Chapter 6 Water Qualities

6.1 Sampling Points and Items of Analysis

The water quality analysis was made on 162 water samples, of which 65 samples were collected from 120 visited villages in the phase 1 of the study, and 99 samples were collected from 100 candidate villages and the sources of existing water schemes in the phase 2. Eighteen water samples were collected from the same points in rainy and dry seasons in order to compare the seasonal difference. Number of the samples taken from various sources is shown in the table below. Locations are presented in Fig.6-1 and 6-2.

Table 6-1 Number of samples and general information in number

Source	Rain	Dam	River	Spring	Pond	Dug Well	Borehole	Total
NOS [1]	1	3	10	14	18	62	53+1 [6]	162
NOR [2]	0	0	1	3	0	9	5	18
NOP [3]	1	3	9	11	18	53	48+1	123
NOE [4]	0	2	8	10	16	29	15+1	65
% of NOE	0	67%	89%	83%	89%	55%	33%	53%
NOU [5]	0	0	0	0	1	4	5+1	11
% of NOU	0	0	0	0	6%	8%	12%	9%

NOS [1] : Number of samples NOR [2]: Number of repeated sampling points
NOP [3] : No. of sampled points NOE [4]: No. of samples exceeding Tanzanian standard
NOU [5]: Number of samples unsuitable for drinking water supply

The analysis was made on following 19 items, including common counts (12 items) and detrimental substances (7 items). The items marked with (*) were *insitu* measurement and others were tested in the laboratory of Regional Water Department Mtwara.

- Common counts:

  Water temperature*, pH*, Electricity conductivity (EC)*, Turbidity*, Dissolved oxygen (DO)*, Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Bicarbonate as HCO_3, Sulfate as SO_4, and Chloride (Cl).

- The items concerning with detrimental substances:

  *Escherichia-coli**, Iron (Fe), Fluoride (F), Nitrate as NO_3-N, Ammonia as NH_3-N, Manganese (Mn) and Arsenic (As).

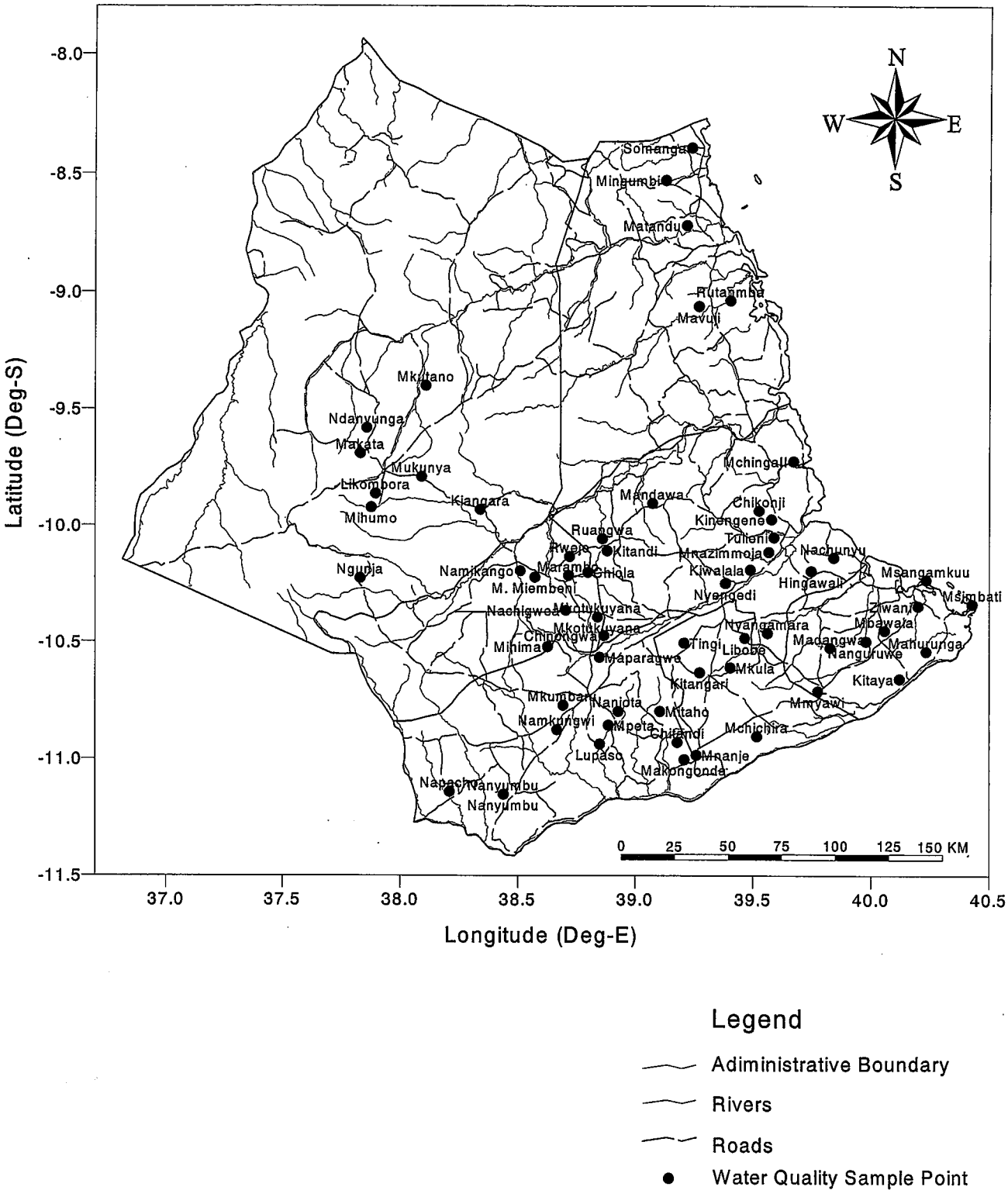

Fig. 6 -1

Water Sampling Points in Phase I Survey (Feb to Mar. 2000)

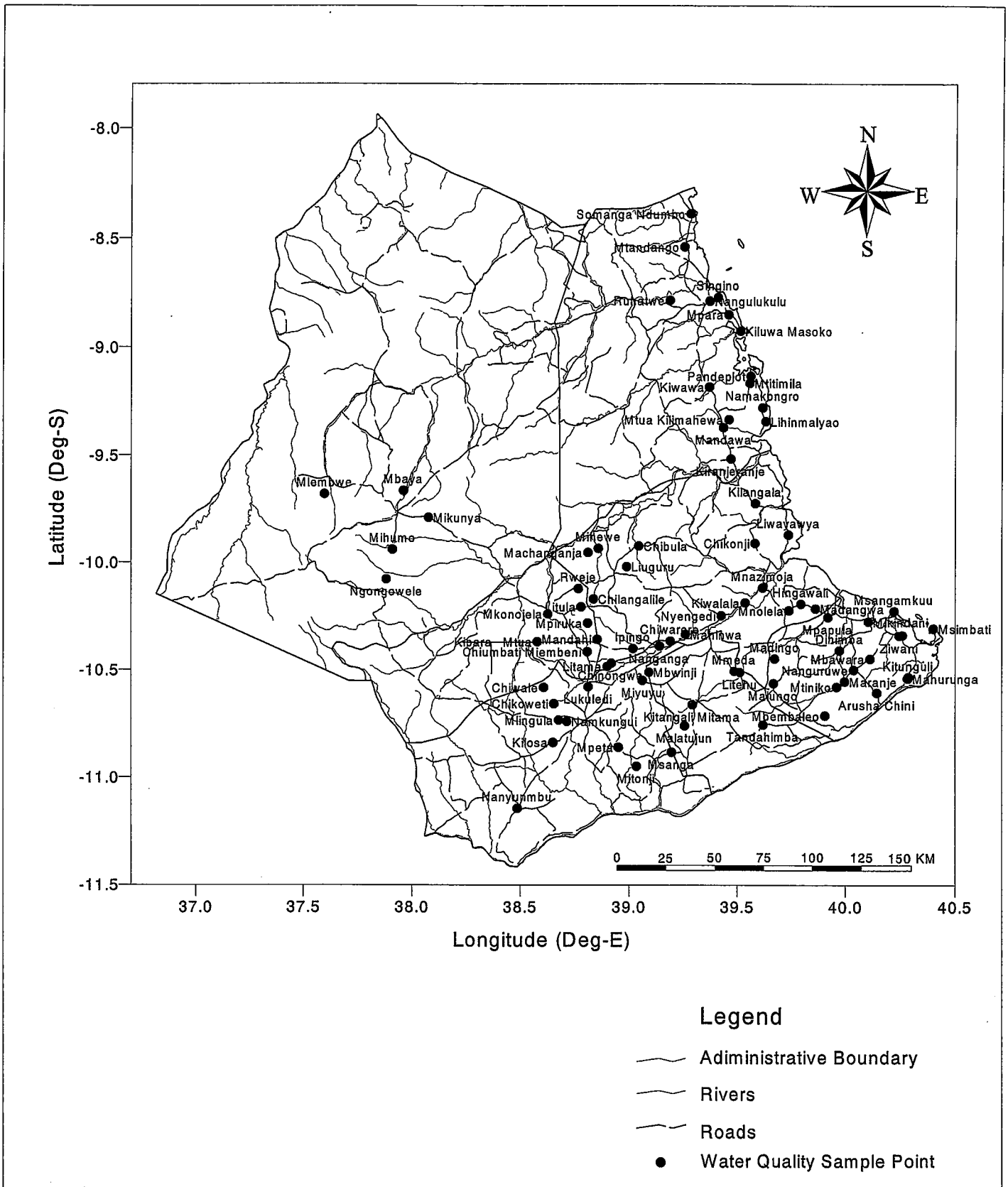

Fig.6 -2

Water Sampling Points in Phase II Survey (Jul to Nov. 2000)

6.2 Results of Water Quality Analysis

The summaries of analysis by district and by sources are given in Table 6-2 and 6-3, and all of the analyzed data are attached in the Data Book.

None of arsenic and few of fluoride have been detected. Other detrimental substances are in a level below Tanzanian water quality standard and also WHO standard, except *escherichia-coli*. Coliform bacilli were found in majority of the dug wells and traditional pits, with considerably high level at 35 places out of 52.

The items for attention among common counts are total iron (Fe), sulfate anion (SO_4^{--}) and total dissolved solid (TDS).

Iron is not so big problem, because it is not the serious problem for health, and it can be easily removed. Water of over 90 % sampled points contains less than 2 mg per liter.

The points of over 3mg/liter Fe content are found at every district except Newala, and the concentrated areas of high content points are at south-eastern part of Masasi district and at Masasi-Nachingwea boundary, which is upper reach of Lukuledi river basin, as shown in Fig.6-3.

Sulfate is also not so serious problem for health, but drinking occasionally causes diarrhea, and moreover, not suitable for drinking purpose by its unpleasant taste. The areas of comparatively high content points are distributed in the western end of Ruangwa district, northern part of Kilwa district and eastern part of Nachingwea district, as shown in Fig.6-4.

High-content points of the total dissolved solids (TDS) counting over 2000 mg/liter are distributed in the coastal area of Kilwa and Lindi districts, and the same area as high sulfate distribution areas, as shown in Fig.6-5.

Very high content of TDS in the coastal areas is obviously caused by seawater, that is to say the NaCl dominated dissolved solid. However, other inland area's high TDS cannot be explained by seawater intrusion. These are probably related to sulfates or carbonates. High content of TDS is usually correlated with high value of electricity conductivity (EC). The inland residents of high EC areas express the water tasting as "salty", however, actual tasting is slightly salty but somehow bitter and bad tasting, probably due to magnesium sulfate or potassium sulfate. Whichever type of high TDS may be, water is not potable so long as EC is over the level of 3000 μS/cm. Since there exists many points of high sulfates wells, and many of the candidate villages are located in the upper reach of the Lukuledi river basin, special attention is required at the groundwater development in this area.

