APPENDIX H REHABILITATION PLAN OF THE WATER SUPPLY SYSTEMS

H-1 DILI

1.1 General

More than two-thirds of people complained of the piped-water supply system; inadequate water, irregular water, no water etc. Hydraulic pressure measurements confirmed the above (refer to Leakage Survey Section). These complaints probably necessitated people keep holding shallow wells even in the service area of the piped-water supply system. The reason is simple technically. The water supply system was developed firstly to serve the city center abstracting nearby streams, then the new system with new water sources was added as city developed. The Bemos river source in the west was developed followed by bores development in the west (Comoro well fields) and in the east (Bidau and Kuluhun well fields).

Nevertheless, water was not distributed properly. Due partly to this, illegal connections were made extensively to try to secure water.

1.2 Basic Design Criteria for Water Sources/Production

Based on the water demand forecast as discussed earlier, the water production required for the years 2003 and 2010 are as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	M^3/day	L/s
2003	21,700	250	26,000	300
2010	33,800	390	40,500	470

The design of water supply systems considers the maximum daily water demand as the basic design criteria for production of water sources

1.3 Long Term Development Strategy

To tackle ever-no-solved water supply problem, the followings are proposed;

- *Sufficient volume of water source*

Surface water was firstly developed. Three rivers are used for water intake. Out of the three rivers, the Bemori and Benamauk rivers flow down to the city so that, if we can develop these two rivers, they will show a very economical means to the water supply system. They give a gravitational flow at a short distance without electricity. However, these two rivers have no more potential for further abstraction.

On the other hand, the Bemos river, tributary of the Comoro river, has large potential for further abstraction. The dry flow at the existing intake will be 200 l/s. The accuracy is not so high because of a few data of stream flow etc. However, we have estimated

this figure using a few data and further, we measured a flow twice in November 2000. We have information from nearby residents about a flow situation. Then, at least 200 l/s can be taken at the existing intake. The water is currently taken at only 30 l/s. so that further 170 l/s can be taken.

Boreholes are extensively developed in 90's with an Australian aid. Five boreholes were in the west and four boreholes are in the east. Besides, three boreholes are in Hera, separate area from Dili. Out of twelve boreholes, only six were in operation in the beginning of 2000. Now ten wells are in operation because we have rehabilitated or constructed four wells at part of the study. Two bores will be constructed with a TFET fund in 2001.

The potentials are high in the well fields; 280 l/s in the east and 1,100 to 1,300 l/s in the west. In total we have 250 l/s surface water potential (200 in Bemos, 30 in Benamauk and 20 in Bemori) and 1,380 to 1,580 l/s groundwater potential (280 in the east and 1,100 to 1,300 in the west). If we add water potential of the Comoro river with large catchment area, the potential will further increase. But, even omitting the Comoro river potential, the potential is far larger than the required water demand; 300 l/s in 2003 and 470 l/s in 2010.

- *Adequate arrangement of distribution system*

Once we have known the adequacy of water resources, the next issue is how to effectively distribute water to the people. Current distribution system is rather patched and not well organized. Water from the two rivers were firstly developed and transported to the city center. Then, the Bemos water was developed and again transported to the city. Finally the well fields were extensively developed and transported to the city center. Still water is not adequately served. Capacities of the pipelines are hydraulically adequate in general (refer to hydraulic analysis). Due to clogs of the pipe, water flow is weak. At the frustration of the inadequate water supply, many illegal connections were made resulting in vicious recycle. We have assessed leakage issue as part of the study and concluded that technically-oriented traditional leakage detection and repair, though important, could not solve the system deficiency.

What we should now is tackling with many illegally connected and technically-faulty connections. There are lots of leakages leading to no water downstream of the system. Downstream residents keep taps open trying a few chance of water available. So together with supplying abundant water from sources, these connections must be rectified. These works does not cost much, compared to the capital investment cost. However, the works should be well organized and continued. They need only qualified engineer (overall strategy) experienced technician, organized workforce and some repair materials. Some expertise particularly at the start of works might be required. TFET-funded PMU is a suitable organization to comply with this continuous work (eventually sustainable operation will be achieved by saving lots of water). Some slight portion of TFET-fund should also be used to this activity.

We propose hydraulically suitable distribution reservoirs, balancing where water comes from and where water goes to. In order to distribute effectively and efficiently water within the distribution system after the distribution reservoirs, we propose zoning systems. Ten zones are proposed taking into considerations of existing distribution

system layout (to utilize the past investment as much as possible), physical facilities such as roads and rivers, elevations of the served areas, and size of each zone. The largest zones are central zone (zone 4).

Zone Name	Water Source	Demand (cu. M per day)	Notes
1	Comoro D and E wells	3,760	
2	Comoro B well	3,220	
3	Bemos WTP	1,590	Note 1
4	Comoro A and New WTP (Bemos river)	8,260	
5	Lahane WTP (Bemori and Benamauk rivers)	3,700	Note 2
6	Kuluhun C well	1,030	
7	Kuluhun B well	1,940	
8	Kuluhun A well	1,000	
9	Benamauk WTP (Benamauk river)	560	Note 3
10	Bidau 1 and 3 wells	980	
Total		26,040	(=300 l/s)

Note 1; Capacity in the Bemos water treatment plant is reduced to half of the so-called 40 l/s. By doing this, filtration rate is maintained at a reasonable rate of 110 m per day.

Note 2; Capacity in Lahane will be increased by 40 percent. due to the undersized design.

Note 3; Capacity in the Benamauk water treatment plant is reduced to one-third due to the over-design.

Note 4; The above are the main reasons that treated water in the Lahane is mostly acceptable and the treated water in the Bemos and Banamauk are sometimes unacceptable during wet period. During dry period with low-turbidity raw water, the treated water in the three water treatment plants are always acceptable.

1.4 Scope of Rehabilitation

1.4.1 Intake Facilities

1) Bemos and Benemauk Intakes

These intake facilities are functioning as sources of respective WTP although a problem in intake method is found. Silts and sands subsequently flown into the transmission main is causing pipe blockage and creating difficulty in adequate treatment at the WTP. To alleviate these burdens on the WTP, it is considered necessary to carry out rehabilitation. Inlet pipes installed at the Bemos intake should be protected by stones and gravels. At Benemauk intake, the concrete conduit constructed across the river requires rehabilitation. Rather than the present intake method (via several holes made on the upper slab of the conduit), installation of perforated pipes is considered more advantageous. Perforated pipes should be designed with sufficient size, installation depth, number and areas of holes, and pipe length.

2) Deep wells at Kuluhun, Comoro and Bidau
It is evident that some of submersible pumps installed in the existing wells had elapsed their economic life. These pumps with necessary appurtenances are to be replaced by new ones to ensure reliability of water supply. They are Kuluhun A,

Comoro A and Comoro E. Regarding the malfunctioning Comoro C, rehabilitation is not proposed as past records show a limited yield from this well.

New/rehabilitation wells

Well name	Work	Note
Comoro A	Replace Pump	-
Comoro B	-	-
Comoro D	-	-
Comoro E	Replace Pump, control panel Replace piping	Increase well yield
Kuluhun A	Replace Pump	Increase from 14 to 19 l/s
Kuluhun B	-	-
Kuluhun C	Listed in TFET 2000/2001 budget	16 l/s
Bidaumasau	Listed in TFET 2000/2001 budget	-
Bidau 1	Replace Pump	5.5 l/s
Bidau 3	Listed in TFET 2000/2001 budget	9.7 l/s

1.4.2 Raw Water Transmission

It is observed during the field survey that leakage is taking place particularly from the air release valves installed on the Bemos raw water transmission main. These outlived devices are to be replaced by new ones to minimize water losses. Regarding the Bemori and Benemauk transmission mains, JICA leakage control team had repaired all leaks detected in the course of the Study. Therefore, no repair and rehabilitation is required.

New Transmission Main (by UNOPS)

Zone	Diameter (mm)	Length (m)	From (Source)	To (reservoir)	Note
1	200	1,035	Comoro E well	Comoro res.	
	-	-	Comoro D well	Comoro res.	Existing
2	200	100	Comoro B well	Aspal Goreng res.	
	-	-	-	-	
3	-	-	-	-	Existing
4	250 300	300 7,000	Comoro A well Bemos Intake	New WTP	 Addition
5	-	-	-	-	Existing
6	150	500	Kuluhun C well	Taibesi res.	
7	200	1,290	Kuluhun B well	Becusi res.	
8	-	-	-	-	Existing
9	-	-	-	-	Existing
10	150	500	Bidau 3 well	Bidaumasau 2 res.	

1.4.3 WTP

1) Bemos WTP

Backwash pump and generator sets are not working. To increase treatment efficiency, new sets of pump, blower and generator should be installed. Specification of these equipment is as follows:

-Backwash pumps: 4.8m3/min x 8m head x 11kw - 2 sets

-Blower for backwash: 0.6m3/min x 0.55fkg/cm2 x 8.5kw - one set as standby
-Watt-hour Meter Box x1
-Main Power Switch Panel x1
-Generator Set x1
-Fuel Tank x1 Pump,
-Compressor Control Board x1
-Pump, Compressor Local Control Board x1

In addition, the existing flow meters mounted on inlet and outlets are to be replaced by new ones to increase their accuracy.

2) Benemauk WTP

Chemical facilities were completely demolished during the last violence. Rehabilitation of mechanical and electrical equipment for chemical dosage equipment is proposed for renewal. As appropriate flow control is an essential task of the WTP, the existing flow meters installed on the inlet and outlets are to be replaced. Further, gabion and bank revetment is proposed for protection of WTP from possible landslide due to flood at the Benemauk river. Following is the specification of the proposed chemical equipment.

Repair of chemical mixing tank with 0.5m^3 storage, 4 in number
Feeder pumps: 6L/hr x 150w - 6 sets
Motorized mixers: 0.5m3 x 0.75kw - 4 sets
Generator Set x2
Fuel Tank x2 Pump,
Mixer Control Board x1

3) Lahane WTP

This treatment plant, although working normally, requires minor rehabilitation. The existing flow meters should be renewed as they outlive their economic span.

4) Central WTP

6,000 m^3/day capacity
Coagulation, Flocculation and Rapid Sand Filter method
Distribution reservoir

1.4.4 Service Reservoir

Out of the existing 9 service reservoirs in Dili water supply, Bemos No. 2 is abandoned. The remaining will be utilized in the future as well. They are Benemauk No. 1 and No.2, Bemos No.1, Becora, Taibesi, Bedoisi, Bidaumasau, Comoro and Lahane reservoirs. As the design of the existing storage facilities are not necessarily based on widely accepted standard, special emphasis will be placed on normalization of the existing facilities. The scope of the rehabilitation includes:

1) Becora

Although working, the reservoir requires minor rehabilitation, including repair of level gauge, and installation of flow meter and controller.

2) Taibesi, Bedoisi and Bidaumasau

These reservoirs do not have level gauges, flow meters and controllers, security fences, and ladders. Particularly Taibesi reservoir lacks equipment for overflow and ventilation, and one inch drain pipe is not sufficient to flush out effectively. This should be replaced by 6 inches GS pipe.

3) Hera A

The reservoir is left for a long time without maintenance. Rehabilitation of the reservoir is required including installation of flow meter and controller, level gauge, security fences and chlorine dosage equipment, repair of broken door and construction of access road.

4) New Reservoir

New reservoirs are required to meet diurnal change of water and to set up zoning

Aspal Goreng reservoir (for zone 2) 1,000 m^3 at 40m msl
Central reservoir (for zone 4) 3,000 m^3 at 70m msl
Becusi reservoir (for zone 7) 600 m^3 at 60 m msl
Bidaumasau 2 reservoir 200 m^3 at 50m msl

1.4.5 Distribution Pipe Network

(1) Assumption

Computerized pipe network analysis was carried out for 10 supply zones proposed. In carrying out the analysis, following are assumed;

1) Minimum water pressure at the end of distribution pipes should be more than 1.5fkg/cm2 (15m head), reflecting the existing condition of Dili town. In the center of the town, many multi-story buildings and offices are gathering.

2) Water flows into a supply zone through one or two distribution mains. To isolate supply zones, gate valves will be installed on all interconnections.

3) Zonal demand will be based on water demand forecast made in Chapter 3.

4) Peak factor (hourly peak demand / maximum day demand) is at 1.75. When unaccounted-for water exceeds 60%, it is rather conservative than those normally adopted.

5) Pipelines considered in the analysis are 50mm (2 inch) or more in diameter.

6) By applying the above distribution zone, many existing distribution mains will be isolated by gate valves. Computation of water flow without pipe rearrangement will

give biased solution. To this end, one or two larger mains are selected among the existing and considered as the distribution mains.

(2) Results of Computerized Pipe Network Analysis

The existing pipe network has been schematically simplified with 1,287 nodes as shown on Figure H-1. Computation is iterated until water pressure and flow rate becomes allowable. Where pipelines are not installed within the service area, new pipelines are proposed. The results are shown on Table H-1.

(3) Required length of proposed pipes

In proposing the rehabilitation plan, it is assumed that the deteriorated ACPs should be replaced by GS pipes. Total length of the proposed pipes are summarized in table below. In the table, pipe length required in Hera village is also included (installation of transmission from Hera A pumping station to Hera service reservoir: 100mm GSP x 500m). As regards the existing distribution mains in Hera (A, B, C), it is assessed that any rehabilitation other than leakage control activities are not required.

