps needs review as in majority of the cases as revealed in the present study, they are non-functional, resulting in the use of rope-and-bucket method. This results contamination of the water source. Protection of the sources from faecal contamination is primarily required to prevent spread of communicable diseases, in this case, water borne diseases. The technology employed in the programme reveal that the users have not enough awareness and experience specifically with reference to the protection of their drinking water source. Open defecation has been practised which is a health-hazard for the community.

4. Summary

The global action plan envisaged through the IDWSSD programme during the decade 1980-90 has been extended beyond 1991. With a view to providing safe water and improved sanitation facilities to poor rural communities of the remote villages of the hilly areas, PASSS (an NGO) and a State Government Undertaking, SEU of KWA have developed natural springs as a source of water supply. Some of the villages are inaccessible Topographical and hydrogeological features in the region have been the constraints for not providing piped water supply to these communities. When private and public wells go dry, especially in summer months, natural springs are the only source of water for sustinance. Development of these springs as a source of protected water supply has been the endeavour of the NGO(PASSS) with the financial assistance of the Dutch Government through the coordinating office of the Kerala Government. This programme is the first of its kind in Kerala Total of 77 springs have been developed by the society at a cost of Rs. 6,46,713, of which Rs 48,513 00 has been contributed by the beneficiaries. This programme reveals that participation of the recipient community is essential for the success of any programme. Motivation, training, follow up action and participation of the community have been the tools employed by the society to implement the programme. Participation of women has been ensured in the implementation and sustainability of the programme by enrolling them as members of WWCs. The formation of WWCs has been found to be a successful venture.

Water quality assessment with specific reference to chemical and biological contamination has been carried out in the current study after the project implementation. Spring water in the region has been found to be acidic in nature Water from some of them is hazy in appearance, chemically the concentrations of minerals are well within the permissible limits, except iron in some cases. Bacteriological quality has been found to be not very satisfactory in post-monsoon season, except four of the thirty spring water samples tested has been found to contain faecal coliforms.

The possible source of faecal contamination of the water is run off water seeping into the sub-surface water strata and entering into the water course. 84 percent of the population has no latrines, which is a need for the protection of the drinking water sources.

Disinfection, as is practised, has been found to be unsatisfactory. Proper awareness camps among WWC members is necessary to keep the water protected from faecal contamination.

Health and hygeinic status of the community has been found to be satisfactory. No incidence of water associated diseases have been reported in the post-project implementation period. However, in order to maintain the health status, it is necessary to provide better sanitation facilities Community latrines, at a safe distance from the drinking water source, for the socio-economically backward community can be constructed on similar basis of implementation of water supply.

5. Recommendations

The objectives of any water supply systems should be (a) to supply safe and wholesome water to users, whether it constitutes a family, a group of families or a community (b) to supply adequate quantity and (c) to make water readily available to users in order to encourage personal and household hygiene.

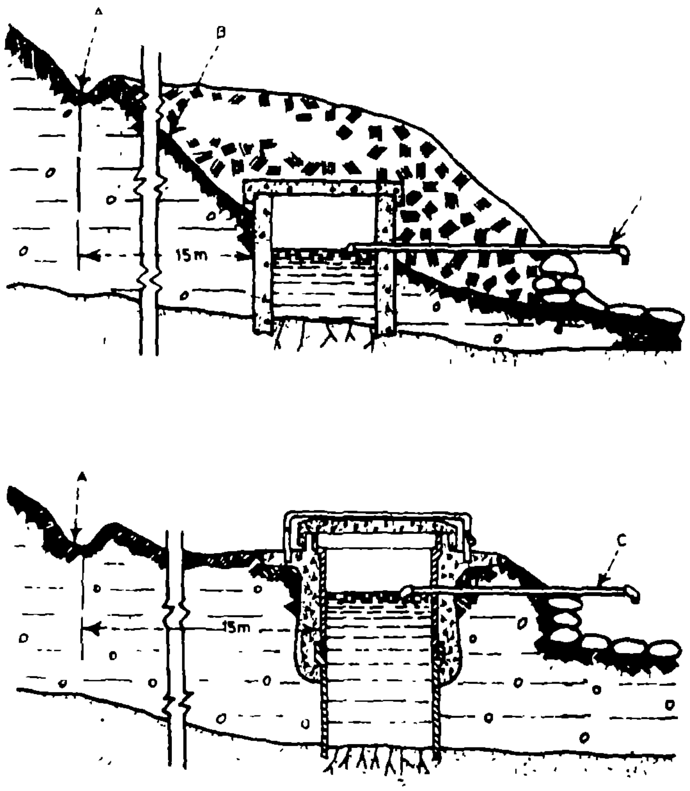
Safe and wholesome water can be defined as that which will not yield harmful effects upon consumption. In the design of rural water supply system primary consideration should be given to protection of the quality of the natural water selected and treatment should be considered as the very last resort. Water which require no treatment to meet bacteriological, physical and chemical requirement and which can be delivered to the consumer by a gravity system should be given first consideration. This would usually be limited to springs and protected drainage areas.