Table 6-2 Summary of Water Quality Analysis Result by Water Sources (2000)

Source	Rain	River		Dam		Pond and Lake		Spring		Dug Well		Borehole	
Num. of smpl pt	1	9		3		18		11		53		48	
Terms	Value	Range	NOE[*1]	Range	NOE	Range	NOE	Range	NOE	Range	NOE	Range	NOE
pH	7.27	5.8-8.1	**2**	6.3-7.9	**1**	4.7-8.3	**5**	5.4-7.91	**4**	4.1-8.5	**20**	4.1-9.3	**8**
Temperature(℃)	23.4	23.7-29.1	no	24.6-29	no	20.4-32.2	no	24.4-30.4	no	23.6-35.6	no	23.3-31.4	no
EC(μS/cm)	140	113-2644	no	192-1010	no	57-5420	no	129-1763	no	68-4650	no	71-7100	no
Coliform	nd[*3]	==	**5**	==	**1**	==	**10**	==	**5**	==	**35**	==	**19**
Do(mg/l)	5.68	1.8-5.8	no	2.6-4.8	no	2.1-6.2	no	2.1-7.2	no	1.3-6.3	no	0.4-6.8	no
Turbidity(UTN)	0	0-40	**2**	107-337	**2**	4-385	**7**	0-5	0	1-1800	**18**	0.1-160	**5**
Na(mg/l)	0.682	12-459	no	64-152	no	6-831	no	18-245	no	7.4-863	no	13-1095	no
K(mg/l)	1.3	3-16	no	3-32	no	1.6-45.4	no	2.4-17	no	0.8-73	no	2-103	no
Ca(mg/l)	3.87	nd-27	no	3.6-33	no	nd-51.4	no	nd-67	no	nd-69	no	nd-173	no
Mg(mg/l)	0.69	0.09-55	no	3.1-30	no	0.1-57.4	no	0.59-40	no	0.5-187	no	0.1-196	no
Fe(mg/l)	0.03	nd-14.35	**1**	0.05-3.28	**2**	nd-2.8	**3**	nd-2.5	**3**	nd-9.2	**11**	nd-6.1	**5**
Mn(mg/l)	---	nd-0.2	0	nd	0	nd-3.3	**2**	nd-0.2	0	nd-1.2	**4**	nd-0.8	**2**
F(mg/l)	nd	nd-1.69	0	0.34-0.42	0	nd-1.8	0	nd-0.8	0	nd-2.5	0	nd-1.9	0
As(mg/l)	---	nd	0	nd	0	nd	0	nd	0	nd	0	nd	0
HCO_3(mg/l)	---	2.3-248	no	18-213	no	14-324	no	7-244	no	5-492	no	11-401	no
SO_4(mg/l)	nd	nd-375	0	nd-50	0	nd-593	0	nd-130	0	1-1430	**3**	nd-1400	**2**
Cl(mg/l)	---	16-247	0	13-95	0	8-607	0	13-168	---	7-884	**1**	24-1261	**1**
NO_3-N(mg/l)	0.1	nd-1.2	0	nd-2.5	0	nd-2.3	0	nd-4.3	0	nd-34	0	nd-23	0
NH_3-N(mg/l)	0.04	nd-0.17	no	0.02-0.13	no	nd-0.4	0	nd-0.06	no	nd-2	0	nd-0.9	0
TDS(mg/l)	15	87-1298	0	455-568	0	220-2169	**1**	110-631	0	71-2582	**4**	88-2503	**3**

NOTES *1: NOE = Number of samples to Exceed Tanzania Standard of Water Quality
*2: no = No standard value was established
*3: nd = No detected
*4: == No available figure
*5: --- No observation result

Table6-3 Summary of Water Quality Analysis Result by Districts (2000)

Region	Mtwara								Lindi									
District	Mtwara		Masasi		Newala		Tandahimba		Kilwa		Lindi		Ruangwa		Nachingwea		Liwale	
Num. Of smpl	23(5)		29(7)		9		6(1)		22(1)		31(4)		12		16		13	
Terms	Rng*1	NOE*2	Rng	NOE	Rng	NOE	Rng	NOE	Rng	NOE	Rng	NOE	Rng	NOE	Rng	NOE	Rng	NOE
pH	5.4-8.3	**5**	5.6-7.6	**8**	4.1-8.2	**3**	5.9-7.6	**3**	4.1-8	**5**	4.9-9.3	**9**	6.1-8.5	**1**	5.8-7.9	**1**	4.65-775	**8**
Temp.(℃)	24.2-30.8	no	23.6-30.5	no	20.5-35.6	no	20.4-28	no	26.5-32	no	23.3-31.4	no	25.2-29.4	no	25.2-29.8	no	25.5-29.4	no
EC(iS/cm)	189-2700	no	68-1580	no	92-573	no	102-470	no	102-7100	no	113-2510	no	105-4630	no	93-5100	no	57-2588	no
Coliform	==*3	**6**	==	**9**	==	**3**	==	**2**	==	**16**	==	**17**	==	**6**	==	**7**	==	**9**
Do(mg/l)	2-5.2	no	1.6-3.8	no	2.1-5.8	no	2.9	no	2.9-3.9	no	1.8-5.8	no	3.4-7.2	no	1.3-6.8	no	0.39-6.23	no
Tbdty(UTN)	0.5-160	**6**	2-856	**8**	4-52	**1**	6-16	0	5-1800	**5**	0-337	**5**	2-197	**2**	1-385	**3**	0-206	**7**
Na(mg/l)	64-608	no	13-295	no	11-269	no	20-102	no	27-962	no	12-1095	no	11-521	no	9-319	no	5.8-300	no
K(mg/l)	3-45	no	2-34	no	4-25	no	3-20	no	3-103	no	3-33	no	2.4-24	no	2-44	no	0.8-15	no
Ca(mg/l)	nd-173	no	nd-23	no	nd-9	no	nd-25	no	nd-69	no	nd-33	no	nd-41	no	nd-33	no	0.05-51	no
Mg(mg/l)	nd-29	no	0.06-196	no	2.5-13	no	3-9	no	0.5-66	no	nd-32.7	no	0.5-187	no	0.2-95	no	2.6-57	no
Fe(mg/l)	0.01-3.3	**3**	nd-9	**5**	0.01-0.4	0	0.03-2	**1**	0.01-2.5	**3**	nd-14.35	**4**	nd-9.2	**2**	nd-6.1	**2**	0.04-1.33	**4**
Mn(mg/l)	nd-0.3	0	nd-0.3	0	nd-0.3	0	nd-0.05	0	nd-0.6	**1**	nd-1	**2**	nd-1.2	**2**	nd-0.8	**2**	nd-3.3	**1**
F(mg/l)	nd-1.4	0	nd-1.9	0	0.2-0.38	0	nd-0.23	0	nd-1.1	0	nd-1.91	0	0.6-2.5	0	0.3-1.7	0	0.04-1.25	0
As(mg/l)	nd	0	nd	0	nd	0	nd	0	nd	0	nd	0	nd	0	nd	0	nd	0
HCO3(mg/l)	75-276	no	2-352	no	nd	no	11-32	no	8-465	no	7-401	no	31-492	no	5-380	no	13-130	no
SO4(mg/l)	nd-280	0	nd-104	0	nd-16	0	nd-7	0	nd-800	**1**	nd-560	0	11-1430	**3**	nd-1015	**1**	1-11	0
Cl(mg/l)	85-200	0	18-325	0	24	0	73-123	0	26-1261	**1**	12-364	0	13-884	**1**	12-644	0	7-74	0
NO3-N(mg/l)	nd-3.2	0	nd-8	0	nd-1.3	0	nd-1.2	0	nd-34	0	nd-7.5	0	nd-8.5	0	nd-2	0	nd-3.8	0
NH3-N(mg/l)	nd-0.6	no	nd-0.2	no	0.1-2	no	0.01-0.3	no	nd-2.04	no	nd-0.85	no	nd-1.2	no	nd-2	no	nd-0.42	no
TDS(mg/l)	346-1400	0	71-1021	0	88-240	0	100-350	0	105-2582	**4**	87-2990	**1**	322-2150	**2**	102-1735	0	114-423	0

NOTES
*1: Rng = Range
*2: NOE = Number of samples to Exceed Tanzania Standard of Water Quality
*3: == No available figure
*4: --- No observation result
*5: no = No standard value was established
*6: nd = No detected