Table – Pipe Installation

Area	Pipe Installation
Comoro:	- 100mm GS x 3,820m to supply to the new customers
Bairo Pite:	- 100mm GS x 1,100m to supply to the new customers - 150mm GS x 400m to supply to the new customers - 250mm DIP x 1,300m to replace the existing old distribution main
Colmera:	- 150mm GS x 950m to supply to the new customers - 200mm GS x 350m as distribution main
Caicoli:	- 150mm GS x 900m to supply to the new customers
Becora:	- 100mm GS x 1,450m to supply to the new customers
Bidau Santana:	- 100mm GS x 1,700m to supply to the new customers
Bidaumasau:	- 150mm GS x 2,350m to supply to the new customers
Vila Verde:	- 200mm GS x 1,200m to replace the existing distribution main

Source: JICA Study Team, 2000

Table – Pipe Requirement for AS Pipe Replacement

Diameter and Materials	Length (m)	Purpose
- 200mm GS pipes	7,000	Replacement of the existing 200mm main
- 150mm GS pipes	2,500	Replacement of the existing 150mm main
- 100mm GS pipes	2,600	Replacement of the existing 125mm main
- 100mm GS pipes	1,100	Replacement of the existing 80mm main

Source: JICA Study Team, 2000

New Distribution Main

Zone	Diameter (mm)	Length (m)	From (Reservoir)	Note
1	-	-	Comoro Res.	
2	200	120	Aspal Gorend Res.	
3	-	-	-	Existing
4	250	40	New WTP (Central Res.)	
	300	200	Ditto	
5	-	-	-	Existing
6	150	50	Taibesi Res.	
7	200	220	Becusi Res.	
8	-	-	-	Existing
9	-	-	-	Existing
10	-	-	-	Existing

Source UNOPS

1.4.6 Service Connections and Public Taps

The field survey indicates that around 2,000 connections out of total 11,000, are assumed illegal. As the illegal connections usually do not have any taps, piped water is continuously flowing out as wastage. This situation should be rectified as early as possible.

During post referendum violence, almost 70% of the existing service connections are damaged. Further, most of the service meters installed are not working normally. Based on this assumption, rehabilitation of service connections and public taps are formulated as follows:

Rehabilitation of the existing connections and taps

The existing 7700 service connections to be repaired or replaced
11,000 service meter installation at all connections
The existing 49 public taps to be repaired.

Works required for new customers

Installation of 6,500 new service connections with meters

H-2 ATAURO

a.) General

The water supply system of Atauro (Vila and Beloi) experienced a series of development/improvement made by NGO's such as AusAID and Biahula, following the construction of the gravity system established by the Portuguese Administrative Government and the development made during the Indonesian Period. Since the post-referendum violence no major rehabilitation works was carried out on the system except for minor repairs and maintenance works made on the distribution and service connections by the local water district workers under the guidance of UNTAET's officers.

In formulating for the rehabilitation plan of the water supply system in Atauro both the population of the capital town of Vila and its adjacent Beloi town residents (assumed to be almost equal in population) will be considered in the projection of the water demand to be served by one independent water supply system.

b.) Long Term Development Strategy

A short-term solution is not practically optimal and cost-effective, particularly in case of water supply planning. It is important to have a long-term strategy for water supply system development. The present rehabilitation plan primarily intends to formulate 3-year rehabilitation program, with the view of a long-term development strategy with considerations to the following issues.

- *Future Water Source*

Within the geopolitical jurisdiction of both towns of reasonable distance, no major water source with adequate potential could be found except one of the existing sources – Tulai Spring. There is no reliable information available that could describe the potential of this spring, but flow measurements made during the study revealed that the spring yields a minimum of about 3 L/s (measured during the dry month of October). Although the Tulai spring yield is enough to meet the water requirement of both towns up to the year 2003, it is likewise necessary to conduct a comprehensive and detailed water resources study for future water source/s with adequate potential capable of supplying the increasing water demand in the future.

Information from the local sources revealed the existence of spring with adequate potential located on the southern slope of Mt. Manucuru and another spring at the southern valley in Makadade Village. These spring sources are currently utilized to supply a limited number of people in other towns and nearby villages of Atauro Island.

- *Flow Control and Measuring Devices*

The function of the 2 existing reservoirs (Tolelona I and II) is ineffective due to the absence of flow control and measuring devices. From these reservoirs, a series of pipes are connected reportedly to supply a few number of households having enough influence in the community. No proper control and equal distribution of water supply is being practiced resulting to acute water shortage in most part of the service area particularly at the critical end of the network including Beloi town. Although the production rate of the two existing spring sources is sufficient to supply the present water demand, the ineffective distribution of water supply and wastage cause the water shortage in most areas.

Therefore, for an efficient and even distribution of water within the service area appropriate flow control and measuring devices have to be installed coupled with the construction of distribution mains replacing the series of existing outlet pipes from the reservoirs.

- *Reliable and Safe Water Supply*

With the existing condition of the distribution network, about 70% of the Vila residents and all of the people in Beloi are deprived to the access of safe and potable water supply. As a result, majority of them particularly in Beloi rely on community wells (shallow

wells) contaminated by seawater. The rehabilitation plan of the water supply system in Atauro will include the installation of chlorine dosing facilities on the existing service reservoirs in order that safe and reliable water supply is evenly distributed to the water consumers of both towns.

- *Service Coverage Target*

Due to the scarcity of the safe and reliable water supply in Vila and Beloi, the improvement of the water supply system will result to an increase in water demand. As discussed earlier in the previous section of this report the 1998 service coverage ratio forecasted to increase from a low of 24% to about 50% and 70 % in the years 2003 and 2010, respectively. This rapid increase in water demand requires the urgent construction of public taps and intensive installation of water service connections.

c.) Basic Design Criteria for Water Sources/Production

Based on the water demand forecast as discussed earlier, the water production required for the years 2003 and 2010 are as follows:

Year	**Average Daily Demand**		**Maximum Daily Demand**	
	m^3/day	**L/s**	**M^3/day**	**L/s**
2003	246	3	295	3
2010	349	4	419	5

The design of water supply systems considers the maximum daily water demand as the basic design criteria for production of water sources. Therefore, for the towns of Vila and Beloi, the water source/s should have production capacity of about 295 m^3/day or 3 L/s.

d.) Scope of Rehabilitation

- *Rehabilitation of Tulai spring*

Currently, there exist an eminent danger of contamination on the water source at Tulai Spring due to the presence human habitation in close proximity to the site and its catchment area. In order to attain safe and reliable water supply for distribution to the consumers in Vila and Beloi appropriate rehabilitation works on the water source (Tulai Spring) should be given urgent importance. The 3-year rehabilitation plan of Tulai includes development/improvement works such as installation of security fence around the intake area, appropriate concrete channel for water collection and intake boxes complete with concrete covers. The existing earth trench for water collection will be replaced with uPVC 75 mm.

- *Rehabilitation of the Existing Haronglerang Service Reservoir*

The rehabilitation of this existing reservoir includes the installation of flow control and measuring devices, water level indicators, chlorine dosing equipment, pipe work that includes drain pipe for maintenance purposes. Adequate protection should be constructed on the service reservoir such as security fence to limit the entry of unauthorized persons and domestic animals.

- *Rehabilitation of the Existing Tolelona I & II and Cementerio Service Reservoirs*

These reservoirs were constructed for the purposes of an efficient distribution of water to the water consumers and to effectively stabilize pressures in the distribution system. From Haronglerang, water is distributed to these 2 reservoirs and into the Cementerio for reservoir, which also transmit water to Beloi. The rehabilitation of these existing reservoirs includes the installation of flow control and measuring devices, water level indicators, and the rearrangement of the pipe distribution network. Appropriate covers and security fencing will be necessary to limit the entry of unauthorized persons and domestic animals.

- *Reconstruction of Transmission Main to Beloi*

The result of the pipe network analysis conducted by the JICA Study Team revealed that the existing 5-km x 2-inch diameter transmission pipe that conveys water to the Lebadoe service reservoir in Beloi has insufficient conveyance capacity. Therefore, the existing main should be replaced with 75 mm pipeline. Appropriate appurtenances have to be installed in the new transmission main such as gate valves, flow meter, air release valves, blow-off and drains. The transmission main should be installed with adequate protection such that appropriate pipe bridge with concrete abutment will be necessary for any river/creek crossing.

- *Additional Service Reservoir in Beloi*

To meet the daily fluctuations of water demand, it is necessary to construct an additional service reservoir to meet the storage requirement for the year 2003. The existing reservoir in Beloi (Lebadoe) with a capacity of about 20 m^3 will not be sufficient to meet the storage requirement for the year 2003 computed as follows:

Storage = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 148 m^3/day (assumed to be 1/2 of the total maximum daily demand for 2 towns)

Therefore, Storage = 148 * 8/24 = 50 m^3

An additional reservoir with a capacity of about 30 m^3 will be necessary to meet the expected increase of water demand fluctuation in the Beloi service area until the year 2003. This new reservoir should be strategically constructed in an elevation high enough to supply the most critical water consumer of the Beloi service area. The reservoir should be equipped with the devices such as measurement and control of flow and other appurtenances necessary for ease in the operation and maintenance of the water network. Due to the distance of the reservoirs from the water supply source it maybe necessary to install chlorine-dosing facilities at Beloi.

- *Construction of Public Taps and Repair/Installation of Service Connections*

The improvement of the water supply system in Atauro will result to an increase in water consumers. To effectively maximize access to safe and reliable water supply to the people in the island it is essential that public taps be constructed to serve more people in both towns. Moreover, service connections will likewise increase. The above works are summarized as follows:

Construction of public taps : Total = 2 (1 for Vila + 1 for Beloi)
Installation of service connections : Total = 140 new connections with meters
Repair of damaged connections : Total = 35 for existing connections
Installation of water meters : Total = 50 for existing connections

H-3 MANATUTO

a.) Quick Project

Due to the complete breakdown of the town's water supply system, Manatuto is among the towns/cities of East Timor selected for the implementation of JICA's Quick Project (otherwise known as Quick Impact Project of UNTAET). This Quick Project of Manatuto, which is scheduled to be operational before the end of 2000 will restore the town's water supply system with the production of safe and reliable water supply from a new source thereby abandoning the existing and non-operational water source. This project includes the construction of the infiltration gallery to draw water from the Laclo River and equipped with pumping facilities and transmission mains that will convey water about 4-km upstream into the town's elevated water reservoir. The infiltration gallery in Manatuto is designed to supply about 15L/s enough to meet the town's average water requirement up to the year 2003. Detailed discussion of this project is presented in **Appendix D 2**.

In anticipation to the reactivation of the water supply system in Manatuto with sufficient water supply from the infiltration gallery, NGO's such as ACF with the assistance of local workers and technicians of the former BPAM are carrying out minor repair works on the distribution network and service connections. Most of these works are done on the damaged and visibly broken pipes. Once the system becomes operational with water pressure recovery, it is anticipated that more pipe leaks and water wastage will be expected in the distribution network. Therefore, intensive rehabilitation works and leak repair programme will be necessary for the Manatuto water supply system for the design year 2003 and onwards.

b.) Long-term Development Strategy

The long-term development strategy of the water supply system in Manatuto is formulated taking into consideration the following:

A short-term solution is not practically optimal and cost-effective, particularly in case of water supply planning. It is important to have a long-term strategy for water supply system development. The present rehabilitation plan primarily intends to formulate 3-year rehabilitation program, with the view of a long-term development strategy.

- *Future Water Source*

A reliable water source with adequate potential to supply the future water demand of the service area is the main factor to consider for the long-term development strategy of water supply planning. Viable water sources (existing and future) have to be investigated to evaluate their potential adequate to supply the long-term demand of the service area.

Sources of water such as surface water from the Laclo River and the spring water, which forms part of the tributary to the Sumasse River about 12 km from the town are considered the potential water sources for the Manatuto water supply system. However, due to high turbidity of the Laclo River during rainy season, it is practically safe and reliable to draw water from this river through infiltration galleries strategically constructed from its riverbed.

Due to the limited data and information, the existing wells in Manatuto were used in the evaluation groundwater sources. The water quality investigations conducted on the samples collected from a number of shallow wells in the town area revealed unacceptable water quality exhibiting high concentration alkalinity hardness and TDS. Therefore, the possibility of exploiting shallow groundwater as source for Manatuto was ruled out due to unacceptable water quality.

During the Indonesian Administrative Period the construction of an infiltration gallery was attempted without apparent success. This unfinished project is located on the eastern bank of the Laclo River less than a kilometer from the town center and a few meters from the bridge. On several occasions during the field survey, the Study Team tried its best to interview local sources on information and status of the project especially the reasons for its abandonment. However, neither concrete reason nor records were made available to the Study Team by the sources.

Thorough investigation made by the Study Team on the project site and its adjacent surroundings revealed the existence of agricultural activities upstream. Aside from the possible contamination of the river water from the use of pesticides and other hazardous chemicals for agricultural purposes, the presence of a horde of water buffalo taking their regular bath on the river water will contribute to the pollution of the surface water in the area. The above conditions suggest that the danger on possible withdrawal of contaminated water from the infiltration gallery (Indonesian Project) could be the main reason for the abandonment of the project.

Therefore, in the selection of the site for the construction of the infiltration gallery the JICA Study Team also take into consideration the most viable location that is reliable, safe and relatively free from possible contamination.