Springs are normally outcrops of ground water, often appear as small water holes at the foot of hills or along the river banks. Generally, these springs are gravity or artesian type. In the gravity springs ground water percolates laterally to the surface because of a sharp drop in surface elevation below the normal ground water table or when obstructions to flow results in an overflow at the surface. The yield of gravity spring will vary with the position of the water table, which in turn fluctuates with rain fall. Such a spring may even dry up during or immediately after a dry season. Artesian springs are formed when faults in impermeable strata permits artesian water to escape from confinement or fissures to rise under pressure to the surface.

Springs in general and gravity springs in particular are subject to contamination in the area close to the point of emergence. A thorough sanitary survey, is, therefore, necessary before any developmental work is initiated. Such a survey should yield information on the origin of the ground water, its yield in various seasons of rainfall, the topography and vegetation of the surrounding area and the presence of possible sources of contamination

Protection of spring water from possible source of contamination is very essential. In order to protect the spring the collection structures should be so located and built as to force surface water to pass through atleast 3m of soil before reaching the ground water. Springs should be housed in permanent structures with water tight walls. Direct drainage should be diverted away from the spring. It is customary to exclude all animal and habitations from a substantial area around 30-90 m. around the collection chamber and to dig a diversion ditch above and around this to interrupt surface run off and divert it away from the ground water collection zone. Springs emerging from solution channels in lime stone formation should be carefully investigated and observed, since under such conditions very little, if any, natural filtration takes place in the ground Such springs are likely to yield grossly polluted water soon after heavy rains. Springs, especially those which can be piped to the use by gravity often provide an economical and safe solution to the water supply problems Typical methods for proper development of springs are shown in Figure 20.

In order to exclude the entry of surface and run off water, the ground surface in the immediate vicinity of the spring should slope away from it and should be well drained. The pump platforms should be atleast 60 cm. above the highest flood levels so as to protect it from the surface run off water. It should be water tight and should extend about 60 cm. beyond the spring lining. Its surface should slope from the centre towards the drain built along its edges as shown in Figure 20. The waste water then be collected by a lined ditch leading to a drainage area or soakage pit in order to avoid the occurance of muddy ground and bogs in the immediate vicinity of the spring. When man holes are provided, the rim should project atleast 8 cm over the surrounding surface and the man hole cover should overlap the rim. Special attention has to be paid so that collection reservoirs should be so built as to exclude light and in this way prevent algal growth. The over flow pipe should be located in such a way that no surface drain enter during heavy rain fall. It is necessary that the man hole covers and gates should be properly locked where it is impracticable to supply water to consumers through a piped distribution net work and untreated. Sources such as springs, bore holes which may not be naturally pure, have to be used, the requirement for piped water supply may not be attainable In such circumstances, disinfection, although desirable is not always practicable and considerable reliance has to be placed on sanitary inspection and not exclusively on the result of bacteriological examination.



A = Protective drainage ditch to keep drainage water a safe distance from spring

B = Original slope and ground line

C = Screened outlet pipe can discharge freely or be piped to village or residence

FIGURE No 20

TYPICAL PROPERLY PROTECTED SPRINGS

NEERI KoZL

Figure.20. Typical properly developed springs

Everything possible should be done to prevent pollution of the water. Water at source may be uncontaminated but likely the quality deteriorate during handling by the infected persons or carriers and storage. Health education in simple sanitary hygiene should strongly be stressed with the help of professional health workers.

Bacteriologically, the objective should be to reduce the indicator organisms' population to less than 10 CFU per 100ml if not possible to eliminate all the organisms. If the indicator organisms are repeatedly found or sanitary inspection reveal perennial pollution source, then an alternative source should be sought where ever possible.

Periodic monitoring of the sources is advisable to keep the quality of the water under control and to provide safe and wholesome water to the community.

For the development of such water supply systems, the responsibility of any agency is not discharged by the installation in a community a watering point; only when the people actually make good use of the new system can the installation be counted as a success. Often public health workers are disappointed to see when the installations have not materially altered the health status in a community. Close examination can reveal that the safe water is either inadequate in quantity or poorly located and distributed or both, the result being that the people continue to use closer, contaminated source or to carry an amount which is insufficient to encourage personal hygiene. It is, therefore, necessary to make long range plans to provide water at easily accessible points and maintain the quality.