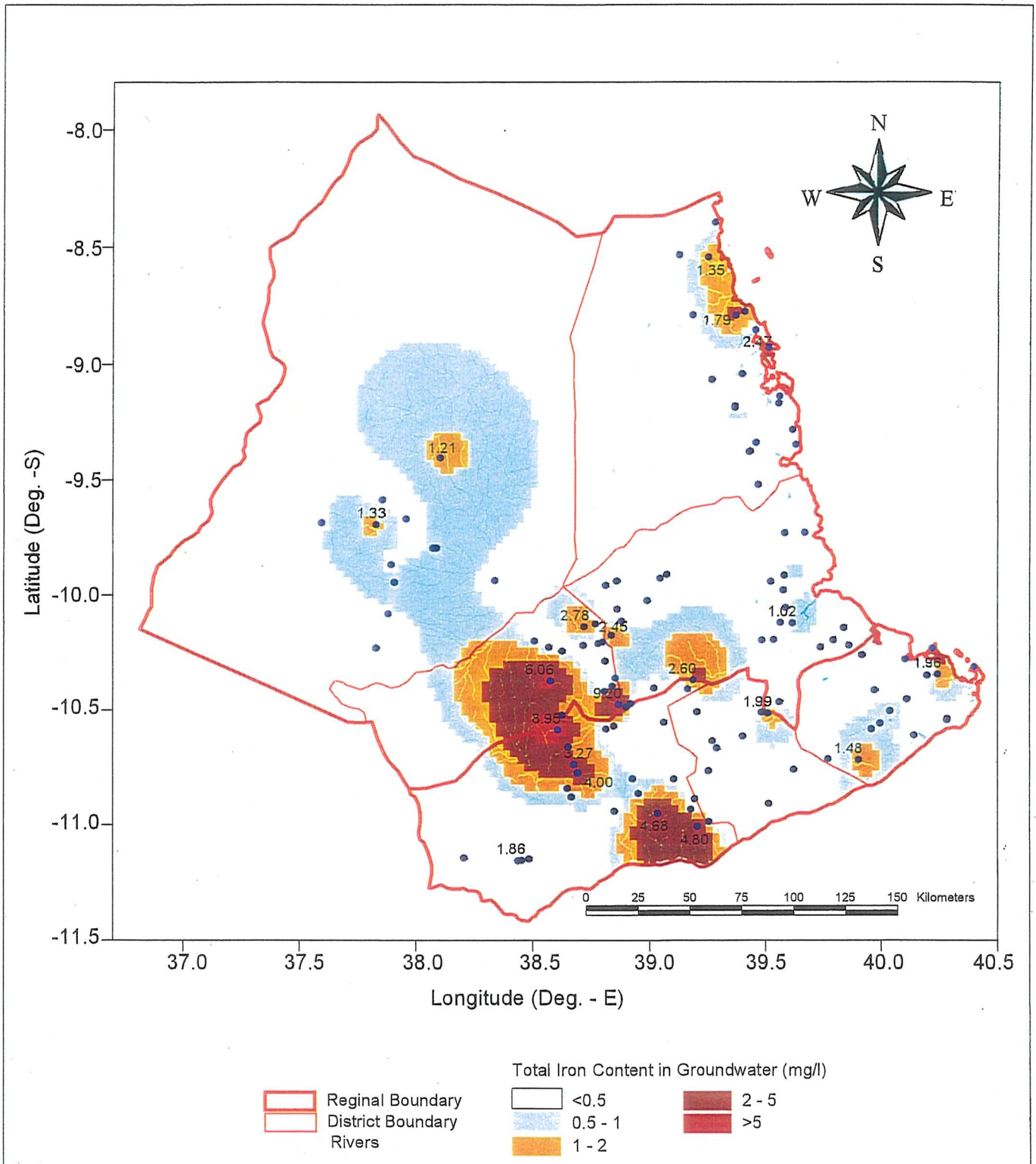

Figure 6-3 **Total Iron (Fe) Content in Groundwater (2000)**

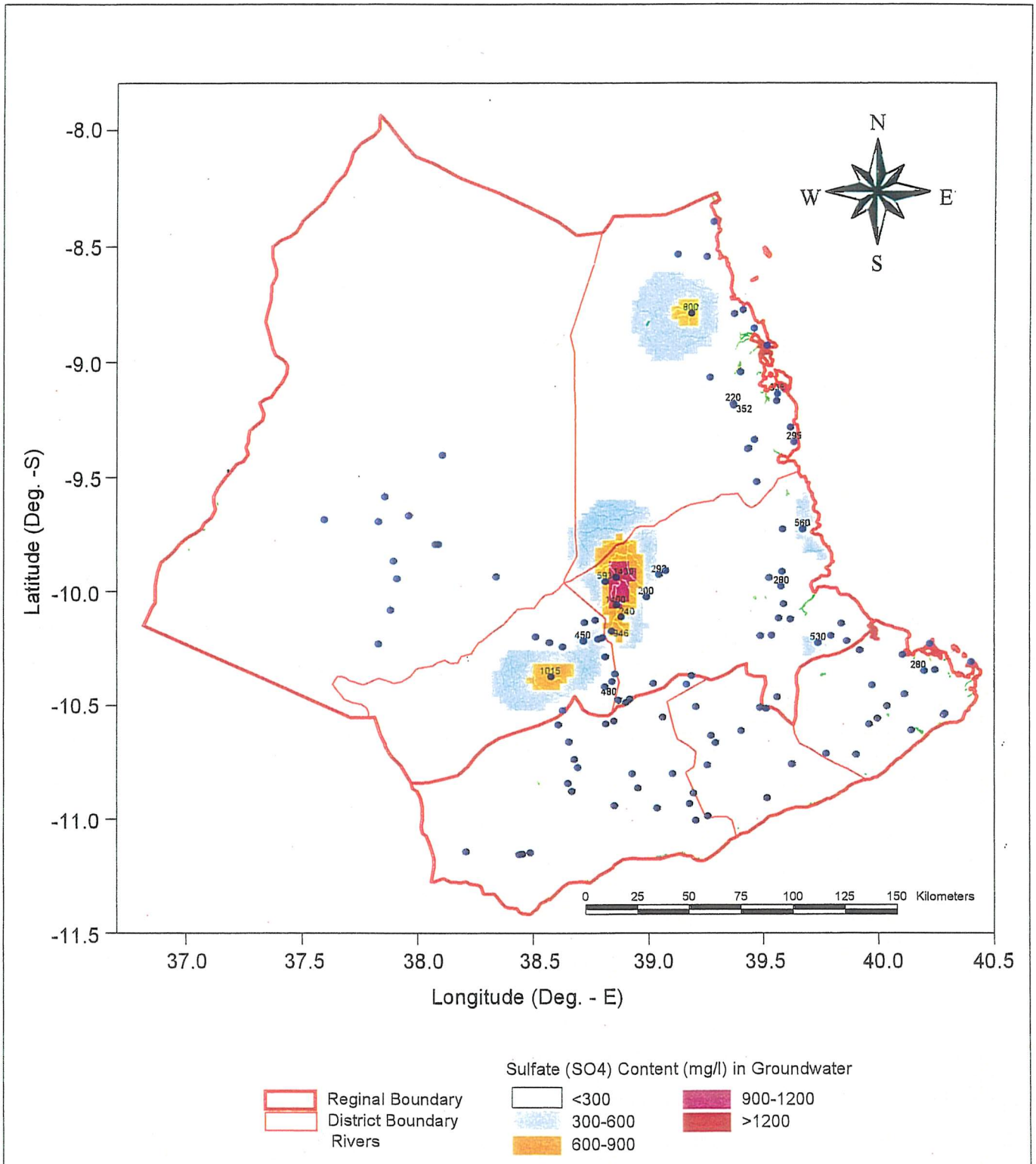

Figure 6-4 | **Sulfate (SO4) Content in Groundwater**

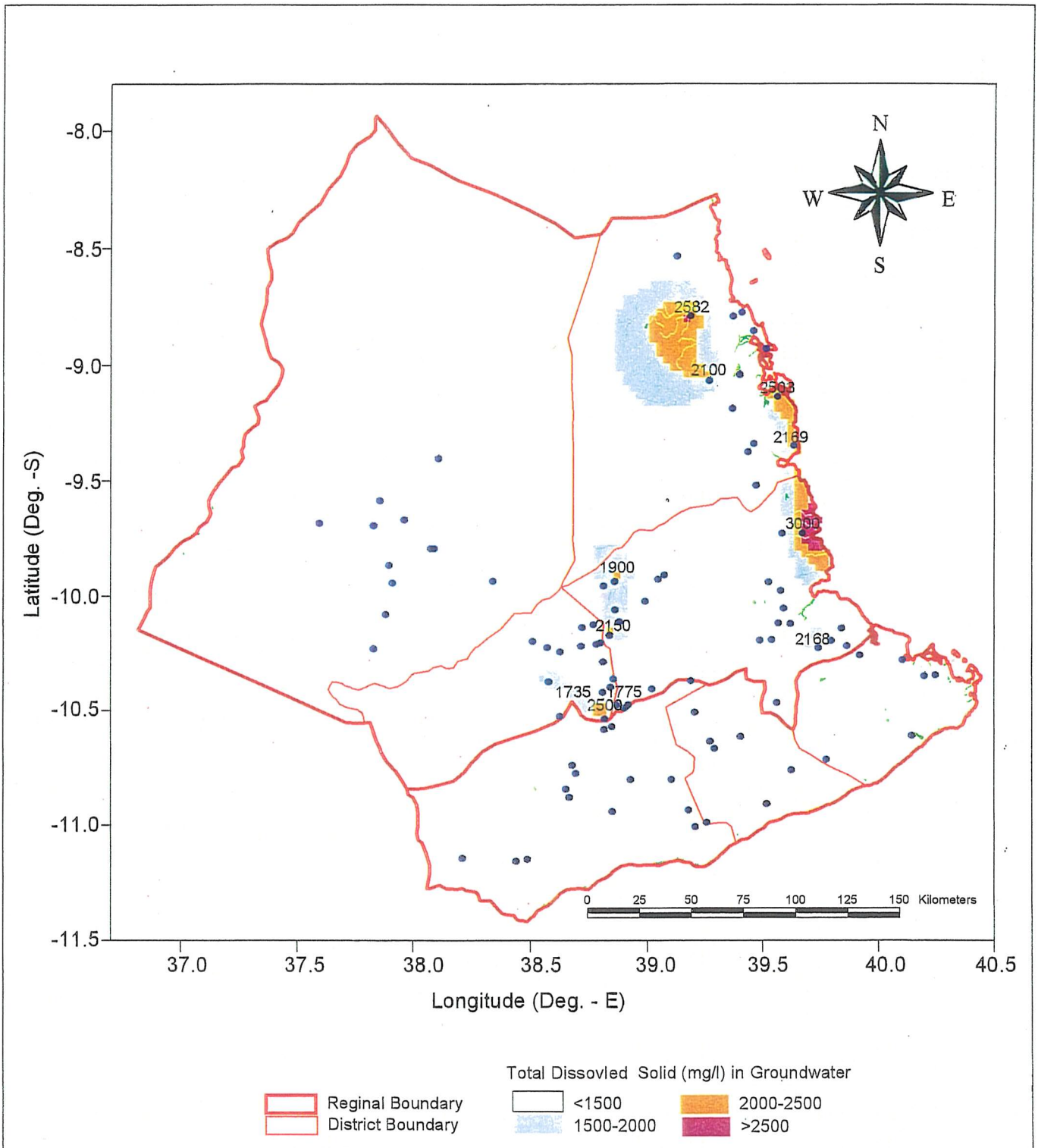

Figure 6-5 | **Total Dissolved Solid (mg/l) in Groundwater (2000)**

Chapter 7 Pilot Study

The pilot study is one part of the feasibility study. The independent and small-scale water supply facilities have been constructed in 6 villages among 100 candidate villages during this Study program for the purposes of:

- training villagers (water users) on autonomous management of their own water scheme, through participation in planning and facility construction,
- training villagers on facility operation/maintenance and operation of the Village Water Committee through actual use of the constructed water supply facility, in order to make the autonomous management take root in the community,
- evaluating suitability of the type of the constructed facility and/or applied management system to the communities through monitoring of the pilot sites, and
- reviewing the established plans of facility type/scale, O/M methodology and project implementation for the future project for 100 villages, based on above mentioned evaluation

7.1 Villages Chosen for Pilot Study Sites

The 8 villages were initially planned for the pilot study sites expecting that at least 8 test wells out of ten would be productive enough as the sources of the pilot water supply facilities. Unfortunately, however, the number of the sites selected was an only 6 out of 10 test-well village, because 3 wells were not productive and 1 well was with highly saline water. The 6 selected villages (3 in Lindi and 3 in Mtwara) as well as the type of constructed facilities are as follows;

Table 7-1 Sites of pilot scheme in Lindi and Mtwara regions

Name of Village	District	Region	Type of Facility
Arusha Chini	Mtwara Rural	Mtwara	Level-2 system (Public faucets)
Ziwani	Mtwara Rural	Mtwara	Level-2 system (Public faucets)
Nanyumbu	Masasi	Mtwara	Level-1 system (Hand-pump)
Kilangala	Lindi Rural	Lindi	Level-2 system (Public faucets)
Pande Plot	Kilwa	Lindi	Level-2 system (Public faucets)
Chinongwe	Ruangwa	Lindi	Level-1 system (Hand-pump)

7.2 Activities in Pilot Study

7.2.1 Pilot Supply Facility Construction

The Level-2 supply system constructed in the 3 villages of **Ziwani** (Mtwara R.), **Kilangala** and **Pande Plot** (Lindi R.) consists of the borehole well as a source (6-inch casing for all but different depth/productivity), generator house, elevated distribution tank (30 m^3 volume and 2.5m.high), 2 sets of public faucet base (domestic points, with 2 taps each), and 100m long distribution pipe. Another Level-2 system constructed at **Arusha Chini** (Mtwara R.) is same as above, except the distribution tank, which was the rehabilitated ground-type tank with 35m^3 volume.

The submersible motor pumps installed in the 4 wells have pumping capability of more or less 100 liters per minute at a total head between 30 and 60 m (6 m^3/hour) regardless with the productivity of the wells. Dimension and/or capacity of the distribution systems are not in accordance with the population served of the concerned villages. Since these are the temporary supply system to be used in the pilot study, the population to be covered by these supply system is limited to only 2,000-3,000, assuming the pumping hour at 10 hours/day and a unit supply amount at 15-25 liters/person/day, although the total population of these 4 villages are well over 3,000. For instance, population size is 8,800 in Kilangala and 6,700 in Ziwani. These pilot facilities should, therefore, be expanded in the implementation stage of the full-scale project.

At the villages of **Nanyumbu** (Mtwara R.) and **Chinongwe** (Lindi R.), one hand-pump set each was installed at the drilled borehole well (that is Level-1 system), because the productivity of the drilled test wells have been proved as less than 50 liters per minutes. Since a well with hand-pump set can supply water to 250-400 people, following 2 alternatives should be taken into consideration at the stage of full-scale project;

- Additional 2 to 4 wells with hand-pump sets are required to be constructed to cover the population to be served in the community
- If one of the wells constructed were productive enough to supply water to the total population of the village, the plan of Level-1 system may be converted to the Level-2 system by use of this high productive well.

7.2.2 Community Participations during Construction Stage

It was found that the villagers' participations in the construction works were poor in spite of repeated suggestions made from the study team to each community. The poor participation to the construction works suggests difficulty in autonomous management of the community-owned water supply facility. It seems as if the projects would not be the sustainable ones, if

implemented under the present situation of poor community participation. The water department of regional and district level must give a patient training to the communities on this matter.

Followings are the findings in concerned villages:

a. The villagers offered no active contribution; do not give labor to the construction works, for example. The villagers remained spectators on the contractor's works. Dependant nature seems common in the regions: All of 6 sites
b. Lack of the village chairman's leadership; in encouraging villagers to carry water for concrete works, for example.: Pande Plot
c. Villagers' interest seems to be concentrated in getting wages for the labor in construction works of their own water facility, especially among younger generation: Ziwani, Kilangala, Pande Plot
d. Villagers were only waiting for tap installation by the contractors at the village where the facility was nearly completed, even though the Team suggested purchasing and installation of the taps by themselves for earlier facility use. The cost of the water tap is only Tsh.1,000 or less, and the town is very near from the village, but, they didn't do that: Ziwani
e. The villagers were expecting that the expenses for the opening ceremony were to be paid by someone else, not by themselves. It was improved later, though.: Ziwani

7.2.3 Educational Activities

(1) General course

The educational activities on operation and maintenance and gender/sanitation issues were taken timely before, during and after construction of the pilot water supply facilities in the concerned villages. The first activity in each village was the general course touching briefly with following items, in the meeting of the villagers collecting as many people as possible under precision of the village chairman;

- Awareness of the project covering 100 villages in Lindi and Mtwara regions, and significance of the pilot scheme
- Introduction of independent water supply system which should be operated under community-base autonomous management, in accordance with the government's new policy on rural water supply
- Role of the water committee and operation methodologies of the committee, in collaboration with the village government, and with technical assistance from Idara ya Maji (district water department)

- Confirmation of the newly chosen committee members by the mutual vote, and confirmation of the involvement of at least 3 lady-members, in consideration of the women's concern in domestic water and important roles in management of daily life related in water
- Role of each committee member
- Operation methodology of the facility, putting emphasis on use of supplied safe water through the year, and fetching water at any favorable time of the day from the domestic points without limitation of supply hour
- Collection of money for operation and maintenance of water scheme (Water Fund), putting emphasis on maintenance cost, for which the villagers had never had idea what it was like
- Independent management of the water fund from the village fund, which means that the collected water fund should be used only for operation and maintenance purpose of water scheme
- Money use items on operation and maintenance
- Requirement of 3 signatories for bank account opening

Questions and answers followed after the explanation of above matters. Questions centered mainly on independent management of the water fund from the village fund, since water funds have been one part of the village funds in majority of the villages in the area.