For the long-term planning, the existing water source of the town's water supply system (spring source before the violence) maybe an economically viable source for Manatuto. Its high location though far from the service area is typical for gravity distribution system requiring less operation and maintenance cost. Although, rehabilitation of this source will require big capital investment and more technical investigations it is likely to incur less operational cost compared to the energy-intensive operational cost of the infiltration gallery.

- *New Water Supply Zone and Service Reservoir*

To maintain an efficient water supply distribution in the service area, the existing facilities need to be evaluated to meet the possible growth of the population and the eventual increase in water demand. Although the existing distribution mains have the sufficient conveyance capacity for the existing supply zone, the network needs

expansion with additional facilities. For the next 3 years up to year 2003, an additional water supply zone is expected to grow westward on the south of the town. This future expansion of the urban area would require the construction of a new service reservoir and distribution mains.

- *Efficient Water Supply Distribution*

To maintain an efficient water supply distribution to the water consumers requires a well-designed network regularly maintained to minimize leakage and water losses. As much as possible, valves, pressure/flow-measuring devices are adequately installed in the system for ease in operation and monitoring. Urgent rehabilitation of the distribution network is required to minimize water leaks and wastage that may be caused by the numerous leaks and breakages in the pipelines particularly in the small diameter distribution mains that were observed during the field reconnaissance survey. Rehabilitation of the distribution mains and service connections is of vital importance to attain maximum efficiency and accountability of water supply.

- *Service Coverage Target*

The scarcity of safe and reliable water sources in Manatuto will contribute to the increase in water demand. Due to the unacceptable water quality of most of the shallow wells around town, people will tend to rely mostly on public water supply system. With an improved public water supply system delivering safe and reliable water supply to the consumers, the people's trust and confidence on the town's water supply system will improve. As a result, the target on service coverage of the system in the urban area of Manatuto will increase to 100% in the year 2003 and beyond. Additional public water taps need to be constructed including the repair of the existing and broken taps installed during the Indonesian Period.

c.) Basic Design Criteria for Water Sources/Production

The basic design criteria used in the evaluation of the water sources/production required in the years 2003 and 2010 will be based on the water demand forecast tabulated as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,315	15	1,578	18
2010	1,507	17	1,808	21

Sound engineering practice on the design of water supply systems considers the maximum daily water demand as the basic design criteria for production of water sources. Therefore, for the year 2003, the maximum daily water demand of 1,578 m^3/day or 18 L/s will be used as the design factor to evaluate the required production capacity of the water sources.

The infiltration gallery (JICA Quick Project) constructed about 4 km from the town is designed with a capacity of about 15 L/s. However, initial results of the pumping tests conducted on this source resulted to a maximum yield of about 25 L/s generating a maximum drawdown of about 60 cm. Therefore, based on the above forecast of water

demand, the JICA Infiltration Gallery Project has adequate potential to supply the water requirement of Manatuto for the year 2003 and beyond until 2010.

d.) Scope of Rehabilitation

- *Construction of Additional Service Reservoir*

To meet the daily fluctuations of water demand, it is necessary to construct an additional service reservoir to meet the storage requirement for the year 2003. The existing reservoir constructed uphill in the town has a storage capacity of about 200m^3. For the year 2003, the expected increase in water demand will require more storage requirement computed as follows:

Storage = Water demand (in m^3/day) * 8 hrs storage per day

where: water demand = 1,578 m^3/day

Therefore, Storage = 1578 * 8/24 = 526 m^3

To augment the existing reservoir, an additional service reservoir with a capacity of about 330 m^3 will be required to meet the daily fluctuations in water demand for the year 2003. As much as possible, this new reservoir should be constructed adjacent to the site of the existing reservoir because it has sufficient elevation above the town where water can reach any part of the distribution system with adequate pressure. This proposed storage facility should be installed with the devices such as measurement and control of flow and other appurtenances necessary for ease in the operation and maintenance of the water network. It is necessary that interconnection of the pipe network to include the new reservoir will be done to achieve an efficient distribution of water supply and for an effective operation and maintenance of the water supply system.

- *Rehabilitation of the Distribution Main and Leakage Control*

The existing distribution main that distributes water to the consumers located at the northern area of Manatuto were heavily damaged. The serious condition of the pipeline necessitates the replacement of the entire existing network with new GSP in order to have an efficient distribution of water and minimize losses.

It is likewise essential that ETTA's WSS and the local workforce will intensify the leakage control program to enhance water accountability and improve water distribution in the service area.

- *Customer Registration and Metering*

To enhance water accountability and to improve tariff collection, it is necessary that the local water district should carryout a complete and updated registration of water consumers. Additionally, 100% metering of water consumers need to be introduced. In so doing, the sustainability of the public water supply system will be enhanced with an improved water tariff collection and efficient operation and maintenance of the network.

- *Public Tap Rehabilitation*

The rehabilitation of the public taps should be given equal importance, especially the repairs of those damaged taps. Improvement to these facilities includes the installation

of flow control and measuring devices in order to minimizes water wastage and losses. People have to realize the importance of water and as such conservation should be encouraged.

H-4 BAUCAU

a.) General

During the survey, the Baucau water supply system was under minor reconstruction, such as repairs to the pumping station and distribution pipelines under the technical and financial aids from the Portuguese Government. The rehabilitation work being carried by the Portuguese-funded projects is an immediate measure to restore and improve the system and does not take into consideration long-term economic and technical viability of water supply system development. Therefore, it is necessary that a long-term rehabilitation plan be formulated to maintain a long-term and efficient water supply service in Baucau. Moreover, coordination of the related works is imperative for an effective implementation of the water supply projects.

b.) Long Term Development Strategy

The long-term development strategy of the water supply system in Baucau is formulated taking into consideration the following:

- *Future Water Source*

The current water source in Baucau located downtown produces abundant fresh and clean water that could adequately supply the town's water requirement until 2010. However, as per the report of the local sources, there exist several springs with abundant yield located at high elevation several kilometers from Baucau town and close to the airport. For the long-term planning, it is worthwhile to conduct a detailed investigation on this springs, which may serve as an alternative/additional water source for the town or to supply an independent community-based water supply system. Its high elevation will permit gravity flow for water supply distribution.

- *Safe and Reliable Water Supply*

The results of the water quality analysis on the water samples taken from the source in Baucau revealed the presence of coliform and bacteria indicating feacal contamination of the water. This condition is attributable to the human habitation in the area.

To safeguard the health of the water consumers in Baucau from possible drinking of contaminated water, disinfection by chlorination is necessary. A chlorine dosing facility should be installed at the intake site prior to distribution of the water. Environmental concern dictates the protection of the resources by securing the intake area to limit the entry of people and animals will reduce possible contamination of the water source.

- *Realignment/Interconnection of the Pipe Network*

Baucau Town Water Supply System was designed and developed (although still remains not complete until now) with the aim of establishing a loop system of the water network. This system of water network need to be completed in order to attain effective

water supply distribution, minimize head loss and ease in operation and maintenance. For the long-term this target will be achieved by dividing the service area into 5 supply zones.

- *Service Coverage Target*

The improvement of the water supply system in Baucau delivering safe and reliable water supply to the water consumers will result to an increase in water demand. From the current low service coverage (estimated about 60%), it will increase dramatically serving 100% of the urban population in the year 2003 and beyond. To achieve this target, the repair of all damaged water service connections and public taps should be given priority.

c.) Basic Design Criteria for Water Sources/Production

The evaluation of the water sources/production is made based on the water demand forecast. For the years 2003 and 2010 water demand forecast for Baucau is tabulated as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,409	16	1,691	20
2010	1,580	18	1,896	22

The design of water supply systems considers the maximum daily water demand as the basic design criteria for production of water sources. Therefore, for the year 2003, the maximum daily water demand of 1,691 m^3/day or 20 L/s will be used as the design factor to evaluate the required production capacity of the spring source in Baucau.

d.) Scope of Rehabilitation

To improve the efficient distribution of water supply to the water consumers in Baucau, the following rehabilitation works are required.

- *Rehabilitation of Pumping Station No. 1 at Wailia*

This Wailia Pumping Station is the most essential water supply facility in Baucau. The existing pumping facilities and generator sets, although still in operation appear to have lapsed their economic life with one of the 2 generators currently out of use. To maintain an effective operation of the system, it is economically and technically viable to replace the existing mechanical and electrical facilities with new sets.

Likewise, it is important to install chlorine-dosing equipment on this site so that water supply is disinfected prior to distribution. Chlorinated water conveyed to a reasonable far distance via galvanized steel pipes normally exhibits low chlorine residual indicating more chlorine loss in the pipelines. During operation, if the chlorine residual becomes nil (or zero) at the point where the main reservoir is located, then it is essential to install a chlorine-dosing facility at the main reservoir.

- *Rehabilitation of Pumping Station No. 2 at Wainiki (Booster Pump)*

This pumping station although structurally and architecturally improved by the local water district through the assistance coming from the Portuguese government, a few more rehabilitation works need to be done. These work include the replacement of the pumps, generator sets and other electrical facilities.

- *Rehabilitation of Pumping Station No. 3and Reservoir at Lamegua*

This pumping station was constructed to supply the water consumers located at higher elevation on the eastern hill of the old town. However, due to the damages on the pumping facilities and generators sets, the people could not get piped water from the system. To actively restore the operation of this pumping station it will require new sets of pumps and generator. Likewise, it is essential to equip the storage facilities with flow meter and control valves in order to maintain an efficient distribution of water to the consumers

- *Rehabilitation of the Main Reservoir at Adarai*

The main reservoir because of its far distance from the source, where 1st stage chlorination is carried out, will require the 2nd stage chlorination prior to distribution of the water supply to the consumers mostly located in the new town of Baucau. The facility also needs the installation of flow meter and control valves fro an efficient distribution of water.

- *Rehabilitation of Tirilolo Reservoir and Transmission Mains*

Originally, the Tirilolo reservoir was constructed and to be supplied with water by gravity from the Main Reservoir at Adarai and by pumping from the Lamegua reservoir turning the whole network into a loop. From here, water will be distributed by gravity to the consumers located on the eastern hill of the town. However, due to the limited supply, the transmission main from the Main Reservoir at Adarai has turned into distribution pipe where the consumers along the line draw water for their use. On the other hand, the Lamegua pumping facilities were damaged and the installation of the transmission mains were not completed with some sections of the pipeline missing. Thus, no water is coming into this reservoir.

To materialize the effective distribution of the water through the loop network, the installation of the transmission mains should be completed and no abstraction of water should be allowed from the transmission pipelines. Likewise, rehabilitation works required on this reservoir will be mainly on the installation of flow meter and control valves, water level gauge and security fence.

- *Rehabilitation of Samadiga Reservoir*

The Samadiga reservoir was originally constructed and to be supplied with water by gravity from the Main Reservoir at Adarai. From here, water will be distributed to the water consumers mostly located on the southern part of Baucau (new town). However, this scheme does not work mainly due to the limited supply and water losses from the transmission mains.

The rehabilitation plan for this reservoir includes the installation of flow meter and control valves, water level gauge and security fence. Repair on the damaged pipelines should be carried out.

- *Construction of Additional Service Reservoir and Transmission Main*

It is necessary to construct an additional service reservoir to meet the storage requirement for the year 2003 computed as follows:

Storage = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 1,691 m^3/day

Therefore, Storage = 1,691 * 8/24 = 564 m^3

As discussed previously, the existing reservoirs in Baucau have a total storage volume of 500 m3. In order to compensate the storage deficit that will be experienced during hourly water demand fluctuations one (1) additional reservoir will be required having a capacity of about 100 m^3. This distribution reservoir should be constructed at an elevation high enough in order that water will reach to the most critical point of the service area with satisfactory pressure. The reservoir should be equipped with appurtenances such as flow control and measuring devices, water level indicator, overflow and drain pipes and adequate ventilation. To minimize the risk of possible contamination of the water supply, the reservoir be installed with appropriate security fence that would limit human and animal entry.

The construction of an additional reservoir will require the installation of transmission main and interconnection to the distribution network. The pipeline work include the following:

Installation of 100 mm x 1.5 km pipe
Interconnection of the transmission main 150 mm x 100 mm
Installation of 100 mm air release and blow-off valves,
Installation of 75 mm x 1.0 km pipe
Interconnection of the distribution main 100 mm x 75 mm
Installation of 75 mm air release and blow-off valves

- *Rehabilitation of Distribution Pipeline and Leakage Control*

The rehabilitation of the distribution pipe network includes the following pipelines and appurtenances.

Reconstruction/replacement of 100 mm x 1.3 km pipes
Installation of 100mm air release and blow-off valves

- *Rehabilitation of Service Connections and Metering*

To minimize water wastage and improve water accountability the following rehabilitation works of the service connections will be required.

Repair of service connections:	Total = 620
Installation of new service connections:	Total = 10
Installation of water meters:	Total = 950

- *Rehabilitation of Public Taps*

To maximize service coverage of the water supply system 14 public taps need to be repaired and improved.