The elaboration of rural water supply programme, thus, involves, besides engineering, planning and design, several other considerations among which promotion ranks high. The involvement of governmental and non-governmental organisations (GOs and NGOs) and community participation are vital in the successful implementation of the water supply programme. Among the GOs, the health administration is the most logical agency to take the lead in promoting such programme, for several reasons:

1. There are few other investments of efforts which will repay as much in health benefits as rural water supply programme, since an adequate and safe water-supply is a basic requirement of a healthy enviroment.

2. The provision of safe water is one of the principal environmental control measures against transmission of most of the diarrhoeal diseases, which often constitute the major public-health problem in rural areas.

The receptor community has an important role to play in rural water supply programme. The community for this purpose may be considered to comprise (1) the local government (2) leading citizens (3) the religious leaders and (4) individuals. The local government may be elective or appointive but, it has jurisdiction over the matters which affect the community. Many leading citizens may not be members of the local administration but at the same time command respect in the community. Religious leaders in many communities are highly important and often cultured who can appreciate the value of such a project and may give vital support

The people of the community must be given some understanding of the need for safe and wholesome water and of the part which the water supply project will play towards filling that need. The enlistment of local government and community leaders will help to attain this end. Health education techniques, applied at the earliest planning stages, preferably under the professional health educator will be of greater value in marshalling public support.

Various population component of the community, usually, may not back the project to some extent: certain groups or individuals may seek for personal advantages, but if the majority can be persuaded on the basis of one or the other aspects of the scheme, full community support will be the result which, in fact, is the desired objective. The manifestation of this may be many, such as:

(1) mobilisation of political support at local levels
(2) contributions of the community to the project in terms of money, land, materials services or labour
(3) more sympathetic attitude from the people towards paying for the operation and maintenance of the system and
(4) increased use of water once it is supplied

Water is becoming a rare commodity especially when it is fetched from long distances or when it is made available at a high cost. None of the programme become wholistic unless the used water is purified and discharged into the source. For this purpose it is necessary to adopt rural latrines as a safe method for the disposal of the used water. Open defecation in the farm land, near and around the water holes are common practice in rural areas.

As water plays a predominant role in the transmission of certain enteric diseases, it is essential to make the water free from the infectious organisms as well as putrefiable materials before the used water enters into fresh water bodies.

It is difficult to imagine any clean and sanitary environment without proper disposal of the used water. When any water supply system is planned, it is absolutely necessary to plan the safe treatment and disposal of the used water to make it wholesome. In rural areas implementation of rural latrines as individual or community units has to be planned along with water supply programme.

The effects of proximity of the source of water supply to latrines and the travel of pollution through ground water has been studied under various soil conditions. Faecal bacteria assisted by leaching liquid can travel horizontally upto 1 and downward upto 3m. in sandy soil. Studies on artificial recharge of aquifers with reclaimed sewage show that bacteria could be transported to a distance upto 30m. from the recharge well in 33 hours. Several studies reveal that excreta-disposal system tend to travel downward until it reaches the water table and then moves along the ground water flow across a path which increases in width to a limited extent before gradual disappearance

It is, therefore, necessary to locate the latrines at safe distances from the springs. Many factors such as slope and level of ground water and soil permeability, affect the removal of bacteria in the ground water. It is of great importance to locate the privy or cess pool down hill on some piece of land, and to avoid, if possible placing up hill directing from a spring. Carefull investigations are required for building pits, privies, bore hole latrines, cess pools and seepage pits in areas containing fissured rocks or lime stone formations, since pollution may be carried directly through solution channels without natural filtration to distant drinking water sources

In almost all successful programmes financial assistance from state, central governments, international agencies and other financial institutions have been found to be essential for the implementation. Post project implementations programmes have been neglected because of non-availability of enough funds. Participation of the receiving community has been sought at the project implementation stage through contribution in terms of labour, land, local materials and other services. The financial planning process should also include post project implementation needs in terms of operation and maintenance costs for the programme. Usually, granting agencies extent one time support for implementation of a programme. While it may not be possible for such agencies to develop financing plans based on reimbursible loans, development of a revolving fund for operation and maintenance of such systems should be given due consideration. Such a programme will not only help sustain the programme but also compel the beneficiaries to realize the value of financial inputs.

Annexure - I

Data Sheet No - 1

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE

KERALA WATER AUTHORITY - SOCIO-ECONOMIC UNIT

PAZHAKULAM SOCIAL SERVICE SOCIETY - PASSS

Development of Natural Springs for Rural Water Supply

No. of Spring : ____________________

Name of Spring : ____________________

District : ____________________

Taluk : ____________________

Block : ____________________

Panchayat : ____________________

Ward No. : ____________________

Name & Address of the Owner : ____________________

____

____

Pin: ____________________

Water yield in peak summer : ____________________

Water storage Capacity : ____________________

Date of Construction : ____________________

Contribution from the group : ____________________

Total cost of Construction : ____________________

Date of water use after development : ____________________

No. of beneficiary families : ____________________

Average number of members : ____________________

Date of motivation class conducted : ____________________

Date of Health Education Classes Conducted	:________________________________
Per capita unit cost	:________________________________
Type of disinfection	:Pot/Batch chlorination
Frequency	:________________________________
Quantity used for each change	:________________________________
Average distance from springs to houses	:________________________________mts.
Distance from the nearest spring Developed	:________________________________
Remarks, if any	:

Annexure - II
Data Sheet No - 2

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE
Kochi Zonal Laboratory
Kochi - 682 025

ANALYTICAL DATA ON CHEMICAL & BACTERIOLOGICAL QUALITY

Part I : Details of the Source

1 Location : ______________________
2 identification No ______________________
3 Code Number ______________________

Part II : Technical Details

4. Yield (Flow rate,l/hr) : ______________________
5. Storage capacity : ______________________
6 Type of disinfection : ______________________
7 Frequency of disinfection : ______________________
8 Type of water withdrawal system : Hand Pump/Rope and Bucket/Pipe with Tap,etc.

Part III : Chemical Quality

No.	Parameters		ISIO500(1983) (Max)	Concentrations (mg/1)	
	Physical				
1.	Colour (Hazen Unit)		10		
2	Odour		Unobjectionable		
3.	Taste		Agreeble		
4	Turbidity (NTU)		10		
5	Total dissolved solids		500		
	Chemical				
1	Alkalinity as $CaCO_3$	(mg/l)	None		
2.	Hardness (Total)	(mg/l)	300		
3	Hardness (Ca)	(mg/l)	25		
4	Hardness (Mg)	(mg/l)	30		
5	Chlorides as Cl	(mg/l)	250		
6	Sulphates as So_4	(mg/l)	150		
7	Fluorides as F	(mg/l)	0.6 to 1.2		
8.	Nitrates as NO_3	(mg/l)	45		
9.	Sulphides as S	(mg/l)	None		
10.	Iron as Fe	(mg/l)	0.3		
11.	Free(residual) Clorine	(mg/l)	0.2		
	Bacteriological				
1.	Faecal coliform bacteria (Colony forming units per 100 ml)		None in 100 ml		

Remarks :

Annexure - III

Data Sheet No - 3

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE

KERALA WATER AUTHORITY - SOCIO-ECONOMIC UNITS

PAZHAKULAM SOCIAL SERVICE SOCIETY - PASSS

Development of Natural Springs for Rural Water Supply
SOCIO-ECONOMIC SURVEY

1 Name and Address
Name ____________________
House No ____________________
Ward No ____________________
Panchayat ____________________
Block ____________________
District ____________________
State ____________________
Pin Code ____________________
____

2 Details of family members

Sl No	Name	Sex	Age	Edu. Status	Occupation
1					
2					
3					
4					
5					

3 Family income per month : Low/Middle/High

4. Land area : ____________ hectares/cents
Utilization pattern : Farm/Estate/Others

5 Type of house Thatched/tiled/terraced

6 Type of chulah Traditional/Smokeless Chimney

7. Facilities for defecation : Latrine (permanent/temporary/open space)

8. Cattle shed : Permanent/temporary (Clean/Unclean)

9. Source of drinking water : (a) Private/Public/Other
: (b) Well/Pipe/Spring
: (c) Distance
: (d) Chances of contamination (bathing; washing clothes; utensils; livestock; run off water; leaching of agro-chemicals; water logging around the source)

10 Type of withdrawal of water from source : Pipe with tap/ Hand pump/ Rope and bucket

11 Daily consumption of water (litres/capita/day)
(a) Drinking :
(b) Bathing :
(c) Kitchen use :
(d) Cattles :

12. Usage

12.1 Do you have different sources for drinking/bathing/cattle/irrigation : Yes/No

12.2 How many times you draw water from drinking water source in a day : 1/2/3/4

12.3 Do you store water ? : Yes/No
Type of Containers : earthenware/aluminium/ss/plastic

12.4 Do you feel scarcity in Summer/ Winter/Rainy Season ? : Yes/No

12.5 What is alternative source, if there is break down ? :

13 Hygeinic Habits

(a) Bath daily : Yes/No
(b) Brush tooth daily : Yes/No
(c) Wash hands before taking food : Yes/No
(d) Make any direct contact with drinking water using hands during collection and transportation : Yes/No
(e) Whom do you consult ? :
(f) Distance from PHC/ Dispensary/Hospital :

14 Common diseases in the house : Diarrhoea, Typhoid, Jaundice, Cholera, Diptheria, Scabies, T.B., Polio, Guinea Worms, Mottling of Teath, Dental Caries, Blue Baby Diseases of Infants, Others

15 General hygeinic conditions Good / Satisfactory / Poor

16 Are you satisfied with the present water supply system to you ? : Yes / No

17. What improvement you desire ? :