Discussion on involvement of the women executive members of the committee was also active during the village meeting, in spite of the common habits of comparatively lower social status of women in the Islam predominated society of the area.

With regard to the O/M cost, majority of the villagers in each of the concerned village were surprised knowing that replacement of the worn-out pump or generator should be included in the maintenance cost, because the autonomous operation and maintenance of the water supply scheme is the first experience for them.

(2) Establishment of new village water committee

Each of the 6 pilot scheme villages had water committee, but none of them was actually functioning. The 4 villages had no reserving of water fund. The 2villages had deposited 50,000-80,000 shillings in the past several years, without any concrete idea of what to do with it but expecting the services from the local government or others.

The study team, in collaboration with the counterpart personnel (mostly district water engineer), persuaded the villagers to formulate the new water committee, suggesting

composition of following 5 to 7 committee members, with the explanation of the role of each member:

- Chairperson of the committee 1 person
- Secretary to the chairperson 1 person
- Treasurer 1-2 persons
- Member in charge of technical matters 1-2 persons
- Member in charge of sanitation 1 persons

As a result, the new water committee was established in each of the 6 pilot scheme villages. The member selection was made by the mutual vote. Contrary to the expectation of the study team, ladies head the 4 committees out of 6. The member lists of newly formed committees are presented in the Supporting Report.

The roles of the water committee and each executive member of the committee have been described in Swahili and delivered to each of the concerned committee. This document has been displayed on the wall of the village government office accompanied by the name list of the committee members and their pictures, so that everyone of the villager can renew their understanding on the role of water committee whenever he/she visit the village office. The Delivered description on the role of the water committee is as follows:

- **Roles of water committee-**

  The water committee representing the water users in the community is responsible in the management of the community water supply scheme by operating the supply facility continuously and by maintaining it long time, which will result to the healthy life of the villagers by reducing water-born diseases, and to the more lively production activities without anxiety of water shortage. The committee has to carry out the overall management of the water supply facilities in collaboration with the village government, with the following specific responsibilities;

  1) Collection of water fund from the users for the purpose of operation and maintenance of the facility (Collection annually, monthly or per bucket shall be based on the users' consensus. Per-bucket-collection from the users of adjacent communities may be preferable.)
  2) Management of incomes and expenditure of the collected water fund
  3) Daily operation of the pumping facility, so that users can fetch water from the domestic points at any time they like
  4) Periodical inspection (daily, weekly and monthly) of the facilities and repair of

minor damage, so that the users can use the facility continuously

5) To keep close communication with Idara ya Maji for asking technical support or assistance at the requirement of training or repair of the damaged equipment
6) To secure the safety of the supply facility (Wage payment to the security guard shall be based on the users' consensus)
7) To mobilize the community on the proper water uses and environmental sanitation, especially on the constant use of supplied safe water even during rainy season

- **Roles of water committee members**

Chairperson is overall in-charge of water management in the village, with following specific roles;

- To convene and preside the scheduled/emergency meeting of water committee to check the committee operation
- To convene and preside the villagers meeting on water related issues when occasion demands, in collaboration of the village chairman
- To evaluate the performance of water committee members

Secretary is the secretary to the chairperson of the committee, with following roles;

- Report writing and proper documentation of all water issues in the village
- To facilitate communication between the village and Idara ya Maji
- To write the monthly report to the committee and quarterly report to the village government in collaboration with the treasurer
- To give public information to the villagers on the activities of the committee and the financial statement of the water fund

Treasurer is responsible in water fund related matters, with following roles:

- To keep the account book and provide the financial statement on the income and expenditure of water fund
- Banking procedure of the water fund
- Payment for purchasing of fuel/oil and spare parts, wages for guards or employed technician, and for the services of Idara ya Maji
- To prepare the draft of monthly financial report for the committee and quarterly report for the village government

Member in charge of facility operation (Pump Attendant) is responsible in all the technical matters in operation and maintenance of the facility, with following specific roles

- To operate generator everyday and control water level in the distribution tank, so that people can fetch water from the domestic point at any time they like between 6 AM and 6 PM
- Daily and/or weekly inspection on the working condition of the facilities for finding out the problems. In case of the minor problems like on water tap or oil filter of generator, purchasing and replacement will be done by himself/herself. If the problems are of beyond control, report it to the secretary for technical assistance from Idara ya Maji
- Purchasing of diesel/oil to be fed to the generator and spare parts, and book keeping on purchasing and consumption of the fuel and parts

Member in charge of sanitation is responsible on the matters of sanitation and health related to water use, in collaboration with the social service committee of the village, with the following specific roles;

- To make sure of the usage of supplied clean water in the community, especially during the rainy season, recommending people not to use unwholesome water for drinking purpose
- To make the spot checks at individual household for inspection/guidance on use of water from hygienic viewpoints
- To make a random survey on amount of water used per person periodically (monthly or quarterly) in order to understand the actual water demand for future expansion of the supply facility, and to prepare the water use report to the committee
- Inspection of the domestic points everyday whether it is kept clean or not. If the sanitation environment is not fairly good, enlighten the users to keep the clean environment

(3) Operation and Maintenance of Water Scheme

Two major concepts in operation of the Level-2 supply system were transferred to the users through training of water committee members.

One is the continuous use of the supplied safe water through the year, which means continuous operation of the pumping facility is important even in the rainy seasons when water is abundant everywhere in the vicinity of the households. This suggestion was made from the viewpoints of (1) safe water use for healthy life, and (2) to elongate the lifespan of the water source and pumping equipment, since leaving the facilities without operation for months causes troubles of immediate battery exhaustion, getting rusty on generator and the short lifespan of the water source (well).

Another point is long lasting and constant daily operation of the facilities, from the

viewpoints of (1) saving time in fetching water, and (2) saving of fuel, and elongation of the equipment lifespan. If the domestic points are open for use all the day from morning to evening, people can fetch water at any time they like without making a long line to wait for their turn. The operation of the generator and motor pump continuously and at a little bit smaller rate of the installed capacity will result the smaller consumption of the fuel than that of full operation in installed capacity in a short time, and will keep the equipment in better condition.The committee member in charge of technical matters (pump attendant) should control the pumping rate by observing the water level in the distribution tank. He or she is also responsible in fuel supply to the generator and keep the record on purchasing and consumption of the fuel and spare parts.

Followings are the other performances and activities taken by the joint study team as one part of the training program of the villagers in relation with the autonomous management of water scheme:

- The signboards attached to the generator house and/or elevated distribution tanks with a catchword in Swahili "All of the water users are responsible for O/M of this facility under management of the water committee" are the general notice to the water users. (4 villages of Level-2 pilot scheme)
- The handing-over ceremonies for the completed supply facilities in the 2 villages of Arusha Chini and Ziwani were also one of the chances for the users' training, being given the encouraging words on autonomous management from the guests of the ceremony, such persons as the District Commissioner Mtwara Rural, District Administrative Secretary Mtwara Rural, a Representative from Ministry of Water, the Regional Water Engineer Mtwara and the Director of JICA Tanzania Office.

Planning of the program and execution of the ceremony by the villagers was useful to let everyone know about the pilot scheme. The song-and-dance admiring water supply scheme, which was composed, designed and performed by the villagers at both of the villages, was the highlight of the ceremony program. This type of performance is believed to be the best way of publicity among people including children.

(4) Operation and Maintenance Cost and O/M fee Collection Method

With regard to the operation and maintenance cost, following figures were given to the water committee as a standard O/M cost for the level-2 water schemes:

1) Monthly operation cost (Running cost)

- Diesel for generator	300-550 liter/month	192,000-352,000 Shill./month

- Parts purchasing		40,000-50,000 Shill./month
- Repair service fee	25,000 Shill, 5 times a year	10,500 Shill./month
- Security guard		10,000 Shill./month
Sub-total		252,500- 422,500 Shill./month

2) Average monthly maintenance cost in long-term maintenance (30 years):

- Well flashing	450,000 Shill, every 5-year	7,500 Shill./month
- Heavy repair	150,000 Shill, every 3-year	4,000 Shill./month
- Pump replacement	3,500,000 Shill, every 12- year	24,300 Shill./month
- Generator replacement	4,000,000 Shill, every 15-year	22,200 Shill./month
Sub-total		58500 Shill./month

The total of above 1) and 2) comes in a range of 311,000-481,000 Shill./month.

The monthly O/M cost to be taken share by one household depends on the number of the household. If 500 households evenly shoulder the O/M cost of the village water scheme, the burden for each household will range 622-962 Shill./month. If the household number is 200, the share to be taken will become bigger as 1,555-2405 Shill./month/household.

For the villages of Level-1 pilot scheme, following estimated O/M cost was given to the water committee:

1) Operation cost: No running cost, because the pump is operated manually.
2) Average monthly maintenance cost in long-term maintenance (30 years):

- Purchasing of spare parts:	40,000 Shill. Per year	3,330 Shill./month
- Flashing of the well:	400,000 Shill., every 5-year	6,670 Shill./month
- Pump-set replacement:	570,000 Shill., every 12-year	4,000 Shill./month
Sub-total		14,000 Shill./month

The above 1) and 2) totals 14,000 Shill./month. Assuming that 50 households use one well, one household should shoulder 280 Shill./month for O/M cost. (If one person use 20 liters a day, the O/M cost required for 1 bucket may amount only 2 Shill./bucket. But, if the unit consumption is limited to 5-10 l/c/d, the O/M cost will come to 5-6 Shill./bucket.)

With regard to the method of O/M fee collection, following three were suggested, mentioning that the third was the most recommendable method for both of Level-1 and Level-2 schemes:

1) Per-bucket money collection
2) Monthly money collection from each household

3) Annual money collection from each household

The reason why 3) being best recommended is to make it possible

- to use the supplied safe water through the year (for L-vel-1 and 2)
- to use enough amount of safe water to keep healthy life (for Level-1 and 2), and
- to elongate the facility lifespan (for Level-2)

If the method of 1) is taken, they will reduce the amount of water for the sake of saving money. If the water-use remains at the present situation of only 2-8 l/c/d, improvement of health condition cannot be expected.

If the methods of 1) or 2) is taken, majority of the villagers will go back to the traditional water points during the rainy season without payment for O/M fee. In the rainy season, charge free water is available everywhere not only at the traditional pits but also rainwater at the vicinity of the houses. Since the sense of hygiene is not yet so much developed in the areas, it is obvious that many people will prefer traditional water points or rainwater, resulting to stop payment for O/M fee.

At the villages of the Level-2 scheme, no payment for operation cost will be led to stop operation of the pumping facility, because of shortage of water fund to buy fuel for diesel engine generator. Moreover, when they wish to reopen operation of the generator, the working condition may become worse after months of suspension.

All of the villages of the pilot scheme began collection of money with the method 1), because it is the most easy method, and some of the village had no deposit of water fund to buy the fuel for the present. Further recommendation should be taken to convert the collection method of 3), taking the chances of the monitoring work for the pilot schemes.

(5) Gender and Sanitation Issues

Majority of the village water committees existing in the study area involve at least 2 female committee members in accordance with the regional policy of the community development. But, no lady chairperson of the committee was found in the area. After the discussions with the villagers pertaining to the important roles of the ladies in water use and sanitation, the joint study team strongly recommended to elect the lady chairperson, suggesting that the social status of women would be much developed through taking the managerial post in the committee. As a result, the lady chairperson was elected in the 4 villages out of 6 pilot study sites by the mutual voting, although there were much of hesitation among ladies and some opposition came from men executive members of the village government during the discussions.