H-5 LOS PALOS

a.) General

The people of Los Palos are suffering from water shortage due to existing condition of the water supply facilities attributed to the damages on the pumping facilities caused by the post-referendum violence. Although the current spring source has abundant supply to meet the water requirement of Los Palos the extensive damage on the electro-mechanical facilities of the pumping stations and treatment facilities makes the distribution of water supply to the water consumers in the service area ineffective. As a result, most of the people living in the critical zones of the service area particularly in higher elevations are deprived from piped water supply service. Untreated and limited water supply is rationed to the consumers using 1 of the pumping stations via 1of the 5 distribution mains.

During the survey, SBSR one of the NGO's operating in East Timor is engage in minor repairs of the pipe network. The rehabilitation work being carried out by this NGO is an immediate measure to restore and improve the system and does not consider long-term economic and technical viability of the water supply system development.

b.) Long Term Development Strategy

The long-term development strategy of the water supply system in Los Palos is formulated taking into consideration the following:

- *Future Water Source*

The existing water source of Los Palos located about 1.5 km from the town center produces enough water to supply the water needs of the town's water consumers until the year 2010. For the long-term planning, this abundant water source needs adequate protection to prevent the water from possible contamination and over-exploitation thereby maintaining the beneficial use of the water for the public water supply system of Los Palos.

- *1 Supply Zone + Elevated Service Reservoir*

The service reservoir in Los Palos was constructed to provide adequate storage capable of meeting the daily fluctuations in water demand. It was also constructed high enough to allow gravity flow of water into the system with satisfactory pressure. However, for the year 2003, the existing service reservoir (storage capacity of about 250 m^3) will be insufficient to meet the storage requirement of Los Palos computed as follows:

Required storage = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 1,909 m^3/day

Therefore, storage requirement for 2003 = 1,909 * 8/24 = 636 m^3

Therefore, an additional reservoir with a storage capacity of about 390 m^3 will be required for the year 2003. The location of the existing reservoir is suitable for the above-mentioned gravity system because it is the highest point of the service area and in close proximity to the WTP.

- *Safe and Reliable Water Supply*

The bacteriological characteristics of the water samples from Los Palos revealed the presence of coliform organisms and bacteria in water. This condition indicates that feacal contamination of the water source is evident. To improve the bacterial quality of the water supply making it safe and attractive for the consumers, reactivation of the existing water treatment plant by implementing appropriate rehabilitation works will be necessary. Additionally, installation of chlorine dosing facility will help improve the bacterial characteristics of the water supply.

- *Service Coverage Target*

The household survey conducted by the JICA Study Team during Phase 1 of this study revealed that the current water supply system in Los Palos serves a low percentage of its urban population at about 32%. This condition is attributable to the extensive damaged to the water supply facilities and the inefficient water distribution network. With the proposed rehabilitation works planned to improve the water supply system it is expected that the service coverage ratio will dramatically increase. The JICA Study Team estimated the future service coverage ratio to rise to about 50% and 70, in the year 2003 and 2010, respectively.

c.) Basic Design Criteria For Water Source/Production

To evaluate the viability of the water source in Los Palos, the water demand forecast as discussed in the previous section of this report is used as basis. The water demand forecast for the year 2003 and 2010 is shown in the table below.

Year	**Average Daily Demand**		**Maximum Daily Demand**	
	m^3/day	**L/s**	**m^3/day**	**L/s**
2003	1,591	18	1,909	22
2010	2,585	30	3,102	36

The design of water supply system normally considers the maximum daily demand as the basic criteria for water sources. In the case of Los Palos, the maximum daily demand of 1,909 m3/day or 22 L/s will be the required production rate of the water source for the year 2003.

d.) Scope of Rehabilitation

- *Rehabilitation of Pumping Station No.1 at Kauto (along the main road)*

This pumping station, which is normally supplied raw water by gravity from the spring, distributes untreated water to the town's water consumers. Due to its limited capacity, water is rationed resulting to water shortages in the most critical areas of Los Palos.

With the proposed rehabilitation plan of the WTP and the activation of the elevated water reservoir, this pumping station will be used as stand-by. However, new pumping facilities and generator set will be required to replace the existing equipment. Flow meter and control valves need to be installed.

- *Rehabilitation of Pumping Station No.2 at Papapa (WTP site)*

This pumping station is composed of 2 systems, namely: System 1 pumps raw water to the WTP and System 2 pumps treated water to the elevated reservoir. To activate the whole system including the re-operation of the WTP needs installation of new sets of pumps and generator sets for the above-mentioned purposes. The works include the following:

Raw water pumps including appurtenances: 2 sets (1 duty + 1 standby)
Treated water pumps including appurtenances: 2 sets (1 duty + 1 standby)
Generator and electrical accessories: 1 set

- *Rehabilitation of Water Treatment Plant and Construction of New Ground Reservoir*

To re-activate the existing water treatment plant at Papapa needs expansion of the slow sand filter (additional 1 basin) to increase the production output of treated water. Likewise, the increase in the production of the WTP necessitates additional ground reservoir with the capacity of about 400 m^3 that will serve as collection chamber of treated water for pumping to the elevated reservoir and to augment the water storage deficit. The expansion of the SSF and the construction of the ground reservoir will be carried out within the existing WTP site. It is necessary to securely fence the WTP area in order to minimize possible contamination of the water supply and to restrict human and animal entry.

- *Rehabilitation of the Existing Elevated Service Reservoir*

Minor rehabilitation works will be required on this existing reservoir such as water level gauge, flow meter and controller.

- *Rehabilitation of the Distribution Main and Leakage Control*

The reactivation of the WTP and the construction of an additional reservoir will result to the distribution of sufficient treated water with adequate pressure. The distribution network constructed during the Indonesian Administrative Period has adequate carrying capacity. There remain some unfinished sections of the network that require urgent attention such as interconnections of the pipelines. These outstanding works include the installation of valves and connection fittings to maintain an effective distribution of water. Thorough investigations on the pipe network must be done prior to the interconnections of the old distribution pipes installed during the Portuguese Period as this may create serious maintenance problems. Intensive leakage control and repair has to be carried out to minimize water loss and wastage.

- *Rehabilitation Service Connections and Public Taps*

Rehabilitation of the service connections and public taps include the following:

Repair of the existing service connections:	Total = 500
Installation of new service connections:	Total = 300
Installation of water meters:	Total = 1,100

Repair of public taps: Total = 8

H-6 VIQUEQUE

a.) General

Viqueque is among the towns in East Timor blessed with abundant water supply from Builua Spring all-year round. The water supply facilities of this town suffered minor destruction, which are limited mainly to the water service connections, public taps, office buildings and warehouse. Water leaks and pipe bursts observed on the distribution pipes are attributable to the lack of proper maintenance on the network. Thus, rehabilitation works being carried out on the system by NGO such as FORTE is centered on the minor repairs of the pipelines that will help improve water distribution among the consumers in the service area and minimize water losses.

In as much as most of the rehabilitation works being carried out by the NGO's are aimed for the immediate restoration/improvement of the water supply service, the rehabilitation plan envisioned by the JICA Study Team for Viqueque is focused on a long-term development strategy that will ensure economic and technical viability of the water supply project.

For the next 3 years, the rehabilitation works for Viqueque will include the repairs of the damaged facilities taking into account the effective and even distribution of water to the consumers and possible preparatory works necessary for future expansion of the system.

b.) Long Term Development Strategy

The formulation of the long-term development strategy on the water supply system of Viqueque was done taking into consideration the following aspects.

- *Future Water Source*

The most viable water source for Viqueque is the Builua Spring, which has abundant quantity and acceptable water quality adequately enough to meet the future water requirement of the town. The topographic location of the source has sufficient elevation favorable for a gravity distribution of water to the water consumers. Therefore, it is technically and economically rational to maintain the use of the Builua Spring as the source of the water supply system in Viqueque for the next 3 years and beyond.

- *2 Supply Zones and Flow Control + 1 Reservoir for New Town*

The water supply distribution network of Viqueque should be developed based on a zoning system comprising of 2 supply zones. It is considered practical for the zoning system to adopt the existing geopolitical subdivision such as the old town (south) and the new town (north). To maintain an efficient and even distribution of water it is necessary that appropriate devices should be installed in the distribution such as pressure and flow controller and other necessary appurtenances.

For an efficient distribution of water in the new town providing enough storage to meet the fluctuations in water demand another reservoir is required. The existing reservoir in the old town having a capacity of about 340 m^3 will be insufficient to meet the storage requirement of the 2 zones in Viqueque computed as follows:

Required storage = Water demand (in m^3/day) * 8 hrs storage per day
Where: water demand = 1,774 m^3/day

Therefore, storage requirement for 2003 = 1,774 * 8/24 = 590 m^3

Therefore, the proposed reservoir in the new town should have storage capacity of about 250 m^3. This reservoir should be constructed in a high elevation suitable for a gravity system of water distribution.

Appropriate rehabilitation and realignment of the water distribution network will be required for an effective distribution of water and to allow more control and more convenient operation and maintenance of the network. In such case, more customer satisfaction will be experienced wherein water with adequate pressure will reach the up to the most critical villages of the distribution network such as, Beobe and Olobai in the southeast and western section of the old town, respectively.

- *Safe and Reliable Water Supply*

The increasing human habitation in close proximity to the Builua Spring appears to be threat to the possible contamination of the spring water. To counter this likely occurrence of pollution on the water supply appropriate measures is urgently required to protect the water source. Entry into the water source and if possible to the watershed has to be restricted. The site of water intake area must be securely fenced to completely limit human entry and the presence of domestic animals.

Although the quality of the water source showed acceptable physical and chemical properties, the bacteriological characteristics indicated the presence of microorganisms that may originate from domestic waste. This condition of bacterial pollution could improve and most likely to be eliminated by the installation of chlorine dosing facilities to disinfect the water supply prior to distribution to the water consumers of Viqueque.

- *Service Coverage Target*

As discussed previously, the service coverage ratio of the water supply system in Viqueque serving mostly its urban population in 1998 reached 62%. However, due to the damaged of the water service connections and few other facilities, it is expected that the ratio has dropped down thereby depriving some of the water consumers from piped water supply. With the current improvement being done by the NGO and rehabilitation works proposed for the system in the coming years, it is expected that service coverage ratio will increase to 90% and 100% for the years 2003 and 2010, respectively.

c.) Basic Design Criteria for Water Sources/Production

The basic design criteria for the evaluation of the production capacity of the water sources are normally based on the water demand. As previously discussed earlier, the water demand forecast for Viqueque is tabulated as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,478	17	1,774	21
2010	1,832	21	2,198	25

For the design of the water supply system in Viqueque the maximum daily demand is considered. Therefore, the Builua Spring or any other water source should have a production capacity of about 21 L/s to adequately supply the town's water consumer for the design year 2003.

d.) Scope of Rehabilitation

For the next 3 years, the JICA Study Team proposes the following rehabilitation works of the water supply system in Viqueque.

- *Installation of Security Fence at Builua Spring Intake*

Appropriate measures have to be taken to protect the water source from possible contamination. The people living close to the Builua Spring remains the big threat to the water quality of the spring. This threat can be minimized by the construction of the security fence on the intake site in order to limit human entry and the presence of domestic animals.

- *Rehabilitation of Transmission Main*

A portion of the transmission main that conveys water to the town of Viqueque is vulnerable to damage. At approximately 2 km downstream from the intake the 6 inches main traverses a relatively stiff slope without adequate support. This condition makes the pipes vulnerable to damage especially during rainy season when more soil erosion occurs that may lead the pipeline to collapse.

Realignment of the transmission main in a safe location with adequate protection and support will make it less vulnerable to damage. This work should include the installation of air valves, drains (at 3 points) and pipe bridge crossing on concrete abutment (at 3 places consisting of 40m x 2 and 30m x 1).

- *Rehabilitation of Break Pressure Tank*

This break pressure tank located on a small hill alongside the road requires the construction of adequate security fence to limit human and animal entry that will minimize possible contamination of the water supply and damage to the facilities.

- *Rehabilitation of the Existing Service Reservoir for the Old Town*

The existing service reservoir that will provide enough storage to compensate the water demand fluctuations of the old town is not operational due to the damage of the inlet pipes. Replacement of the damaged inlet pipes and rearrangement of the pipelines to follow the zoning system should be undertaken in this reservoir. This work should also include the installation of flow measuring and control devices and chlorine dosing facilities.

- *Construction of a New Reservoir for the New Town*

Following the establishment of the zoning system, it is necessary to install one new reservoir for water supply storage in the new town. Based on the above computations, the proposed reservoir for the new town water distribution should have storage capacity of about 250 m^3. It is ideal to construct this reservoir at the northern edge of the new town and to be equipped with adequate appurtenances such as flow measuring and control, chlorine dosing and other necessary piping facilities.

- *Rehabilitation of the Distribution Network and Leakage Control*

To maintain satisfactory pressures at every point of the network, it is necessary that the pipelines especially the distribution mains must have sufficient capacity to minimize losses. Based on the network analysis the existing 2-inch and 3-inch distribution mains should be replaced with 75 mm and 100 mm, respectively. Likewise, appropriate gate valves should also be installed. Leakage control and repair must be intensified to minimize water losses and wastage.