The lady manager came into existence at the establishment of the autonomous management system on water scheme. It is believed to be an epoch-making event in the 2 regions, and it is

desirable that the new committee as well as the new management system would take root in these regions.

Strengthening of the system and encouragement of the committee operation must be promoted taking the chances of monitoring work of the pilot scheme.

With regard to the sanitation issue, keeping the living environment clean by proper preparation of latrines or by waste disposal was briefly touched during discussion. Major focus was use of clean and safe water for healthy life. Since provision of water, whether it is clean or not, was used to be the first priority in the area, villagers were not so much interested in use of clean and safe water. But, upon getting the safe water in the pilot scheme sites, importance of using only clean water was enhanced especially for drinking purpose, even in the rainy season.

7.3 Monitoring on Pilot Scheme Sites

7.3.1 Short Term Monitoring

The monitoring on the facility operation and the operation of the newly established water committee started before and immediately after completion of the pilot facility. (Five sites were the targets, because the construction works were not yet completed at Pande Plot. Completion was the end of December 2000).

Findings of this short-term monitoring work are as follows:

1) Confirmation of Water Committee Establishment

It was confirmed that all of 6 sites had established the new water committee.

Composition of the committee is following, which is in conformity with the government's guideline for water committee. The lady chairperson has been elected at 4 villages:

- Chairperson
- Secretary
- Treasurer (and assistant treasurer)
- Member in charge of sanitation (and assistant)
- Member in charge of technical matters (Pump attendant, and assistant)

2) Performances of Water Committee and Water Users

Facility use condition was observed at the 5 sites from a few to several weeks after the start of its use.

(2) Facility surroundings

Condition of facility surroundings was generally good at every site, like;

- The users have constructed the fence around intake facility under initiative of water committee in order to avoid the children's mischief (2 sites)
- The surroundings of the domestic points are kept clean (5 sites)
- Water taps are firmly closed not to waste water (2site)

(3) Sanitation related

Lack of the sense of sanitation was outstanding at all sites, like;

- People began use of drained water from the tank, that was put into the tank for the purpose of cleaning inside the tank (1 site)
- People began use of muddy water first passed through the pipe (3 sites)
- Many of the containers for water collection were not clean (5 sites)

- Majority of people did not come to the domestic points on rainy day. They were still collecting rainwater, or fetching muddy water from the traditional pits, because it is free of charge (2 sites)
- Self-flowing water from the well flew into the pit through the ditch which turned water muddy at Kilangala village. People were taking this muddy water from the pit just beside the domestic point, although clean water from the tap was already available.

(4) Water fund

Since the autonomous management of water scheme is the first experience for the villagers, it seems difficult to be accustomed in a short time in the management system. In spite of the recommendation on earlier start of money collection for water fund, the 2 villages did not collect money until the time of facility completion.

After finishing the test operation, they could not continue operation with no fuel, no money to buy fuel.

With regard to the money collection method, they chose per-bucket collection method among suggested 3 types of collection method. The easiest method, but the worst method it was. People's feeling will remain as if they are buying water from the water vender (water vender=water committee), instead of paying for O/M cost, so long as per-bucket collection method is taken, which will result in no recognition of their ownership of the facility. Payment for O/M in "per-bucket" method will also result in excessive saving of water on the days of no money, or in going back to the traditional dug well and/or rainwater during the rainy season. These are against the concept of "Healthy life with clean and enough water."

The per-bucket collection method should be the temporary one while the committee has not yet deposited the enough water funds to cover the expenses for facility operation for the time being.

In Ziwani village, however, this per-bucket collection method seemed as if successfully advancing. The treasurer of the committee was sitting all the day beside the domestic point and collecting 20 shillings per bucket. The deposited money was surprisingly big, amounting over 200,000 shillings within 2 weeks. They opened the bank account, and were cheerfully keeping the account book. But, how will be the condition during the coming rainy season of February-April? The next monitoring in May 2001 will give the answer.

7.3.2 Methodology for Long-Term Monitoring

Based on the results of the short-term monitoring, it was planned to conduct the monitoring work about half a year, 9 months and 1 year after the completion of the pilot facilities in the similar manner, but paying special attention to the following matters.

1) Team composition for monitoring work

The team for the educational activity and monitoring work on the pilot scheme sites are to be composed of one JICA study team member and one each official concerned of regional and district water department, with an initiative taken by the official from district water department.

2) Points on monitoring

The monitoring on pilot scheme and educational activities will not only focus on the village water committee and water users but also on the officials of regional and district water engineers. Since the training activities to be taken by these officials should cover all of 100 candidate villages, prior to implementation of the full-scale project, their performances on monitoring work during absence of the JICA study team may become important point for evaluation. Following items will, therefore. Be evaluated;

① Whether the monthly monitoring work was properly conducted by the district water department, and

② Whether the department immediately corresponded to the requests of trouble shooting from the water committees.

The monitoring and evaluation on operation of village water committee and water use condition by the users comprise of following items: The survey will be done through interview with the members of water committee and through observation by the survey team. As for the performance of the water committee members will be through interview with the village chairman

- Operational conditions of the constructed facility
- Use of supplied water, whether continuously used during rainy season
- Troubles encountered so far, and countermeasures taken against them
- Method of O/M fee collection
- Monthly variation in money collection and expenditure
- Daily generator operation hour
- Water flow from spout of hand pump or public faucets, stock of fuel, method of water level control in the reservoir tank, keeping operation record, etc.
- Sanitary condition of well and domestic points surroundings
- Performances of new water committee, especially of that of the lady-chairperson
- Performances of each committee member

7.3.3 Result of Long-Term Monitoring

1) Activities taken by the District Water Department

The patrol service to the sites of pilot schemes by the district water engineers was conducted periodically, not every month but nearly every month, during absence of the JICA study team. Their technical assistances were immediately extended when request came from the village water committee on inspection/repair of the troubled pumping equipment and other facilities. The district water engineers know details of the facility condition and well recognize what is going on the site, and the villagers seem to give their trust on water engineers. Such good performances of the district water department surely give good prospect in conduct of future development of water supply in the area. However, the solution of the organizational troubles seems quite difficult thing for the district water engineers. There happened quarrel between village committee and water committee on independent operation of water fund in four pilot scheme sites, but the water engineers could not mediate the trouble in some villages.

2) Operational condition of the facilities

In all of the sites except, Pande Plot, facilities have been continuously operated throughout the past one-year. Suspension of operation was 3-4 days at the most, because repair or parts replacement was quickly done by the committee member or assisted by district water engineer. However, operational condition is not ideal, especially for the Level-2 system sites. The pumping operation hour has been limited to 2-4 hours a day, or one-time filling of the tank, probably with intention of saving fuel. One of the 2 faucet bases has not been used in all sites. People made a line and waited their turn. This is probably due to the per-bucket water fee collection system. People should not have been allowed to fetch water from the tap of collector absence. These matters were pointed out and suggested to improve every time the team visited t, but little improvement has been made.

The pump operation hour during rainy season had become much smaller than that in dry season; once in 4-5 days from the end of April to middle of May in Ziwani, for example, since number of people coming to the water point was extremely reduced in the height of rainfall.

-- Pande Plot: Water of Pande Plot well is not fairly good quality (high salinity), therefore, there is no choice but to use as the supplemental water source in dry season in this village.

3) Operation of village water committee

The facilities are working, but there is a big problem in operation of the village water committee in most of the village, mostly in relation with the management of the water fund. The deposited water fund, which has been unexpectedly big amount, has produced friction between

village council and village water committee. The village council tried to take over the management of water fund from the water committee intending to incorporate it into village fund, under the current circumstance of extreme shortage of village fund. The village council dismissed all of the water committee members and appointed new members including some of councilors, at the village where the water committee refused to handover the management of water fund. (At 4 villages of Ziwani, Nanyumbu, Kilangala, and Chinongwe. Later, same thing occurred in Arusha Chini along with change of the village chairman.)

Since the new water committee members have little of know-how on committee operation, most of the committee's activities were discontinued; keeping of account book, reporting to the villagers on income and expenditure, discussion on money collection method, etc., etc. Accordingly, the accumulated water funds are about to vanish into the night, and success of the pilot schemes is becoming hopeless, to say nothing of success of the future water project.

The district water engineer made effort to persuade the village council that proper activities of water committee should be taken by the elected committee members. Persuasion succeeded in the 2 villages of Ziwani and Nanyumbu, but for other 3 villages, it seems quite difficult. Therefore, the JICA team suggested that this matter should be put into hands of regional water engineer or suitable persons like district/regional administrative secretary.

Operation of the water committee was in good condition before intervention by the village council. It suggests that operation of the water scheme can be successful only by the independent account from the village finance. Thus, it can be said, "guide for future has been obtained by the pilot schemes".

4) O/M fee (Water fee) collection method

Money collection for operation and maintenance purpose for the pilot scheme began with the easiest method of "per-bucket" collection, because there was no working fund for opening operation (Tsh.10 per 20-liter bucket for Level-1 schemes, and Tsh.20 for Level-2 schemes).

The accountant and/or assistant accountant sat beside the water point and put collected coin into the locked wooden box. The 3 signatories of committee members opened the bank account, and the deposit increased day by day with amazing progress. However, the study team recommended that money collection method should be changed to annually or monthly collection from each household, so that collectors need not attend the water point and people can fetch water at any time of the day. It was also suggested that 10 or 20 shillings per bucket was excessively high.

The 2 villages of Nanyumbu and Chinongwe (both with Level-1) changed to monthly collection method according to the recommendation, collecting Tsh.500 per household per month. The actual water fee per 20 liters was reduced from 10 to 2 shillings by this change. The villages of Level-2 system, however, are keeping per-bucket collection method against the

team's recommendation.

At Arusha Chini, where the biggest amount of water was used, a ten to twelve thousand shillings were collected per day during dry season, and the balance of the income and expenditure had become nearly 2 million surplus within 10 months. (Money collection rate was reduced to one to ten or less during rainy season).

It was a matter of great disappointing that the account open to the public was forced to become the closed ones one by one by the intervention of the village council.

5) Water use in relation with improvement of sanitation

The day's maximum water use in dry season in Arusha Chini was $10m^3$ (500-buket from the record of water fee collection). More than 200 families (over 1000 people) are using supplied water, but consumption was only 500 buckets. It means that the average consumption rate of supplied water is less than 10 liter per person a day, regardless with the big enough capacity of the source and pump to supply over 40 m^3 a day. Consumption rate was too small even in dry season.

The seasonal variation was quite big. The water fee collection record designates that only 40 to 50-bucket of supplied water a day was used in this village during the rainy season. It means that very few people have come to the public faucet, and majority of the people returned to the traditional water points during rainy season.

The improvement of the sanitation condition by supplying safe water seems quite difficult until people are accustomed use enough amount of water and use only safe water throughout the year. Patient education hereafter will be necessary beforehand implementation of the project

The "per-bucket" water fee collection method may be the major reason of small- amount use in view of saving money. Revision on money collection method may be necessary to make the future project effective. Otherwise, the scale of the facility should be reduced by reducing the planned unit supply amount from 20 to 10 litters/capta /day or less.

Chapter 8 Water Resources Development Plan

8.1 Basic Concept of the Water Resources Development Plan

8.1.1 Stable and Safe Water

The target source for the rural water supply for the 100 candidate villages in the study area is groundwater including spring water, in consideration of both stability and safety.

Although varieties of other water resources are available in the study area, such as rainwater (either of directly collected one to the vessels or storage tank, naturally stored one in the pond/lake or stored in the farm pond) and river water (either of naturally flowing stream or dammed up river water), they will hardly meet with even only one condition among 2 necessary conditions of stability (Can be supplied through the year) and good quality (Potable without treatment).

The reasons why the supply sources other than groundwater are not suitable are as follows:

- Rainwater is everywhere available in the area, but it is limited to only during rainy seasons. (Not stable): Construction of a large-scale rainwater collection gallery utilizing hill slope is difficult, since the land is almost flat at every village. A small-scale collection system can be used only one or two months after rainy season.
- Naturally flowing river water is also available, but at the very limited areas, since majority of the rivers are the seasonal (intermittent) river. (Not stable)
- The perennial streams exist at the lower reach of such major rivers of Mavuji, Mbewmkuru, Lukuledi and Ruvuma, but the treatment is required for use as water supply source. (Problem in quality): Maintenance of water purification and other treatment facilities require huge cost, which is difficult to be covered by the users. (The villages situated closely to the clean perennial stream exist, but those villages have not been selected as the candidate villages because of not so urgent needs).
- Many of the farm ponds or the dammed-up river water are dried up near the end of dry season, and stagnant water often causes growth of bacteria and breeding of aquatic parasite. (Occasionally not stable, and moreover, not reliable quality)

Groundwater development is possible in and around the majority of candidate villages, although the area involves very difficult areas regarding with not only quantity but also with quality. Especially in the upper reach of Lukuledi river basin in the basement rock area, both problems on quantity and quality will be most likely encountered. Try-and-error will be required in drilling of wells in this area, but once the wells are successfully completed, water

pumping up from the wells will be in same condition as those in other areas.

8.1.2 Independent Schemes for Easier Autonomous Management

Groundwater as the source of the water scheme has another advantage, from viewpoint of community participation, in accordance with the new national policy on rural water supply.

The independent water scheme by community, that enables the community to autonomously manage it, requires the water sources inside or in the vicinity of the village. The groundwater development makes it possible. When one well or plural numbers of wells are to be drilled inside the concerned village, the overall management on the water scheme of their own becomes easier. If the troubles occur either on the water source or on some portion of the supply facility, users themselves can take countermeasures immediately, with the technical assistances from regional or district water department. The water users need not hopelessly wait water transmitted from the source point far apart from the community, like in the villages that are incorporated in a collapsed large-scale water scheme.

8.2 Groundwater Development Plan by Villages

8.2.1 Definitions of Water Supply Sources

Three types of water sources have been planned as the supply sources for the water schemes for 100 villages in the study area, namely spring source, shallow well and deep well. The wells are all borehole wells (tube wells). The dug well is usually called shallow wells, but here, the shallow well is defined as the well drilled to a depth shallower than 50m below ground surface, and the deep well means the drilled well deeper than 50m.

The definition of shallow or deep well in this report is according to the drilling depth, although the shallow wells are also suggestive of the wells equipped with hand-pump (manually operated pump) in general, and the deep wells suggest the wells with motorized pump. Pumping-up capability of hand-pump is usually limited to 45-50m or less. However, the hand-pump can be installed to the deeper well than 100m if the water level in the well comes up to a level higher than 40m below ground surface. (When drilling happens to hit the confined aquifer, the water level in the well rises up to the piezometric surface of that confined aquifer.) On the contrary, the motorized pump is occasionally installed to a shallow well, depending on the water demand.

Since there are many sites of expected confined aquifer, and also there are some villages of big water demand which can be met with shallow wells, definition of shallow or deep is made merely by drilling depth.

8.2.2 Water Schemes using Spring Sources

Use of spring water as the source of water supply may be the best way in view of good quality of water, and moreover, of the low cost operation and maintenance, so long as the spring source is available in the vicinity of the village. If the springing point is too far from the village center, the maintenance of long transmission line costs high, and a long distance causes inconvenience in daily pump operation at the source. Taking these points into consideration, only 5 villages out of 100 have been nominated as the villages of using spring sources. Those are within 3 km distance between the source and village center.

These are Mkwiti and Namindondi Juu in Tandahimba, Miyuyu in Newala, Kilimahewa and Madangua in Lindi Rural.

8.2.3 Water Scheme using Shallow Borehole-Wells

Shallow borehole is planned as the sustainable water source in the 2 villages of Msimbati and Msangamkuu in Mtwara Rural district. Since seawater intrusion is anticipated in these 2

villages, the wells within a depth of 20 m have been planned, the bottom of which is above sea level. Number of the wells in these 2 villages is in accordance with the water demand with a limitation of 5 at the most.

The hand-pump will be installed at the wells of these 2 villages, but the wells of hand-pump installation are not limited to these 2 villages.

8.2.4 Water Scheme using Deep Borehole-Well

The deep borehole well as a supply source is planned at majority of the villages counting 92. The villages where the static water level in the well is surely estimated at shallower than 45m counts 16. In these villages, the hand-pump installation to the wells can be planned. If the well drilling hits the confined aquifer resulting to rising of water level in the well up to shallower than 45m below ground surface, the planned Level-2 water schemes can be converted to the Level-1 schemes. However, since it is difficult to estimate the number of such wells before execution of well drilling, planning of level-1 scheme may be limited to only 16 villages out of 92 villages.

Chapter 9 Plan on Water Supply Facility

9.1 Plan of Service Level

9.1.1 Water Demand

Water demand of each candidate village is to be determined based on daily unit demand (unit supply amount) and the existing population to be served in this plan.

The service population should be the projected population of the target year, in general. However, since the population projection is not available at present due to absence of exact population data and the occurrence of recent rapid changes in many of the villages, the demand is obliged to be determined on basis of existing population data.

The water demand is calculated simply multiplying the unit demand by population to be served without including the factors of water loss or daily maximum, as usually done in the rural water schemes, different from those in urban water schemes.

1) Unit supply amount

The unit demand is basically set at 20 liters per person a day (20l/c/d) in accordance with the revised master plan framework. However, the actual supply amount will be lower than 20 l/c/d in some of the villages depending on the availability of the water source development, and also by the limitation in scale of the facility to be designed. With the consideration that the community-based autonomous operation of the water scheme is the first experience in this area, the first scheme may better be the moderate one, not the full-scale one, by putting emphasis on easier operation and maintenance. The expansion of the schemes to the full-scale ones may be after autonomous operation system takes roots in this area.

2) Service population plan

The population to be served is planned as the population of the entire area of the concerned village as of 2000. Increase of population in the future is not considered.

The up grading of the service level or expansion of the service area should be duly considered, if necessary, after the updated population census being conducted.

9.1.2 Distances to Water Points

The domestic points to be designed in this plan is limited to the major clustering area of each village, especially pertaining to the Level-2 service system, without considering the sparsely populated area or the far detached sub-villages. The distance in accessing water is within a few hundred meters in the major clustering area, but the people dwelling in the

surrounding area or in the sub-villages must walk 1 to 3 km, accordingly. The expansion of the scheme will be the matter of consideration after the water users being accustomed in autonomous management of the scheme.

9.2 Supply Facility Plan

9.2.1 Types of Supply Facility

The two types of supply facilities are to be applied, namely Level-1 and Level-2 supply system. The factors for type decision are, population scale of the concerned village, water source development availability and depth to the water level in the drilled well.

(1) Level-1 facility

Plural numbers of the point source (Borehole well equipped with hand-pump) are to be provided in the village. A 270 to 360 number of people will use one well. Number of the wells in one village is determined by dividing the total population of the concerned village by 315 that is the average value of 270-360.

Since operation and maintenance for Level-1 system is much easier and costs lower when compared with those in the Level-2 system, the trial was made to increase the ratio of Level-1 system among 100 villages. Number of the villages of the planned Level-1 facilities is, however, only 18, hampered by the inconvenient conditions of topography and hydrogeology.

If the elevation difference between the ground surface and presumed groundwater table is larger than 45m, this Level-1 system is not applicable, due to limited pump-head of the manual pump.

2

(2) Level-2 facility

Level-2 facility supplies water by the public faucets. The facility comprises of water source whichever of borehole wells or spring, reservoir/distribution tank, distribution pipe and domestic points (faucet-base with 2-3 taps), accompanied by the motorized system for pumping up water from the well or spring to the distribution tank.

Distribution from the tank to the domestic points is to be done by the natural flow, which is popularly called as gravity system.

Volume of the distribution tank and number of the domestic points as well as the length of distribution pipe will be in accordance with the population to be served and the area for service in the concerned village. Number of the taps, for example, is the quotient of total service population divided by number of the persons who are to be served by one tap (400 person is assumed). Number of the villages where the Leve-2 system have been planned is 82, of which the borehole well as the supply source is 77, and the spring as the source is 5.

9.2.2 Scale of Supply Facility

The water supply facilities have been designed generally according to the water demand of

each candidate village, but the scale of the facility has been planned to be as small as possible to meet the minimum requirement within a range of uncertain water demand, taking the easier and lower cost operation and maintenance into consideration. The full-scale scheme to meet the maximum requirement will not make the scheme sustainable, because the autonomous management system of the scheme by the users is the first experience in entire project areas; in other words, the beneficiaries have not been accustomed in operation and maintenance of the independent scheme.

In addition to above plan, the scale limitation has been planned, especially to the quite largely populated village, because of the 2 reasons of 1) questionable water demand which is based on the questionable population data, and 2) anxiety in groundwater development in terms of both quantity and quality, such as:

- Limitations of the scale in Level-1 scheme: The number of the wells in one village will be limited to 5 at the most, in view mostly of the groundwater development availability.
- Limitations in the Level-2 scheme: A limited volume of the distribution tank at 50 m^3, maximum length of 500m distribution pipes and the limited number of the public faucet-base that is 5 at the most, in view of above mentioned both 1) and 2).

The expansion of the scheme to the full-scale scheme, such as increase of the domestic points and extension of the distribution pipe, shall be the matters of consideration after confirmation of a good operation of the constructed small-scale facility.

9.2.3 Number/Amount of Planned Facilities

The total number/amount of the planned facilities for 100 villages are as follows:

- Estimated total depths of the wells for 95 (93) villages: About 16,600m
  For Level-1 scheme, 76 wells in 18 villages: 6,370m
  For Level-2 scheme, 63 wells in 77 (75) villages: About 10,200m

In consideration of try-and-error for successful well, especially in the basement rock areas, the total drilling depths including fruitless drilling are estimated at 29,500m.

- Total number and volume of the distribution tank for 82 villages

20-50 m^3 tank	80 sets	Total volume	2,240 m^3
20	49		980 m^3
30	10		300 m^3
40	9		360 m^3
50	12		600 m^3

- Total number of the faucet base and faucets for 82 villages: 262 bases, 524taps.
- Total length of distribution pipes for 82 villages: 4,000m

- Total length of transmission pipes from spring for 5 villages: 7,500m
- Total number of pump station for spring water pumping up: 5 places
- Total number of diesel engine generator house: 75 sets
- Total number of solar energizing system: 5 sets

9.2.4 Standard Design for Supply Facilities

The standard design for each of the facility and the general plain map of facility arrangement are given in the Main Report.

9.2.5 Cost Estimation for Facility Construction

The total construction cost for 100 villages supply facility approximates USD 15.5 million including the cost for equipment procurement necessary for implementation of the project. The facility construction cost is estimated at US$ 11,767,750 including engineering fee, and the cost for the new sets of drilling equipment, 1 set of tools/parts for existing equipment, and other necessary equipment and materials for execution and maintenance of the project are estimated at US$ 3,763,613.

Chapter 10 Operation and Maintenance

10.1 Responsible Bodies for Operation and Maintenance

All of the water users are responsible in operation and management of the water scheme of their own community. The village water committee represents the users on management of the scheme in collaboration of the village council.

Role of the village water committee is as follows;

- Daily operation of the supply facility
- Inspection of the facility and minor repair of troubled portion
- Collection and management of the operation and maintenance cost
- Keeping close contact with the district water department and making request of technical assistances for major repair or replacement and redevelopment of the well

The district water department is responsible in technical assistance in operation and maintenance of the community's water supply facility in compliances of the request from the village water committee. The district water department is also responsible in training of the villagers and village water committee on proper usage of supply facility and operation of the water committee by taking periodical patrol services.

The regional water department is responsible in manpower development of the staff of the district water department, and in technical assistances to the district water departments on the matters that the district level cannot cope with, such as water resources management, repair of pumping equipment, well re-development, etc.

The regional and district administrations are responsible in taking necessary budgetary measure to the water departments, which enables the departments take satisfactory activities in the technical assistances.

The rural water supply department of the Ministry is responsible in monitoring of the water scheme operation and condition of the collaboration between above mentioned bodies, and in giving technical advices to the regional and district water departments.

10.2 Cost Estimation for Operation and Maintenance

Majority of the operation and maintenance cost is to be shouldered by the water users. The village water committee collect O/M fee from the users and manage as village water fund. The amount of O/M cost varies by type (Level-1 or Level-2) of the facility and by the scale of Level-2 system.

The operation and maintenance cost to be shouldered by the district water department comprises of personnel fee, allowances and vehicle management cost necessary for periodical patrol services.