- *Rehabilitation of Service Connections and Public Taps*

Rehabilitation of the service connections and public taps include the following:

Repair of the existing service connections:	Total = 430
Installation of new service connections:	Total = 360
Installation of water meters:	Total = 970
Repair of public taps:	Total = 6

H-7 SAME

a.) General

Water supply condition in the town of Same is generally good despite minor damage to few of the facilities such as the elevated water tank at Posto, the distribution mains, service connections, and office buildings. For this reason, international donor agencies and NGO are not implementing any intensive activities for the system's rehabilitation except for the minor repairs on the pipe network being undertaken by the local water district workers under the guidance of UNTAET.

b.) Long Term Development Strategy

The formulation of the long-term development strategy on the water supply system of Same was done taking into consideration the following:

- *Future Water Source*

In the vicinity of the town, there are three existing and highly potential water sources such as Darelau (Carbulau), Kotalala and Merbuti springs. These spring sources produce sufficient yield capable of supplying the water needs of the water consumers in Same up to year 2010. This rehabilitation plan for the Same water supply system is being formulated to take into consideration proper and efficient utilization and maintenance of the existing water sources rather than development of new/additional water source/s.

- *3 Supply Zones*

For an effective operation of the water supply system, zoning of the distribution area will provide various advantages. Aside from a well-organized and even distribution of water to the consumers, it will help improve the monitoring of the system's performance, leakage control and ease in maintenance and operation. The introduction of three (3) supply zones in accordance with the topographic location of the 3 existing sources is found to be the most suitable scheme for Same. Minor improvement works on the pipe network needs to be done since the present set-up already exist. Therefore, this rehabilitation plan with the view of the 3 supply zones is considered the most viable development of the water supply system in Same for the next 3 years and onwards.

- *Safe and Reliable Water Supply*

One of the basic concepts on the rehabilitation plan of the water supply system in Same is the distribution of safe and reliable water supply to the consumers. Since the water quality analysis on the water samples taken from the water sources indicated bacterial contamination, its is therefore necessary that appropriate chlorine dosing facilities be installed in order to disinfect the water prior to distribution to the water users.

- *Service Coverage Target*

Within the urban area of Same there remains about 60% of the town's population not served by the public water supply system and relying mostly on unsafe water supply sources. This large ratio of unserviced population was revealed by the latest survey conducted by the JICA Study Team. The proposed rehabilitation plan of the water supply system is aimed to increase the service coverage ratio of the urban population. It is expected that with the improvement of the system its service area will expand thereby increasing the serve population to about 50% and 70% in 2003 and 2010, respectively.

c.) Basic Design Criteria for Water Sources/Production

The forecasted water demand will be used as basis for the design of the required production capacity for the water sources. As discussed in the foregoing section of this report, the projected water demand for the years 2003 and 2010 is tabulated in the table below.

Year	**Average Daily Demand**		**Maximum Daily Demand**	
	m^3/day	**L/s**	**m^3/day**	**L/s**
2003	1,295	15	1,554	18
2010	2,133	25	2,559	30

For the design of the water supply sources in Same the maximum daily demand is considered. Therefore, the water sources should have a total production capacity of about 18 L/s to adequately supply the town's water consumers for the design year 2003.

d.) Scope of Rehabilitation

- *Rehabilitation of Darelau (Carbulau) Spring Intake*

The existing intake structure constructed on the side of the road leading to Maubisse is neither securely fenced nor adequately protected to restrict human and animal entry. Because of its accessibility from the road, high risk of contamination exists. During the survey excessive quantity of leaves and tree branches were seen floating on the surface of the spring water.

To minimize the risk of water contamination it is necessary to securely fence the intake including the surrounding area of the spring. Appropriate roofing maybe required minimizing maintenance works and damage to the facilities. It is desirable to provide a public tap outside the fenced area to serve the public thereby minimizing the risk of vandalism.

- *Rehabilitation of the Darelau Transmission Main*

Realignment of this transmission main is necessary to prevent pipe damage caused by nature such as falling tree branches and the like. The pipe should be properly installed with appropriate protection especially in river/creek crossing. Proper pipe arrangement is required with the installation of air release and blow-off valves.

- *Rehabilitation of Posto Reservoir*

Since this reservoir has sufficient capacity to provide storage for the water demand in this area, rehabilitation works will include the replacement of the damaged pipework, installation of flow meter, control valve and chlorination facilities.

- *Expansion of Hularua Reservoir*

The Hularua Reservoir serves about 30% of the total water demand in Same with a storage requirement of about 190 m^3. This reservoir having a existing capacity of 30 m3 will be insufficient. It is therefore necessary to install an additional reservoir with a capacity of about 160 m^3 to effectively provide the required water storage volume capable of meeting the fluctuations in water demand. Appropriate pipework will be necessary including flow control and measuring devices and the installation of chlorine dosing equipment.

- *Expansion of Merbati Reservoir*

The Merbati Reservoir serves about half of the water consumers in Same. The existing reservoir having a capacity of 50 m3 is inadequate to provide the total storage requirement of the service area. Therefore this existing reservoir needs expansion by constructing new reservoir with a capacity of about 200 m^3. This proposed reservoir should be equipped with the necessary pipework, flow control and measuring devices and chlorination facilities.

- *Rehabilitation of Distribution Main*

Part of the distribution mains particularly the smaller diameter were damaged during the post-referendum violence. To avoid water loss and wastage it is necessary to repair/replace the damaged section.

- *Rehabilitation of Service Connections and Public Taps*

The rehabilitation works for this component include the installation and repair of the following:

Repair of the existing service connections:	Total = 420
Installation of new service connections:	Total = 260
Installation of water meters:	Total = 680
Rehabilitation of public taps:	Total = 3

3 public taps rehabilitation

H-8 AINARO

a.) General

The workers and technicians of the former BPAM under the guidance of UNTAET, are engaged in minor works of the water supply system such as the repairs of pipe leaks, cleaning of clogged pipelines, and other routine works for operation and maintenance. Any intensive or major rehabilitation and improvement works of the damaged facilities has not been carried so far.

The town, despite the availability of abundant water flow from the Sarai River, has been suffering from chronic water shortage. This condition is attributable to the existing state of the facilities, such as the ineffective function of the water treatment plant and the long period of neglect to the facilities without proper operation and maintenance. This WTP consisting of grit chamber and the slow sand filters facilities is ineffective.

Normally, after rains highly turbid water is drawn from the source through the intake structure into the transmission main and passes through the grit chamber and into the slow sand filters without the desired improvement of the water quality. From the WTP, the "still turbid treated water" then flows into the distribution mains causing pipe blockages brought about by sand and silt deposition in the pipelines.

b.) Long Term Development Strategy

The long-term development strategy of the water supply system in Ainaro will be focused on the effective distribution of treated water from the Sarai River to cover a large portion of the town's urban population. Rehabilitation and improvement works on the WTP including the recruitment and appropriate training of skilled workforce who will efficiently and regularly maintain the operation of the WTP and all other facilities will improve the existing condition of the water supply system. Routine operation and maintenance of the water system especially on the WTP must be strictly followed.

- *Future Water Source*

The Sarai River has abundant flow all-year round capable of supplying the water needs in Ainaro for the next 3 years and beyond. The location of the existing water intake facilities is high enough to permit gravity flow at satisfactory pressures within the service area.

- *Safe and Reliable Water Supply*

The results of the water quality analysis on the samples from Ainaro showed unacceptable bacteriological characteristics of the water as revealed by the presence of

coliform organisms and bacteria. This characteristic of the water indicates possible human contamination.

To improve the water quality of the water supply that will safeguard the health of the water consumers in Ainaro, it is necessary to put back the WTP into operation. However, prior to the re-activation of the existing WTP, rehabilitation works will be required, such as the installation of concrete overflow weir, and butterfly valves. These major improvement works on the WTP and few others on the facilities will help improve its treatment operation. Regular and efficient operation and maintenance works on the WTP and the pipe network will not only help improve the water quality but will also contribute to the preservation on the economic life of the water facilities. Appropriate chlorine dosing devices will also be required to disinfect the water prior to distribution.

- *Service Coverage Target*

In 1998, the water supply system served about 63% of the urban population in Ainaro. The development plan of the water supply system is proposed to serve about 90% and 100% of Ainaro's urban population in the years 2003 and 2010, respectively.

- *Effective Water Distribution Management by 2 Supply Zones*

It is essential to rehabilitate and realign the existing distribution network that will follow 2 supply zones (high and low). The location of the existing reservoirs is suitable for the above arrangement with Reservoir Nos. 1 and 2 serving the storage requirement of the low and high zones, respectively. The pipe network connection will be rearranged accordingly with the proper installation of flow control and measuring devices.

c.) Basic Design Criteria for Water Sources/Production

The water demand forecast as presented in the earlier section of this report will serve as the basis for the evaluation of the water sources and the production capacity. For the planning years 2003 and 2010, the water demand calculations of Ainaro is presented in the table as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	M^3/day	**L/s**	**m^3/day**	**L/s**
2003	854	10	1,025	12
2010	1,096	13	1,316	15

For sound engineering design of the water supply facilities, the maximum daily demand of 1,025 m^3/day will be used for the design criteria of water sources.

d.) Scope of Rehabilitation

- *Repair of Raw Water Transmission Conduit*

During rainy season, heavily turbid surface water runoff enters into the channel from broken concrete covers causing serious problems to the WTP and the pipe network. To improve raw water quality and minimize operational problems in the WTP and pipe network it is necessary to repair/replace broken/leaking concrete covers of the

transmission conduit. Appropriate concrete covers (25 sets: 1000 mm x 350 mm x 50 mm) will be needed for the said rehabilitation work.

The inefficiency of the grit chamber to retain the desired quantity of grit coupled with the large amount of sand coming from the broken concrete covers are the major causes on the degradation of the water quality and pipe blockages. An overflow weir with the dimensions of 300 mm x 300 mm should be installed in one of the concrete wall. This overflow weir and butterfly valves will help maintain the water level in the grit chamber thereby improving settling of the grit. The entry of large quantity of sand could be prevented by the repairs of the broken concrete covers.

- *Rehabilitation of Slow Sand Filters (SSF)*

The inlet pipes to the SSF requires the installation of 2 sets of butterfly valves having a diameter of 150 mm. Routine maintenance of the SSF by washing the filter beds will help improve the water quality. Prior to the distribution of the water supply, disinfection by chlorination will be required. Therefore, chlorine-dosing device need to be installed in the WTP.

- *Rehabilitation of the Distribution Network*

The realignment of the distribution network is required to establish 2 supply zones in the service area. This rehabilitation work includes the following:

Installation of 150 mm x 2.7 km distribution main from Reservoir No. 1
Installation of 150 mm x 1.2 km distribution main from Reservoir No. 2
Installation of 75 mm x 400 m distribution main
Installation of 150 mm x 1 set butterfly valve
Installation of 150 mm x 6 sets gate valve
Installation of 100 mm x 3 sets gate valve
Installation of 100 mm x 2 sets gate valve

- *Rehabilitation of Service Reservoirs*

The existing reservoirs will be used for effective distribution of the treated water from the WTP to the 2 supply zones within the service area. Appropriate rehabilitation works are required in these reservoirs such as pipe realignment including the installation of flow control and measuring devices, water level gauges and appurtenances. The 2 existing reservoirs must be securely fenced to avoid possible water contamination and minimize the risk of damage to the facilities.

- *Installation of Service Connections & Repair of Public Taps*

To minimize water wastage and maximize service coverage it is necessary to carry out the following rehabilitation works.

Installation of new service connections	-	80
Repair of existing service connections	-	400
Repair of damaged public taps	-	4

H-9 AILEU

a.) General

During the survey, it was found out that a Portuguese-funded NGO was engaged in repair work of the pipelines. Thorough investigations revealed that the rehabilitation work being carried out by this NGO is an immediate measure to restore and improve the system and does not consider long-term economic and technical viability on water supply system development.

b.) Long Term Development Strategy

- *Future Water Sources*

The most technically viable water sources with acceptable water quality and with adequate potential capable of supplying the future water needs of the people in Aileu are the Mantane River through infiltration gallery and the Naufaisaran Spring. The assessment made on two other existing surface water (Sloi Kraik and Hularema) showed unstable and undesirable characteristics such that their flow rates drop to a very critical level during dry season and high turbid water is drawn during rainy season.

- *Reliable and Safe Water Supply*

The present system supplies raw water without any form of treatment. This condition poses health risk to the water consumers and in the long run creates possible danger to system due to the accumulation of sand and silt in the network. For the next 3 years, the JICA Study Team proposes a rehabilitation plan of the water supply system delivering safe and reliable water supply to the consumers in Aileu. The utilization of the 2 existing sources at Mantane River Infiltration Gallery and Naufaisaran Spring should be maintained and improved through appropriate rehabilitation work. Two other sources (Sloi Kraik and Hularema) should be stopped because of high turbidity during rainy season and substantial drop in yield to almost nil during dry season.