The total of estimated annual O/M cost for 100 villages ranges between Tsh.367 million and 607 million. This amount is to be paid by about 54,800 households in 100 villages. The breakdown is shown below;

- **Village water fund**

1) For Level-1 facility: Tsh. 170,000 for 1 well per year

76 wells for 18 villages, totaling	Tsh.12,920,000/year
Pump parts purchasing:	Tsh.40,000/well/year
Well flashing (every 5-year)	Tsh.80,000/well/year
Pump replacement (every 12-year)	Tsh.50,000/well/year

O/M fee to be paid by 1 household ranges between Tsh.810 and Tsh.2,830 averaging Tsh.1,980/household/year.

2) For Level-2 facility: In a range of Tsh.3,460,000-5,860,000 for one system per year

77 Level-2 systems for 77 villages totaling Tsh.466 million

O/M cost for Level-2 facility is divided into 2. One is operation cost including fuel for generator, minor repair and security guard hiring(Tsh.2,670,000-5,070,000/year). Another is maintenance cost including heavy repair, well flashing, equipment replacement and renewal of pipes (about Tsh.790,000).

O/M fee to be paid by 1 household ranges between Tsh.9,000/year and 29,000/year , averaging Tsh.14,000/household/year.

For the facility using solar energizing system (5 villages), O/M cost is nearly 1/3 of above mentioned cost because operation cost is negligibly small.

- **The operation and maintenance cost covered by district water department**

In addition to the annual budget allocated to each of the district water department, Tsh.3,600,000/year should be distributed, which include increase of 1 staff and expenses for periodical patrol services.

Chapter 11 Project Evaluation

11.1 Economic Evaluation

11.1.1 Introduction

The Project has been designed to satisfy basic human needs of the people residing in rural areas of Lindi and Mtwara regions. Out of 909 communities (excluding urban areas) in the study area, a total of 100 rural communities have been selected as the target villages for the implementation of the Project.

The objectives of the Project are: i) to provide and distribute sufficient and safe potable water to meet the needs of domestic water users in 100 villages to the year 2015 and ii) to establish improved operation and maintenance system in prioritized villages through participation of the villagers.

Based on the phased project implementation concept, the Project will be implemented in two phases, each phase covering 50 villages. Phase-1 project works will be implemented by the year 2003 and Phase-2 by the year 2004.

11.1.2 Evaluation of Economic Benefits of the Project

1) Overall benefits

The implementation of the Project is expected to yield various kinds of benefits including direct as well as indirect benefits. These benefits include not only quantifiable benefits such as increased number of beneficiaries, health improvement and time saving benefits, but also non-quantifiable benefits such as consumer satisfaction and improved quality of life of the people in general. The Project is also expected to yield indirect benefits such as employment generation as a result of time saving, reduction in morbidity and mortality of children as a result of increased time of women for child care, increased activities of rural population for community development as a result of time saving and so on.

2) Increased Beneficiaries

One of the significant effects of the Project is the increased number of beneficiaries as a result of increased supply of safe water.

Project works will cover 100 villages in Lindi and Mtwara regions covering actual population of 157,688 persons in Lindi region and 112,515 persons in Mtwara region.

There are currently no public water supply systems in these villages except those of 6 pilot sites, it is assumed that the coverage rate in the target villages is zero percent. Number of beneficiaries is 155,271 persons in Lindi region and 122,056 persons in Mtwara region with a total population of 277,327 persons.

Number of Beneficiaries in Lindi Region

	No. of Target Villages	**Beneficiaries (Actual Population in 2000)**
Kilwa	9	25,799
Lindi Rural	17	68,403
Ruangwa	10	17,712
Nachingwea	9	34,167
Liwale	5	7,190
Total	50	155,271

Note: Population in 2000 is based on the actual figure in each village.

Number of Beneficiaries in Mtwara Region

	No. of Target Villages	Beneficiaries (Actual Population in 2000)
Mtwara Rural	17	56,340
Newala	11	13,815
Tandahimba	11	19,935
Masasi	11	29,966
Total	50	122,056

Note: Population in 2000 is based on the actual figure in each village.

3) Improvement in Health Conditions

One of the main objectives of rural water supply program is to improve health conditions in rural areas. The proposed Project has also been designed to reduce the incidence of waterborne diseases through provision of improved water quality and increased water use.

The better access to water may change personal hygiene habits, promoting increased bathing and clothes washing. Increased water use for bathing, washing and food preparation can lead to a reduction in water-washed diseases (e.g. skin diseases). Improved water quality can be expected to reduce the incidence of waterborne diseases (e.g. diarrhea). In addition, spending more time on child care and food preparation may lead to a reduction of child mortality and morbidity.

The extent of the effects which provision of clean water will give to water users in their

health conditions can be estimated from the result of analyses conducted by USAID and WHO. (Refer to World Development Report, 1992). It is estimated that out of the total reduction in the incidence of diarrheal diseases due to provision of clean water and improvement in sanitation, 78% is attributable to provision of clean water and the remaining is attributable to improvement in sanitation. It is also reported that incidence of diarrhea has been reduced by 22% due to provision of clean water and improvement in sanitation. It can be concluded from these analyses that provision of clean water alone can reduce the incidence of diarrheal diseases at least by 17%. It should be noted, however, that improved water quality alone is not sufficient for eventual impact on human health improvement. Water supply should have links with other activities such as hygiene practice, sanitation, health education, and so on.

4) Time Saving Effect of Water Collection

One of the main objectives of water supply project is to reduce the workload of the residents, particularly women and children, for water collection. Time for water collection consists of travel time, queuing time and fill time. By providing stable supply of water through the improved facilities, water users will have better access to water sources. As a result, time for water collection will be significantly improved. Saved time may be used for social, educational, agricultural or commercial activities.

11.2 Financial Analysis

11.2.1 Financial Project Cost

Financial Project costs have been estimated on the basis of the market prices as of April 2000. The Project costs comprise the costs for drilling works, construction of water supply systems including water storage facilities, distribution lines, service pipes, standposts, handpumps and platforms, operation and maintenance equipment, and engineering services.

Base costs of the Project at the price level of April 2000 amount to 2,222 million Yen (US$ 18.1 million) as summarized in the following table (refer to Table 11.3).

Table 11-1 Summary of Financial Project Costs

Unit: 1,000 Yen

Cost Items	Foreign Portion	Local Portion	Total
1. Construction	761,126	417,630	1,178,757
2. Equipment	441,747	2,359	444,106
3. Engineering Services *	202,078	7,760	209,838
Total	1,404,951	427,749	1,832,701
(US$ equivalent)	(1,712,523)	(65,764)	(1,778,287)

Note: Exchange Rates of US$ 1.00 = Japanese Yen 118.00 and Tsh.1.00 = Japanese Yen 0.149 as of February 2001 are applied.

11.2.2 Financial Sources

Financial sources of the Project will be derived from the government budget and financial assistance from foreign countries and/or international lending institutions. Although financial source of the government and water charges collected from beneficiaries will not be enough to support major part of the investment costs, these sources are expected to contribute significantly to the recovery of operation and maintenance costs.

1) Financing of Investment Costs

The total investment costs of the Project comprise foreign currency portion of 1,404,951 thousand Yen (76.7 %) and local currency portion of 427,750 thousand Yen (23.3 %). It is the policy of the Government of Tanzania that the Government shall finance the capital costs of water supply program under the condition that each local community will be responsible for operation and maintenance costs of the water supply facilities.

In consideration of the size of the investment costs and current financial status of the

government of Tanzania, financial assistance from foreign sources will be indispensable. External assistance in terms of grant aid will be necessary to cover the entire foreign currency portion and a part of local currency portion of the Project costs.

2) The Government's and Communities' Contributions

(a) Financing of Capital Costs

The Government will be responsible for financing a part of capital costs for the implementation of the Project. The budget allocation for the Project will be arranged by Regional Water Departments in Lindi and Mtwara through MWLD.

(b) Financing of Operation and Maintenance Costs

DWEs in Lindi and Mtwara regions and VWCs in the target villages will be responsible for operation and maintenance costs for water supply facilities including borehole wells, water storage facilities, pipelines and pumps. VWCs at the target villages will be responsible for operation and maintenance of water supply facilities in the forms of water charge and voluntary labor.

(c) Provision of Project Staff

RWEs and DWEs will be responsible for arranging technical and administrative staff necessary for the implementation of the Project. DWEs will take action to recruit some technical staff (e.g. hygiene education experts) from other government agencies when necessary.

3) Recovery of Capital Cost and Recurrent Cost

1) Basic Concept

It is the policy of the government of Tanzania that beneficiaries are responsible for covering a part of the investment costs in water supply project. Under the proposed Project, all the construction works including drilling of boreholes, construction of water supply system including water storage and pipelines, installation of hand pumps, and construction of platforms will be conducted by the implementing agency. After the completion of the Project facilities, the residents in the beneficiary villages will organize VWCs to collect water charges and to conduct periodical works for operation and maintenance of the facilities.

In consideration of the present income level of the residents in the Study area, it is suggested that water charges should be maintained at levels to ensure recovery of the full cost of operation and maintenance.

2) Recovery of Operation and Maintenance Costs

Annual operation and maintenance costs of the Project will consist of the costs for

annual operation and maintenance (including replacement costs) of water supply facilities. It is the policy of the government of Tanzania that these costs will be borne by the beneficiaries.

Annual operation and maintenance costs for level-2 water supply facilities are estimated at Tsh. 3,732,000 to 5,772,000. Variation of these costs depends on the size of village population. In the case of household number of 500, the burden for each household will be Tsh. 622 to 962 per month. In the case of household number of 200, the same will be Tsh. 1,555 to 2,405 per month.

Annual operation and maintenance costs for level-1 water supply facilities are estimated at Tsh. 168,000. In the case of household number of 50, the burden for each household will be Tsh. 280 per month.

11.3 Institutional Evaluation

11.3.1 Role of Regional Water Department

RWE offices in Lindi and Mtwara will be the executing agency for the proposed Project. For smooth and effective implementation of the Project, it is recommended that a Project Management Unit (hereinafter referred to as "PMU") should be established at each RWE office. A team of technical staff comprising a water supply engineer, a water quality specialist, and an administrative staff will be stationed at the PMU under a Project Director who is responsible for overall management activities of the Project. During the construction stage, PMU shall play an intermediary role between the agencies concerned and the beneficiary villages. After the completion of construction works, PMU shall function as the Monitoring Unit for periodical monitoring of rural water supply facilities in the Project area.

The activities of RWEs should be concentrated on planning, training and monitoring of the water supply program and will act as facilitators of overall project activities.

With regard to operation and maintenance (O&M) activities, RWEs shall be responsible for monitoring on water quality, manpower training on operation and maintenance, and technical assistance to each DWE office on heavy repairs of the existing facilities.

11.3.2 District Level

With regard to operation and maintenance activities, each DWE office will be responsible for monitoring of the existing facilities in the communities, manpower training for VWCs, and technical assistance for heavy repairs on the existing facilities in the communities.

11.3.3 Establishment of VWCs at Target Villages

The Government of Tanzania is promoting rural development activities through the village development committee (VDC) and village water committee (VWC). VWCs are responsible for water resource development program in all sectors, including water supply projects.

There exist VWCs in most of the target villages, but these VWCs are not properly functioning. Therefore, reorganization of the existing VWCs was attempted in 6 pilot project sites. Through a series of discussions with representatives of villagers, election of water committee members including chairperson, secretary, treasurer, and pump attendant was conducted. Role of VWC and its members was also clarified.

Reorganization of VWCs in the target villages other than 6 pilot project sites should be

conducted in parallel with the construction works of the water supply facilities. Such activities should be conducted by each DWE office in collaboration with other agencies such as Health Department in each district.

A distinct difference between the conventional and proposed O&M systems is that preventive maintenance and minor repairs of hand pumps will be conducted by each VWC through VWC members in charge of technical matters (e.g. pump attendant) elected by the water users. DWEs will be responsible for provision of spare parts to VWCs, training for caretakers, and assistance in the case of serious repairs based on the request from each VWC.

Establishment of new VWCs is expected to stimulate a full sense of ownership of the water users on water supply facilities. It is also expected that the water users are encouraged to make substantial contribution in cash or in kind to operation and maintenance works for their own hand pump system.

11.4 Technical Evaluation

11.4.1 Concept for Improvement in Water Supply Service

The proposed Project has been designed on the basis of the following concepts.

(1) Improvement of the water supply service level through provision of new public water supply facilities to the level of 20 liters unit daily supply amount per person on average

(2) Improvement of operation and maintenance system through establishment of VWCs in each target village

The level of technology adopted in the Project design will not involve any technically special knowledge compared to the present level, and therefore the Project works will be conducted without any difficulty from construction stage to operation and maintenance stage.