- *Service Coverage Target*

During the pre-violence period, the water supply system in Aileu serves about 96% of the town's urban population. However, with the current condition of the water supply system especially the non-operation of the infiltration gallery, it is expected that the service coverage had dropped to undesirable level. With the proposed improvement and rehabilitation plan of the water supply system, it is estimated that 100% coverage of the town's urban population will be attained in the year 2003.

c.) Basic Design Criteria for Water Sources/Production

To evaluate the viability of the water sources in terms of its productivity, it is technically sound to use the water demand forecast as basis. The water demand estimates for Aileu calculated for the years 2003 and 2010 is shown as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	968	11	1,161	13

2010	1,064	12	1,277	15

As per the above table, the maximum daily demand of 1,161 m^3/day or 13 L/s is used as the design factor for the water sources in Aileu serving the water requirement up to the planning year 2003. This water demand is to be supplied from the existing sources of Mantane River Infiltration Gallery and Naufaisaran Spring.

d.) Scope of Rehabilitation

For the planning year 2003, the JICA Study Team proposes the rehabilitation of the water supply facilities to include as follows:

- *Rehabilitation of the Mantane River Infiltration Gallery*

To maximize the productivity of the existing gallery appropriate reconstruction works need to be carried out to include as follows:

Installation of the 200 mm x 150 m water collection pipe (with perforation) at a depth of about 2.5 m below ground.
Construction of a new pump pit 2000 mm dia. x 5000 m height
Replacement of the damaged electrical facilities such as the generator, wiring and switchboards
Construction of the security fence

As per the assessment on the mechanical facilities it is assumed that the pumps and its accessories are operational. The existing pump house will be utilized with minor structural repairs such as windows and doors.

- *Construction of New Service Reservoir*

For an efficient distribution of water in the new town providing enough storage to meet the fluctuations in water demand another reservoir is required. The existing reservoirs having a total capacity of about 300 m^3 will be insufficient to meet the storage requirement of Aileu for the year 2003 computed as follows:

Required storage = Water demand (in m^3/day) * 8 hrs storage per day

where: water demand = 1,161 m^3/day

Therefore, storage requirement for 2003 = 1,161 * 8/24 = 385 m^3

The storage deficit of about 85 m^3, could be rectified by the construction of additional reservoir. The proposed reservoir should be constructed adjacent to the existing because it is located on an area high enough to permit gravity flow of water to the service area.

- *Rehabilitation of the Distribution Network and Leakage Control and Repair*

Based on the pipe network analysis, the distribution main serving the government housing estate has insufficient capacity. Therefore, this existing main needs to be upgraded to diameter 3 in. to attain an efficient distribution of water. Although the analysis of other distribution mains revealed sufficient capacity, rehabilitations works will be required to include the installation of appropriate valves and the repair of broken/leaking sections.

- *Repair and Installation of Service Connections and Public Taps*

To maximize water service coverage of the urban population in Aileu, it is necessary to undertake rehabilitation works in the service area to include the following:

Installation of new service connections	-	80
Repair of existing service connections	-	430
Repair of public taps	-	4

4 public taps to be repaired

- *Rehabilitation of Sloi Kraik and Hularema Water Sources*

These 2 existing sources will be disconnected from the town water supply by appropriate valves to serve an independent community-based water supply system. Minor rehabilitation works will be necessary especially on the pipe network and the installation of chlorine dosing equipment. Installation of more public taps may seem suitable for this scheme rather than individual water service connections.

H-10 MAUBISSE

a.) General

During the survey, the JICA Study Team found out that no major rehabilitation work on the water supply system is taking place in Maubisse except for minor repair work (of poor workmanship and unacceptable standard) being done by the workers of the former BPAM. Thorough investigations carried out by the team revealed that the facilities is in a state of deterioration due to the absence of regular maintenance and that major damage to few of the facilities were left unattended. Water supply of limited quantity and occasionally unacceptable quality is distributed to the town's water users by rationing. It is essential to formulate rehabilitation plan for the Maubisse water supply system that will result to the delivery of an efficient, safe and reliable water supply to the town's water consumers.

b.) Long Term Development Strategy

- *Future Water Sources*

Only 3 (Erulu, Raikuak Ulun, and Bucana) out of the four existing water sources in Maubisse have reliable flow even during the dry season. During the survey, the total accumulated flow of the above-named sources is approximately 4 L/s, which is sufficient to supply the town's urban population up to the year 2003. Beyond 2003, alternative/additional water source/s has to be investigated to meet the increase in water demand. A comprehensive water resources study will be required that will satisfy the technical and economic consideration of the possible water source for Maubisse.

- *Separate Supply Zones*

Due to its topographical configuration, the existing water network in Maubisse is divided into 4 independent zones supplied from 4 different sources located at various points of the town. Although, this system appeared suitable for a small town like Maubisse having rugged topographical characteristics, problems are occuring from

illegal connections tapped by the residents on the transmission mains. This condition (particularly the Bucana transmission) causes pressure drop and losses before the water could reach the storage reservoirs. The JICA Study Team proposes the rehabilitation plan of the water supply system that clearly specifies the functions of transmission and distribution pipelines. The existing water supply system scheme of separate supply zones will be maintained.

- *Efficient Water Supply Distribution and Leakage Control*

The rehabilitation plan of the water supply system in Maubisse is focused on the efficient and even distribution of water to the water consumers. Illegal water service connection will be prohibited especially on the transmission mains in order to allow water to flow freely into the distribution reservoirs thereby minimizing head loss and water wastage. Abstraction of water through service connections will be allowed from the reticulation/ distribution network. Likewise, the numerous pipe leaks observed on the distribution network and service connections must be urgently attended and fixed. This exercise will be extensively carried by the local water district workforce under the guidance and support from the ETTA.

- *Service Coverage Target*

In 1998, the water supply system of Maubisse was serving 48% of its urban population. It is expected that the service coverage had dropped to low level mainly due to the deterioration of the water supply facilities coupled with the lack of routine maintenance especially the ill-effects brought about by the post–referendum violence.

The proposed rehabilitation plan of the water supply system aims to increase the service coverage at 70% and 80% for the years 2003 and 2010, respectively.

c.) Basic Design Criteria for Water Sources/Production

To evaluate the viability of the water sources in terms of productivity, the water demand forecast is used as basis. The water demand estimates for Maubisse calculated for the years 2003 and 2010 is shown in the table below.

Year	**Average Daily Demand**		**Maximum Daily Demand**	
	m^3/day	**L/s**	**m^3/day**	**L/s**
2003	297	3	356	4
2010	410	5	492	6

As per the above table, the maximum daily demand of 356 m^3/day or 4 L/s is used as the design factor for the water sources in Maubisse serving the water requirement up to the planning year 2003. This water demand is to be supplied from the 3 existing sources such as Erulu, Raikuak Ulun and Bucana.

d.) Scope of Rehabilitation

- *Rehabilitation of the Intake Structure at Erulu Spring + Transmission Main*

During the survey, water from this source never reached the town's service reservoir due to the broken section of the transmission main. Water was just wasted into a vacant land

adjacent to the intake area thus forming a temporary pond of water. The rehabilitation work proposed in Erulu include the following:

Repair of the damaged transmission main dia. 4" GSP
Construction of the security fence around the intake area
Construction of adequate drainage facilities
Installation of a public tap outside the fenced area

- *Rehabilitation of the Service Reservoir at Erulu Spring*

The existing town reservoir supplied by the Erulu Spring has sufficient capacity enough to provide water storage for the town zone up to year 2003. Therefore, the rehabilitation plan for this reservoir will be to the installation of the chlorine dosing facilities, flow control and measuring devices, water level indicator and appropriate piping for drain and ventilation. To restrict human and animal entry the reservoir area must be securely fenced. Construction of the drainage facilities in this area will prevent/minimize contamination of the water source.

- *Rehabilitation of the Transmission Main from Bucana Spring to Pousada Reservoir*

As discussed earlier, withdrawal of water supply through illegal connections are taking place from this transmission main before water reaches the Pousada Reservoir. As a result, considerable amount of water wastage and pressure loss is occurring in the pipeline. To have an efficient distribution of water to the town particularly those consumers located in the high zone, the existing pipeline should be abandoned and replaced. This new transmission main of diameter 3 in. x 1.7 km GSP should be installed below ground level with a minimum earth cover of about 800 mm.

- *Rehabilitation of the Pousada Reservoir*

The Bucana water source has an estimated yield of about 0.7 L/s or 60 m^3/day. To store water coming from the source that could compensate water storage of 8 hours per day, the capacity of the reservoir should be as follows:

Required storage = 60 m3/day * 8/24 = 20 m^3

The capacity of the existing reservoir = 23 m^3

Therefore, the existing reservoir has sufficient capacity and does not require expansion. The rehabilitation work needed for this reservoir will be the installation of chlorine dosing equipment, flow control and measuring devices, water level gauge, ventilation and drain pipe.

- *Rehabilitation of Distribution Main from Pousada to Town Center*

Due to the numerous leaks and damages on the existing distribution main replacement may prove economically and technically viable. The following pipe reconstruction works will be necessary:

Installation of 75 mm x 700 m pipe complete with valves and appurtenances
Installation of 50 mm x 500 m pipe complete with valves and appurtenances

- *Rehabilitation of Raikuak Ulun Intake Facilities*

Rehabilitation of the intake facilities for Raikuak Ulun include the following:

Construction of the collection chamber: 2.0 m x 3.0 m x 1.50 m
Construction of the concrete weir: 5.0 m width x 2.5 m height
Installation of intake pipes (with perforation): 75 mm x 15 m
Construction of the security fence around the intake area

The intake pipes should be constructed in gravel bedded layer of media that would allow maximum infiltration of clear water into the pipe. The spring intake area should be covered with steel wire mesh to prevent the entry of foreign matters that may lead to the contamination of water and create pipe blockages. The unauthorized human and animal entry will be restricted by the construction of security fence.

- *Rehabilitation of the Transmission Main from Raikuak Ulun to Leputo Reservoir*

The portion (approximately 100 m) of this transmission line should be replaced from the existing 2 in. by a new 75 mm and equipped with necessary appurtenances such as air release, gate valves, and blow-off valves.

- *Rehabilitation of the Leputo Reservoir*

The Raikuak Ulun water source has an estimated yield of about 1.7 L/s or 146.9 m^3/day. To store water coming from the source that could compensate water storage of 8 hours per day, the capacity of the reservoir should be as follows:

Required storage = 146.98 m3/day * 8/24 = 49 m^3

The capacity of the existing reservoir = 20 m^3

Therefore, an additional reservoir with a capacity of about 30 m^3 will be required. The rehabilitation works will include the installation of chlorine dosage equipment, flow control and measuring devices, water level gauge, drain and ventilation. The construction of the security fence will be necessary to protect the water supply.

- *Rehabilitation of the Service Connection and Public Tap*

To minimize water wastage and maximize service coverage in Maubisse the following rehabilitation works will be required:

Installation of new service connections	140
Installation of new public taps	2
Repair of damaged public taps	8

H-11 GLENO

a.) General

The workers and technicians of the former BPAM with the support from UNTAET and NGOs are engaged in repairs of pipe leaks on the distribution network and remedial works to the damaged transmission mains. However, due to the limited resources and

lack of expertise, the current workforce could not carry out major rehabilitation works such as the repair of the damaged Mota Boot intake facilities and transmission pipelines, which is main source of water supply to the town. Thus, water shortage is experienced by most of the water consumers in Gleno. Additionally, interruptions to the operation of the WTP normally occur due to the limited manpower and resources. In most cases, the untreated and limited water supply is rationed to the water users.

b.) Long Term Development Strategy

The long-term development strategy of the water supply system in Gleno will be focused on the reliability of the water sources including its facilities and the effective operation of the WTP.

- *Future Water Source*

Mota Boot and Mota Kiik have abundant flow all-year round capable of supplying the water needs in Gleno for the next 3 years and beyond. The locations of the existing water intake facilities are high enough to permit gravity flow of raw water to the WTP. The Ergrogo spring will be abandoned because the flow is subject to seasonal fluctuations, which in extreme cases becomes dry during dry season. Moreover, the intake structures and transmission mains are in constant repair due to damages caused by landslides and floodwaters.

- *Safe and Reliable Water Supply*

The inactivity of the WTP and non-chlorination of the water supply are the major causes of the unacceptable characteristics (particularly turbidity and bacteriological properties) on the water supply of Gleno. To improve the water quality, the JICA Study Team proposes the rehabilitation plan of the slow sand filter including chlorination of the water supply prior to distribution.

- *Service Coverage Target*

In 1998, the water supply system served about 73% of the urban population in Gleno. It is estimated that with the proposed development plan of the water supply system, the served population will increase to about 90% and 100% in the years 2003 and 2010, respectively.

- *Effective Water Distribution by Expansion of the Existing Reservoirs*

The existing reservoirs in Gleno (total capacity = 200 m^3) are insufficient to meet present and future water storage requirement. For the design year 2003, the total required storage volume is computed as follows:

Required storage for 2003 = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 1409 m^3/day

Therefore, required storage for 2003 = 1,409 * 8/24 = 470 m^3

The above computations indicate that there is a storage deficit of about 270 m^3. Therefore, it is essential to expand the existing reservoir by constructing a new

additional storage tank with a capacity of 300 m^3. This construction will include the installation of additional distribution main and the realignment of the existing pipelines.

c.) Basic Design Criteria for Water Sources/Production

The water demand forecast as presented in the earlier section of this report serves as the basis for the evaluation of the water sources and the production capacity. For the planning years 2003 and 2010, the water demand calculations of Gleno is presented in the table as follows:

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,174	14	1,409	16
2010	1,524	18	1,829	21

The daily maximum water demand of 1,409 m^3/day or 16 L/s is used as basis for the design of the water sources and the WTP production rate for the year 2003.

d.) Scope of Rehabilitation

- *Rehabilitation of the Mota Boot Water Intake and Transmission Main*

The existing Mota Boot intake facilities and transmission mains are currently out of use due to the extensive damage caused by landslide and floodwaters. Rehabilitation of the existing intake facilities and repair to the transmission main will be necessary to draw sufficient raw water for treatment. The proposed intake structures and transmission mains should be properly constructed with adequate protection in safe places to make them less vulnerable to damage. The rehabilitation works include the following:

Construction of the collection chamber: 5.0 m x 3.0 m x 1.50 mm
Construction of the concrete weir: 7.0 m width x 2.50 m height
Installation of intake pipes (with perforation): 150 mm x 15 m
Repair of 150 mm transmission main
Construction of the security fence around the intake area

- *Rehabilitation of Slow Sand Filters (SSF)*

The existing WTP frequently breaks down due inefficient operation and lack of routine maintenance. Large volume of grit, sand and other debris are accumulated in the filters causing problems to the treatment process and blockages to the piping system. This operational problem could be rectified by routine maintenance of the SSF through washing of the filter beds and the installation of flow control devices. Prior to the distribution of the water supply, disinfection by chlorination will be required. The chlorine-dosing device should be installed in the treated water chamber prior to the existing reservoirs.

- *Construction of Additional Service Reservoirs*

To rectify the water storage deficit calculated earlier, it is necessary to install an additional reservoir having a capacity of 300 m^3. The present location of the existing storage tanks is suitable for the proposed reservoir since it is high enough to permit

gravity flow of water to the service area. The construction of the new reservoir will include appurtenances such as, inlet weir, and ventilation; overflow pipe, drain, and flow control and measuring devices and chlorine-dosing equipment. To avoid the possibility of water contamination, human and animal entry could be restricted by the construction of security fence around the WTP and reservoir site.

- *Rehabilitation of the Distribution Main*

The existing distribution main in Gleno will be insufficient for the future expansion of the service area and the expected increase in water demand. For the next 3 years, the rehabilitation of plan includes the installation of additional pipes 150 mm and 100 mm that will be used for distribution of water supply to the new service area.

H-12 ERMERA

a.) General

During the survey, international NGO such as ACF was undertaking rehabilitation works on the damaged distribution pipe network in Ermera. Due to the scarcity of water in the area, technical and logistical assistance is provided to the local residents by giving them hand-pumps in order to obtain water abstracted from shallow groundwater wells. These humanitarian activities provided by the NGO are expected to improve significantly the current poor water supply condition in Ermera.

In consideration to the improvement activities provided by ACF, the JICA Study Team proposes rehabilitation works that will cater for the long-term (design year 2003) water requirement of the urban population in Ermera.

b.) Long Term Development Strategy

The long-term development strategy for the improvement of the water supply system in this town will focus on the following basic issues.

- *Future Water Source*

The Ermera water supply system currently relies on 3 spring sources having limited yield that significantly drops during the dry season. This unreliable water sources are not technically and economically viable for the future water needs of Ermera's urban population. Based on the water resources investigation conducted by the JICA Study Team, the most viable source having adequate potential and of reasonable distance to the service area is the Mota Bora River.

To supply the current and future water needs of Ermera, it is necessary to construct new intake facilities on this river. The intake facilities should be constructed high enough (about 6 km upstream from the town) in order to allow gravity flow of water to the distribution center. The existing Ersoi and Lubulala springs will continue to operate with minor rehabilitation works while the Mota Bura spring will be abandoned.

- *Safe and Reliable Water Supply*

Water analysis conducted on the water samples collected from the water sources in Ermera revealed possible human contamination as indicated by the presence of coliform organisms and bacteria. The development of the new source in sufficient quantity such as the Mota Bora River and to be equipped with water treatment unit (slow sand filter) and chlorination facilities will help minimize the possible outbreak of water-borne diseases in Ermera.

- *Service Coverage Target*

According to the household survey conducted by the JICA Study Team in May to June 2000, the water supply system of Ermera recorded the lowest service coverage ratio of its urban population at 13% for the year 1998. The proposed rehabilitation works of the water supply system will lead to the increase in the served population. For the design years 2003 and 2010, the service coverage ratio is estimated to rise in 2003 and 2010 at 50% and 70%, respectively.

c.) Basic Design Criteria for Water Sources/Production

Water demand forecast discussed in the preceding section will serve as the basic design criteria of the water sources in Ermera for the design years 2003 and 2010, shown in the table below.

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	356	4	428	5
2010	599	7	719	8

Based on the table above the maximum daily demand of 428 m^3/day or 5 L/s is the basic design criteria for the water sources in the next 3 years.

d.) Scope of Rehabilitation

For the next 3 years, the JICA Study Team proposes the following rehabilitation works of the water supply system in Ermera.

- *Rehabilitation of the Existing Intake Facilities for Ersoi and Lubulala Springs*

The existing spring intake facilities are always subjected to natural damage especially during rainy season because they were constructed in unsafe locations where erosion and flooding are normally taking place. The structures were constructed below standard and without adequate protection. The rehabilitation works proposed for the intake facilities include the reconstruction of the intake structures to be built in safe places with adequate protection to make them less vulnerable to damage. The works include the construction of 2 collection chambers (2000 mm x 3000 mm x 1500 mm) and inlet pipes of diameter 2 inches.

- *Construction of New Intake Facilities for Mota Bora*

The proposed source at Mota Bora will be constructed with new intake facilities to include the following:

Construction of concrete weir, 7.0 m width x 1.5 m height
Construction of grit chamber, 2.0 m x 2.0 m x 1.5 m
Installation of intake pipes with perforation, 100 mm

- *Installation of Raw Water Transmission Main*

With the proposed additional water source at Mota Bora, installation of a new transmission main will be required. This 100 mm x 6 km transmission main will be installed from the intake structure up to the service area complete with the necessary appurtenances, such as, air release valves, gate valves and blow-off.

- *Construction of New Water Treatment Plant*

The proposed new water source will require water treatment plant facility that will treat the water prior to distribution. This project include the following:

Land acquisition with the required area of 50 m x 40 m
Construction of slow sand filter: 6 m x 8 m (2 basins)
Construction of filtered water chamber: 3 m x 5 m x 2.5 m
Installation of chlorine dosing equipment (manual type)
Installation of flow control and measuring devices
Installation of appropriate pipelines (75 mm x 100 mm) and valves
Construction of operator/staff house
Construction of security fencing and other accessories

- *Construction of New Service Reservoir*

To provide adequate water storage capable of meeting the daily fluctuations in water demand, it is necessary to construct a new reservoir close to the service center at an elevation high enough to permit gravity flow of water. This 80 m3 capacity reservoir will be equipped with flow measuring and control devices, water level gauge, ventilation and drain pipe. In order to minimize human and animal entry into the facility appropriate security fence need to be constructed.

- *Installation of Additional Distribution Mains*

A new 100 mm x 1.0 km distribution main will be necessary to effectively distribute water to the water consumers in the service area.

- *Rehabilitation of Service Connections and Public Taps*

To maximize service coverage of the water supply system, the following rehabilitation works are necessary:

Repairs of damaged service connections	60
Installation of new service connections	270
Installation of water meters	330
Repair of existing public taps	5

H-13 LIQUICA

a.) General

Severe water shortage is endangering the people's life in Liquica. Although, there are a total of 12 water sources (8 abstractions from various intake points of 3 major rivers + 4 wells) developed during the Portuguese and Indonesian Administrative periods, most of them are out of operation and require major rehabilitation due to damages caused by natural disaster and vandalism.

International NGO's notably Oxfam carried out repair and development works on some of the damaged water sources. Although there are failures in some aspect of their rehabilitation program (such as the attempt to operate Maumeta 2 deep well), they succeeded on few others in getting them back to operation producing insufficient water supply rationed to the water consumers. With the limited resources and technical expertise, the current rehabilitation projects carried out by the NGO and local workforce are merely urgent and immediate repair to restore back the system. A lot more remains to be done to improve the water supply system that will serve the people of Liquica with sufficient, safe and reliable water supply. Thus, the JICA Study Team proposes the rehabilitation plan of the water supply system in Liquica to improve the current situation until the year 2003.

b.) Long Term Development Strategy

- *Future Water Source*

The 2 water intakes (Daulo and Eanlua) that abstract water from Goularlua River and the Emilalua intake from Carbutaeloa River are the existing water sources with adequate potential capable of meeting the current and future water demand in Liquica. The above-mentioned water sources with relatively large catchment area have substantial flow less affected by seasonal fluctuations compared to the 5 other water sources that normally decreases substantially during dry season.

The groundwater reservoir in Liquica has limited potential that could augment water production from the rivers. The alluvial plain of the Goularlua River where the 4 existing deep wells were constructed is the most viable location for groundwater abstraction.

In the course of the study, 2 of the existing deepwells (Maumeta 1 & 2) were rehabilitated to augment the water production from the surface water sources. However, because the rehabilitation of Maumeta 1 & 2 was not successful, 2 new wells were constructed on the site about 1 km from the existing. The capacity of the 4 existing wells in Liquica is limited and subject to seasonal fluctuations. The 2 other wells (Dato 1 & 2) will be abandoned because of the serious damaged on the boreholes.

- *Effective Water Distribution Via 2 Supply Zones*

As the town stretches on a slope at an altitude between 10m to 120m above mean sea level, it is appropriate to divide the service area into two supply zones; high and low zones. In each supply zone, water will be distributed via the existing service reservoirs at Mean and Raitogoto serving as supply centers for the high and the low zones, respectively. Water supply to the Mean Reservoir will be coming from Eanloa and Daulo intakes, while that of Raitogoto from the Emilaloa intake. Chlorination of the water supply will be done on these reservoirs prior to distribution. The existing Maumeta service reservoir will also function as one of the main reservoirs in the low

supply zone.

Water production from the deep wells will be pumped into the Mean Reservoir to serve mainly the water users from the high zone, although interconnection of the distribution pipeline should be carried out to counterbalance the possible fluctuations in water demand between the 2 zones. The operation of the deep wells maybe limited during the rainy season since more production is expected from the surface water sources.

With minor improvement especially to the interconnection of the distribution mains, the existing pipe network has adequate conveyance capacity until 2010.

- *Safe and Reliable Water Supply*

The proposed rehabilitation plan of the existing water supply system is focused on the efficient distribution of safe and reliable water supply to the water consumers in Liquica. The plan includes improvement to the existing intake and transmission facilities of the 3 surface water sources and rehabilitation/construction of deep wells in order to produce sufficient water capable of meeting the water needs of the urban population. Chlorination of the water supply prior to distribution will help improve the properties of the water particularly the bacteriological characteristics thereby minimizing the risk of outbreak for water-borne diseases in the town.

- *Service Coverage Target*

The proposed improvement plan of the existing water supply facilities will likely lead to the increase in served population. More people will be inclined to be served by the system through individual service connections and public taps. The service coverage ratio is estimated to increase from a low 35% to 70% and 80% in the years 2003 and 2010, respectively. Under any circumstances, it is not desirable to rapidly expand the service area without appropriate rehabilitation works of the water supply facilities and the development of reliable water sources.

c.) Basic Design Criteria for Water Sources/Production and Reservoir Storage Capacity

The water demand forecast in Liquica for the design years 2003 and 2010 is shown in the table below.

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,874	22	2,249	26
2010	2,465	29	2,958	34

Based on the above table the maximum daily demand of 2,249 m^3/day or 26 L/s will be used as basic design criteria for the water sources and its production capacity in the year 2003.

The existing reservoirs have total storage capacity of about 550 m3. Assuming an 8-hr water storage required to meet the fluctuations in water demand, the total required storage volume for the year 2003 is computed as follows:

Required storage = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 2,249 m^3/day

Therefore, storage requirement for 2003 = 2,249 * 8/24 = 750 m^3

Thus an additional storage reservoir with the capacity of 200 m^3 will be required to supply the high zone for the design year 2003.

d.) Scope of Rehabilitation

For the design year 2003, the JICA Study Team proposes the following rehabilitation works for the water supply facilities in Liquica.

- *Rehabilitation of the Existing Intakes @ Daulo, Eanloa and Emilaloa*

The existing intake facilities for the above sources are often subjected to natural damage especially during rainy season because they were constructed in unsafe locations where erosion and flooding normally occur. The structures were constructed below standard and without adequate protection. The rehabilitation works proposed for Daulo and Eanlua include the reconstruction of the intake structures to be built in safe places with adequate protection to make them less vulnerable to damage. The works include the construction of intake weirs and collection chambers and the installation inlet pipes and transmission mains.

Oxfam recently carried out rehabilitation works to the existing Emilaloa intake structure. For the next 3 years, JICA proposes additional development works that will help improve the existing condition of this water source. The work includes the installation of screen at the intake chamber and the construction of the transmission mains 150 mm x 4 km from the intake up to the Raitogoto Reservoir.

- *Construction of Additional Deep Well*

To augment the existing capacity of the water sources especially during the dry season, it is necessary to construct 1 additional deep well with the design production capacity of 5 L/s at the Goularlua alluvial plain. The unreliability of the surface water sources during the dry season will require additional water supply from the deepwell. This work includes the following:

Geophysical survey with a coverage area of about 2 km^2
Well construction including installation of pumps and pumping tests
Installation of pipelines 75 mm
Construction of pumping station to include the electro-mechanical facilities and other necessary appurtenances

- *Installation of New Transmission Main*

The proposed additional deep well will require transmission pipeline that will be used to convey water pumped from the well up into the Mean Reservoir. The pipe-laying work includes installation of 150 mm x 1.5 km pipes, valves and fittings, air release valves, blow-off and other necessary appurtenances.