11.4.2 Improved Operation and Maintenance System

A distinct difference between the conventional and proposed O&M systems is that preventive maintenance and minor repairs of water supply facilities will be conducted by the committee members of the VWCs to be established in each village. DWE office at each district will be responsible for provision of technical assistance to these VWCs, training for VWC members, and assistance in case of serious repairs.

11.5 Environmental Evaluation

In general the implementation of the proposed rural water supply project has significant positive socio-environmental impacts on the area. However, the following adverse natural and socio-environmental impacts, although they are not so much significant in its magnitude, could occur during and after the implementation of the project:

1) Water level drawdown or depletion of shallow wells and reduction of spring yield in the vicinity of the area where new wells will be drilled;
2) Acceleration of shallow well water contamination by increase in wastewater as a consequence of increased use of domestic water;
3) Opposition from private water vendors who make a living by transporting and selling water to remote rural areas, for fear that they might loose their business;
4) Confusion in water management system, especially in water fee collection, due to the adoption of new charging system prepared by each VWC; and
5) Damage of plantations when construction equipment and materials are brought in.

11.6 Overall Evaluation

The proposed Project has been evaluated from various aspects including social, economic, financial, institutional, and WID aspects. Project evaluation is summarized as follows.

Table 11-2 Overall Project Evaluation

Evaluation Items	Benefits Identification and Evaluation
Economic	1) Water supply coverage will be increased from 0 % to 100 %. 2) Number of beneficiaries will be increased by 128,676 person. 3) Time saving for domestic water collection 4) Time saving for agricultural water collection 5) Travel time saving to go to clinic and to buy medicine as a result of health improvement. 6) Increased farming opportunities as a result of increased supply of water 7) Satisfaction of BHN 8) Improved quality of life in general
Financial	1) Internal financial resources and water charge from the beneficiaries are not sufficient to cover the Project cost. Financial assistance from external sources will be required. 2) Water charge will be collected from the beneficiaries to cover a part of operation and maintenance cost. 3) Water charge will be set at 11,340 Tsh. (US$ 3) per year per household.
Institutional	1) Smooth and effective implementation of the Project by PMU 2) VWCs members' training by DWE offices 3) Sustainable management of Project facilities through formation of VWCs and Training Program for villagers.
Technical	1) The level of technology adopted in the Project design will not involve any technically special knowledge compared to the present level 2) Project works will be conducted without any difficulty from construction stage to operation and maintenance stage. 3) Preventive maintenance and minor repairs of water supply facilities will be conducted by VWCs to be established in each village under technical assistance extended by each DWE office.
Environmental	1) The Project will give significant positive socio-environmental impacts on the area 2) Some adverse natural and socio-environmental impacts may occur (e.g. water level drawdown or depletion of shallow wells and reduction of spring yield in the vicinity of the area where new wells will be drilled)

Chapter 12 Conclusions and Recommendations

12.1 Conclusions

One of the most important conclusions of this study program is the urgent need to implement the water supply projects for the prioritized 100 villages in the area. The prioritized 100 villages are only a small part of the two regions where over 900 villages are distributed. There are another 200 villages or more that are under similarly poor supply service conditions.

The projects for the first 100 villages may be, so to speak, a case study of the proposed community-based O&M methodology, as it is quite new to the water users. It will take time for the autonomous management system to take root among the users, and a lot of trial and error will be required to determine the most suitable O/M system in the area.

The second and third groups of prioritized villages cannot wait such a long time without a supply of potable water, which is why immediate implementation of the projects for the first 100 villages is essential.

Generally speaking, the following two points will be good indicators for evaluating the success or failure of the rural water supply projects:

1) Whether or not the time saved on water fetching is practically used for rural development through an increase in social, educational, agricultural or commercial activities.
2) Whether or not the use of clean water supplied in sufficient amounts throughout the year results in the improved health of the inhabitants leading to prosperous rural development.

It seems quite difficult, however, to initiate with a full-scale project, as it would be hindered by many geographical, social and economic constraints. Improving water supply conditions in steps is preferable for this area, such as by first aiming at securing water sources near the houses (within the villages) that are stable throughout the year, and then focusing on utilization of the supplied clean water throughout the year.

The difficulties that have been made clear through the study are as follows;

From the viewpoint of natural conditions:

Many of the candidate villages are located on the plateau area where the groundwater level is low resulting in a high pumping cost. Moreover, the quality of the groundwater in some of the plateau area is not good for drinking purposes, as it has a high content of sulfates and other dissolved ions. The investment cost required to drill deep wells and to hit water of good quality is also high. Small-scale facilities with a reduced unit supply amount (from 25 to 20 ℓ/c/d) have been planned in order to reduce the investment cost and the O/M cost. However, the O/M cost

for some of the villages still seems too high for autonomous management. Solar energized pumping systems are to be introduced for low cost operation, although this system may not pump a sufficient amount of water, especially in rainy season.

From an economic point of view:

The responsibility of management of the water schemes in the rural areas was transferred from the central government to the cooperative bodies of the local government and the water users in 1992. This policy change was done in accordance with the decentralization policy, and was also directly motivated by the financial constraints of the central government. However, the financial situation of the local government and the local communities is also tight. The regional and district administrations have not distributed enough budget to the water departments that have been directly involved in water supply schemes in the regions. Moreover, the beneficiaries of the community water schemes, who suddenly became responsible for shouldering most of the operation and maintenance cost under the new policy of the government, are barely managing their lives, with very low annual cash incomes averaging Tsh.240, 000. About 10% of the households in each of the villages have a cash income lower than Tsh.50, 000. Such financial constraints as in each of the bodies give anxieties as to whether the schemes are sustainable or not.

From a social point of view:

The underdeveloped social background of the area also gives uncertainty as to whether or not the community-based water schemes will be long-lasting. For example, due to a shortage of social services in the areas, the level of education is low and this has led to poor operation of the organizations concerned. In addition, there is no concept of using time effectively to allow for productive activities so the villagers may not be motivated to use the supply facilities continuously (As fetching water from far-away water points is a long accustomed habit, they do not realize the urgent need for a supply facility.) There is also a lack of education in hygiene and sanitation, and as a result, people may return to the nearby traditional water points, especially in the rainy seasons, in spite of their unsanitary conditions. Finally, there was not much village participation in operation of the Level-2 supply system in the previous water supply schemes, and consequently, they lack the necessary technical skills, etc.

However, an encouraging factor was found during the study period making good operation and maintenance of the water schemes possible; that is the serious and obedient nature of the people in the area. Preparing the villagers will require patience, but if motivated and properly trained, they are likely to perform their duties well and the autonomous water schemes will surely take root in the communities.

The pilot schemes operated mainly by the village water committees also have given a bright outlook for autonomous management of the rural water schemes. The village water committees' performance in operating the pilot schemes was fairly good, especially, that of the committees headed by a female chairperson. Such committees did better than expected, suggesting that management of water related affairs should be undertaken mainly by women who generally engage in almost all aspects of water collection and its use. It is expected that the social status and voice of women in the community will be strengthened through their participation in the management of water related matters.

Although many difficulties are anticipated in realizing the aims of the projects in the area as mentioned above, the urgent need to implement the project is an undeniable fact when taking into consideration the basic human needs of the villagers and the poor conditions of the existing water supply. The total investment cost required for construction of the water supply facilities in 100 villages is estimated at about 15.79 million US dollars. In consideration of the considerable size of the investment cost and also the current financial status of the government of Tanzania, the introduction of financial assistance, especially of grant aid from foreign sources is indispensable.

12.2 Recommendations

The following four major items related to policy on rural water supply and water scheme operation methodology are recommended based on the findings of the study.

(1) Water policy and the design manual for water supply facilities

The draft of the national policy on water supply and sanitation revised in 1999 mentions that the water schemes must be implemented side by side with the scheme to provide sewer systems. However, neither sewer systems nor sewerage treatment facilities are urgently required in the scarcely populated rural areas, especially in small villages with populations of a few thousand. A further revision on the draft seems necessary differentiating the small rural communities from the densely populated areas.

There is a similar problem with the design manual of the water supply facilities. Although the existing manual has been prepared for the supply systems of both urban and rural areas, the rural areas mentioned in the manual are limited to large-scale villages with populations of more or less ten thousand. A design manual for facilities of small-scale villages should be prepared with a more simple design and a lower construction cost, because inhabitants of the small-scale villages cannot afford sophisticated facilities.

(2) Positive participation of women in water scheme management

The national and regional policies encourage women's participation in the water schemes by requiring two to three women to be appointed to the village water committees. Going a step further, it is recommended that women's leadership in water scheme management be institutionalized. Although women alone take part in water-related activities, their participation in water management organizations such as the village council or the village water committee is limited to mere assistants or supporting staff, and generally they have little or no say in decision-making. As seen in the pilot study sites, women are more suitable for managing the schemes as they are directly involved in water related matters.

Allowing women to play a major role in water management is an effective way of strengthening the voice of women, which will in turn raise their social status in the area.

(3) Participation of the private sector in O/M of water schemes

The new national water policy suggests that operation of the water schemes by experienced private firms should be taken into consideration in order to solve the technical problems, especially in maintenance work in the water schemes.

Since the private sector is motivated by profit, however, the objective sites may be limited to largely populated villages (10 thousand or more) and areas abundant in water resources.

There are few villages among the 100 candidate villages that fulfill those conditions; therefore, it would be worthwhile to establish the private firm's intention prior to implementing the project. The choice of autonomous management by the users themselves or paying for the services of a private firm should be left to the inhabitants, though.

Some of the large-scale piped schemes that cover several villages with a total served population of over 10 thousand are still in operation in the area under O/M services of the district water departments. However, because of a shortage in water resources, water distribution is insufficient and the water charge collection rate is very low. As a result, none of the private bodies are interested in taking over the services from the district water department.

(4) Methodologies for sustainable and effective operation

The staffs from the district water departments should be in charge of training the water users in the technical skills and institutional matters required for the schemes to be successful. In regard to this, the following are strongly recommended:

1) Increasing the effectiveness of the projects by utilizing clean water throughout the year

   A hygiene campaign should be held in cooperation with the district hygiene committee members, concentrating on the use of the supplied safe water even in the rainy seasons. The district government should take budgetary measures for this type of campaign.

2) Villagers' participation, maintenance, water fund, etc., for sustainable Projects:

   The three major elements essential for making the projects sustainable are users' participation, maintenance technology and the fund. The persons that have what it takes to train the water users in technical and institutional matters are the staffs of the district water departments. In addition to training activities, they should take periodical patrols and put emphasis on the following matters.

   - Making sure the villagers understand that the facilities to be constructed under the Project are the property of the communities, and encouraging people to participate in the planning, construction work and maintenance of their own facilities.
   - Making sure a village water committee is established in all the candidate villages. It is preferable that the committee members be elected by mutual election, rather than be appointed by the village council, as one type of villager's participation.
   - Having frequent contact with the committee members for technology transfer
   - Making sure the villagers understand that the water fund shall not only be used to cover the running cost of the facility but also the maintenance cost, including the replacement of pumping equipment, etc., in future.
   - Not fixing the water charge in consideration that some families live in extreme poverty.
   - Establishing a system of pay that will encourage use of the facility throughout the

year. The method of paying per-bucket, which will be most likely adopted in the majority of the villages, will discourage villagers from using supplied water in the rainy season.

- Ensuring that the water fund is used solely for O/M of the water scheme. The district governments shall be responsible for strengthening administrative guidance to the village councils on the expenditure of the water fund.

When the government of Tanzania makes a request for financial assistance from foreign sources, it is recommended that they include the procurement of equipment and materials for maintenance service to be done by the district water departments. Incorporating a soft component, which will give motivation to the water users, is also recommended.

The implementation of the water schemes for the 100-community must be understood as one part of the project to improve the water supply situation in the project area. More than 200 villages out of the 913 villages in the two regions are in a similarly critical condition, due mainly to the rapid deterioration of the previous water schemes, resulting from the poor maintenance services over the past 15 years.

One of the reasons for poor maintenance was probably due to the fact that it was unclear where the responsibility of maintenance lay, aside from the financial constraints of the concerned bodies.

Once it is confirmed that the autonomous management system is firmly established in the first 100-communities, the system should be popularized in the two regions by carrying out the second and third stages of the project.

In consideration of the above, it is recommended that the water supply projects of the prioritized 100-communities commence as soon as possible.