- *Installation of Distribution Main and Leakage Control*

The establishment of 2 supply zones in the service area will require the installation of

distribution main 150 mm x 5 km and 100 mm x 4.0 km to supply the high and low zones, respectively. Appropriate appurtenances will be included in this activity such as installation of flow control, air release and blow-off valves and other devices.

- *Expansion of Service Reservoirs at Raitogoto*

For an efficient distribution of water supply to the town's water users, taking into consideration the hourly fluctuations in water demand it is necessary to expand the existing Raitogoto Reservoir. The present location of Raitogoto storage tank is suitable for the proposed reservoir (capacity = 140 m^3) since it is high enough to allow gravity flow of water to the high zone. The construction of the new reservoir will include appurtenances such as, inlet weir, and ventilation; overflow pipe, drain, and flow control and measuring devices and chlorine-dosing equipment. To avoid the possibility of water contamination, human and animal entry could be restricted by the construction of security fence around the 2-reservoir site.

- *Rehabilitation of Service Connections and Public Taps*

The expected increase in water production and improvement of the water supply service will lead to an increase in water demand through individual service connections and public taps. Because of the unsatisfactory condition of these existing facilities, rehabilitation and repair works are necessary to minimize water losses and wastage. This water service improvement project include the following:

Repair of the existing service connections	450
Installation of new service connections	580
Installation of water meters	1,030
Repair of public taps repair	12

H-14 SUAI

a.) General

During the survey, it was found out that international agencies and NGOs like Oxfam, USAID, AusAID, Bia Hula, have worked collectively to restore the water supply system in Suai. With their logistical and technical support, the existing deep wells, pumping facilities and several public taps are currently in operation. However, with the daily and short operational period of the pumping facilities, water rationing is still experienced by the town's water users. Water shortage is still prevailing in Suai particularly the critical areas of the distribution network such as the western and southern part of the town. This situation is aggravated by the substantial decrease in water production from the surface water sources during the dry season.

To alleviate the present condition of the water consumers in this part of the region, the JICA Study Team had proposed the rehabilitation plan of the water supply system for the next 3 years.

b.) Long Term Development Strategy

- *Future Water Source*

Based on previous reports and the survey made by the local counterpart team, the

possible water sources in the area with adequate and reliable potential will be supplied from groundwater sources by deep well abstraction. The spring and surface water sources located in northern mountain area substantially decrease in flow during the dry season. Although operation of the pumps is energy intensive and will incur high recurrent cost, groundwater abstraction through deep wells is considered technically viable because of its adequate and reliable potential. Previous studies and the current JICA water resources study had recommended the Sukabilaran well field where the existing deep well sources (Sukabilaran 1 and 2) are located as the most suitable area with potential groundwater storage to supply the current and future water needs of Suai.

- *2 Supply Zones*

The present zoning system (composed of 2 major supply zones) is considered appropriate for Suai up to the year 2003. The water consumers are supplied from two storage reservoirs, namely: Hospital Reservoir located at the town center and Leogore on top of the hill. This system operates wherein all groundwater supply is pumped into the Hospital Reservoir for most of the town's water supply consumers at the low zone and the spring and surface water sources flow by gravity into the Leogore Reservoir through the Bereluik Reservoirs to supply the water users located at the high zone of the town. However, water production from the spring and surface water sources is sensitive to seasonal fluctuations that normally drop substantially during the dry season. In addition the transmission mains are vulnerable to natural damage affecting the water production from these sources during the rainy season. In most cases, supply to the Leogore Reservoir is augmented from the Hospital through booster pump.

Efficient and reliable water supply distribution based on the existing scheme will be effective if sufficient quantity of water is produced by the water sources. Water consumers located high above Leogure will be directly supplied from the Bereluik Reservoirs 1 & 2.

- *Safe and Reliable Water Supply*

To safeguard the health of the water consumers in Suai from possible infection of water-borne diseases, it is necessary to install chlorine dosing facilities in the water system in order to disinfect the water supply prior to distribution.

- *Service Coverage Target*

The proposed rehabilitation plan of the water supply system will lead to the increase of the served urban population in Suai. It is estimated that the service coverage ratio will rise to about 70% and 80% in the years 2003 and 2010, respectively.

- *Effective Water Supply Distribution and Leakage Control*

To effectively distribute water supply to the consumers in Suai appropriate improvement/rehabilitation works will be necessary such as the repairs of the damage transmission mains and distribution network. Water wastage and losses should be maintained in a low level through leakage control and repair and routine maintenance of the system. Valve arrangement on the distribution network should be given equal importance to attain smooth operation and monitoring of the network.

c.) Basic Design Criteria for Water Sources/Production

For the evaluation and design of the water sources, the water demand forecast as

discussed previously is used as basis. The projected water demand for Suai for the years 2003 and 2010 is shown in the table below.

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,589	18	1,907	22
2010	2,126	25	2,551	30

Based on the above table the water sources in Suai should produce a total output of 1,907 m3/day or 22 L/s in the year 2003.

d.) Scope of Rehabilitation

To save operational cost during the rainy season, the operation of the deep wells should be limited. A large portion of the town's water requirement must be supplied from the surface and spring sources (Ameriko, Maugusu and Olivio) yielding sufficient water during the rainy season. Rehabilitation works will be necessary on these sources in order to attain maximum their productivity. On the other hand, rehabilitation of the Kuluai water source may not be economically and technically viable due to the extensive damage to the transmission main, its relatively far distance and the vulnerability of the pipelines to damage.

- *Rehabilitation of Sukabilaran No. 1*

As per the evaluation made on the existing pumping facilities and generator set, it is more practical and economically viable to replace these equipments because they had lapsed their economic life. A new set of pumps and generator set complete with the necessary control panel and accessories will be required in order to attain an efficient operation.

- *Rehabilitation of Sukabilaran No. 2*

The extensive damage caused by the post-referendum violence to the pumping facilities and the electro-mechanical equipment had rendered this deep well unproductive. However, through the effort made by the PKF, this well has been put back into operation on temporary basis. A mobile pumping equipment and generator set are used to draw water from this deep well and pumped into the water truck for distribution to the water consumers in Suai. To permanently put back this well into productive use, rehabilitation works will be required such as the following:

Installation of the pumping facilities
Installation of the generator set
Installation of the control panel and other accessories
Refurbishment of the pump house

- *Construction of a New Deep Well*

Based on previous studies, it was revealed that the Sukabilaran well field has the most adequate groundwater potential that could supply the current and future water needs in Suai. It is proposed that a new deep well needs to be constructed in this area to augment the water production of the existing sources. The water resource development work

includes the following activities.

Geophysical survey of the Sukabilaran well field
Well construction and pumping tests
Installation of the pumping facilities and other electro-mechanical equipment
Construction of the pumping station and other ground development work

- *Installation of the New Transmission Main*

Water drawn from the new deep well will be pumped into the Leogore Reservoir. This proposed scheme requires the installation of new transmission main 75 mm x 1.3 km length complete with flow measuring and control devices.

- *Expansion of the Hospital Reservoir*

The total storage requirement for Suai is computed as follows:

Required storage = Water demand (in m^3/day) * 8 hrs storage per day

Where: water demand = 1,907 m^3/day * 45 % (assumed water demand in low zone)

Therefore, storage requirement for 2003 = 858 * 8/24 = 286 m^3

The storage capacity of the existing Hospital Reservoir (196 m^3) is insufficient to meet the daily fluctuations in water demand. An additional circular tank with capacity of 100 m^3 will be necessary to provide enough storage. This proposed reservoir should be equipped with flow measuring and control devices, water level gauge, ventilation and drain. Pipe interconnections to the existing network should also be carried out.

- *Expansion of the Leogore Reservoir*

Water drawn from the proposed deep well will be pumped directly into this proposed reservoir to be constructed adjacent to the existing tank. This reservoir will have a capacity of about 20 m^3 and to be equipped with flow measuring and control devices, water level gauge, ventilation and drain. Pipe interconnections to the existing network should also be carried out.

- *Rehabilitation of Service Connections and Public Taps*

To maximize service coverage of the water supply system, it is necessary to rehabilitate and improve the following connections and public taps:

Repair of existing service connections including water meter installation	250
Installation of new service connections including water meter installation	360
Repair of damaged public taps	4

H-15 MALIANA

a.) General

During the survey, it was found out that NGOs like Oxfam, Bia Hula and the PKF were carrying out rehabilitation works on the water supply system of Maliana. These works,

which include the supply of the emergency generators for the pumping stations, repair of damaged pipelines, mobile type WTP and others maybe considered urgent improvement activities to restore the town's water supply system. The JICA Study Team proposes the rehabilitation plan of the water supply system taking into account the present condition of the facilities with the evaluation and recommendation of the most viable improvement projects capable of meeting the present and future water requirement of Maliana.

b.) Long-term Development Strategy

The long-term development strategy for the improvement of the water supply system in Maliana will focus on the following basic issues.

- *Future Water Source*

Except for the Aikumu and the Colegio water sources, the water resources investigations revealed that all other water sources in Maliana such as Beremau, Dabucci Springs (Dabucci, Beapelu and Beamos) and the irrigation canal have sufficient yield to supply the future water needs of the town's urban population.

- *Safe and Reliable Water Supply*

The proposed rehabilitation plan includes improvement to the existing WTP and installation of chlorination facilities that will disinfect the water supply prior to distribution.

- *Effective Water Distribution by 2 Supply Zones*

The existing water supply distribution in Maliana operates through 2 major supply zones, high and low zones. The network is basically designed following the topography of the town. Distribution reservoirs were strategically constructed in high elevation to permit gravity flow of water to the consumers. Production of treated water from the WTP is pumped into the higher elevation Sta. Cruz Reservoir for distribution. The proposed rehabilitation plan will maintain the existing water distribution network with additional reservoir.

- *Service Coverage Target*

With the proposed rehabilitation and improvement project of the water supply system, it is expected that more people will rely on the public water supply. It is estimated, that the 1998 and current service coverage rates will then increase significantly to 90% and 100% for the years 2003 and 2010, respectively.

c.) Basic Design Criteria for Water Sources/Production

For the evaluation and design of the water sources, the water demand forecast as discussed previously is used as basis. The projected water demand in Maliana for the years 2003 and 2010 is shown in the table below.

Year	Average Daily Demand		Maximum Daily Demand	
	m^3/day	L/s	m^3/day	L/s
2003	1,987	23	2,385	28

2010	2,554	30	3,065	35

Based on the above table, the water sources in Maliana (Beremau + Dabucci springs and the irrigation canal) should have a total water production that is capable of meeting the maximum daily water demand of 2,385 m3/day or 28 L/s in the year 2003.

d.) Scope of Rehabilitation

For the year 2003, the proposed rehabilitation plan of the water supply system in Maliana will include the following development and improvement works.

- *Rehabiliation of the Beremau Intake Facilities and Transmission Main*

There is sufficient water available from this source, however a limited supply is abstracted due to the unacceptable standard of construction used in the intake facilities. The construction of weir (1 m height x 3 m width) across the main stream will help improve water impoundment thereby increasing abstraction of water from this spring. Water quality could also be improved by the installation of screen on the intake chamber. The risk of human and animal contamination could be prevented by the construction of security fence around the spring area.
The damaged section of the transmission main was repaired by Oxfam using HDPE 2-inch x 40 m and HDPE 3-inch x 35 m as a temporary measure. To minimize head loss, the above repair work needs to be rectified by replacing the entire damaged section with 6-inch GSP.

- *Rehabilitation and Expansion of WTP @ Irrigation Canal*

The rehabilitation plan of this facility includes the installation of 1 additional package-type WTP unit with a capacity of 7 L/s. This WTP consists of the following:

Mixing & coagulation tank	1 unit
Sedimentation tank with sloping plates	2 units
Rapid sand filters	5 units
Intake pumps	1 set
Treated water booster pump	1 set
Generator	1 set
Pipeworks, 150 mm	
Flow meters and valves	

The new proposed WTP will be constructed adjacent to the existing and will draw water from the irrigation canal. Pipe interconnection with the existing treatment units will be necessary.

- *Rehabilitation of the Existing WTP Laboratory and Store Room*

The existing laboratory and storeroom were heavily damaged during the post-referendum violence. Repair works to these buildings include roofing, windows, doors, electrical installations, ventilation, plumbing and other furnishings. The laboratory apparatus need to be re-installed, such as chemical dosing equipment for alum, lime, chlorine mixing devices, motors, and pumps.

- *Expansion of the Sta. Cruz Reservoir*

The existing Sta. Cruz Reservoir (capacity = 97 m^3) is insufficient to store the

augmented water production of the WTP. A new storage reservoir will be required with the storage capacity of about 20 m^3. This proposed storage tank will be equipped with flow control and measuring devices, overflow and drain pipes, ventilation and water level gauge. Appropriate security fence will likewise be installed.

- *Rehabilitation of the Distribution Main from Santa Cruz Reservoir*

To accommodate the increase in water production that would allow efficient distribution of water supply to the water consumers a distribution main (150 mmx 1.5 km) will be constructed to distribute water from the Sta. Cruz Reservoir.

- *Rehabilitation of the Service Connection*

Since Oxfam had done the repair and improvement works on the existing public taps, the proposed rehabilitation plan will be focused on the service connections with the following activities:

Repair of the existing service connections	630
Installation of new service connections	280
Installation of water meters	910