3. NATURAL AND DEMOGRAPHIC FEATURES

3.1 Topography

Timor Island is one of the many islands in the South Pacific, which is about 400 km north of the Australian Continent. East Timor is the eastern half of Timor Island with an area of about 8500 km^2 and is located between latitude 8^o and 9^o $30^{'}$ south and between longitude 124^o and 127^o 30' east. The whole Timor Island is dominantly an agglomeration of mountains and valleys, which is geologically unstable. The topography of the island is generally mountainous characterized by rugged terrain and small narrow valleys. A chain of mountains runs through the island, providing watershed from north to south. The Rameleu Mountain Range extending from west to east has an altitude of over 2000m with the highest peak, Tata Mailau at an altitude of 2,963m. In the north, uplifted coral reef stretches along the coast, which shows typical karstic topography. Coral reefs are seen to develop along the shores of Dili and Manatuto and most of the eastern half of the island.

3.2 Climate

The climate in East Timor is characterized by intense monsoon rain followed by a pronounced dry season. The rainfall in Timor is mainly due to the north west monsoon coming from South China Sea, while the dry southeast trade winds is coming from the Australian Continent. The north coast of the island has a limited rainy season, which starts from December to March; the south coast has a longer rainy period from December through June. The highland region is dominated by high intensity rainfall mostly over 1500mm. Dili has an average annual temperature of about 26^oC. August is the coolest month of the year with a mean monthly temperature of 24.3^oC. November & December recorded the warmest temperature of 27^oC.

3.3 Geology

The Timor Island is part of the Bunda Island Arc System The presence of abundant limestone formation of various ages as well as the absence of volcanic rocks geologically characterizes East Timor. In addition to the typical reef limestone widely found in Baucau and Los Palos, other formations also contain calcareous rocks of different types. The dominant orientation of geological structures such as dip-strike beds, folding or anti-cynical and syn-cynical axes has a northeast east to southwest-west boundary on the different formations. The oldest geological unit is the Lolotoi complex of pre-Permian age. It is composed of metamorphic rocks of volcanic and sedimentary origin. Other old rocks of Permian and early Mesozoic age are also largely distributed in the mid-west. These rocks belong to the Maubisse formation of Permian age, Aileu formation of Jurassic to Permian age and the Aitutu formation of Triassic age. In areas around the nation's capital Dili, the Aileu formation is widely distributed. These rocks are metamorphosed sandstone and slate, mica schist and amphibolite.

3.4 Population

In the aftermath of the result for the 30 August 1999 referendum in East Timor more than 75% of the population was displaced by the widespread destruction to the physical infrastructure and violence to most of the residents. With the situation coming to a controlled and stable condition, the displaced residents are coming back to their original domicile where basic infrastructure and utilities are restored. Current estimated figures provided by UNOCHA are per district, sub-district and village level. The figures listed may vary from time to time depending on the movement of the East Timorese, the rate of returnees, which are more often subject to the progress of the reconstruction on physical infrastructure and rehabilitation of basic utilities. The national population has decreased by 24% from 901,686 in 1998 to 687,572 in November 1999. The behavior of the present population although increasing in most districts is still uncertain to project a relatively accurate figure.

4. SERVED POPULATION AND WATER DEMAND

The present plan intends to formulate scope, method and implementation schedule of the rehabilitation on the existing water supply systems urgently required up to the year 2003. In projecting the service population for the design period, several factors were considered such as the population growth rate (depends largely on a number of returnees from overseas, progress of housing projects and an increase of employment opportunity) the degree of rehabilitation on the existing facilities and the results of the household survey conducted by the JICA Study Team. The service coverage ratio was estimated based on the 1998 figures. The result of the calculation is shown on Table 4.1 below

Table 4.1 POPULATION ESTIMATE AND SERVICE COVERAGE RATIO

City/Town	1998*			2003			2010		
	Population Estimate	% Served	Served Pop	Population Estimate	% Served	Served Pop	Population Estimate	% Served	Served Pop
Dili	145,620	46	67,000	159,100	70	111,400	195,700	80	156,600
District Capital									
Aileu	3,920	96	3,500	4,200	100	4,200	5,000	100	6,000
Ainaro	4,470	63	2,820	4,900	90	4,400	6,000	100	6,000
Baucau	5,910	97	5,760	6,500	100	6,500	7,900	100	7,900
Gleno	6,000	73	4,380	6,600	90	5,900	8,100	100	8,100
Liquica	11,600	35	4,040	12,700	70	8,900	15,600	80	12,500
Los Palos	13,350	32	4,320	14,600	50	7,300	17,900	70	12,500
Maliana	8,910	61	5,410	9,700	90	8,700	12,000	100	12,000
Manatuto	5,420	97	5,250	5,900	100	5,900	7,300	100	7,300
Same	10,840	39	4,200	11,800	50	5,900	14,600	70	10,200
Suai	10,840	49	5,360	11,800	70	8,300	14,600	80	11,700
Viqueque	7,250	62	4,450	7,800	90	7,000	9,300	100	9,300
Sub-district Capital									
Atauro (Vila + Beloi)	2,500	24	600	2,700	50	1,400	3,200	70	2,200
Ermera	3,970	13	530	4,300	50	2,200	5,300	70	3,700
Maubisse	2,510	48	1,200	2,700	70	1,900	3,400	80	2,700
TOTAL	243,110	49	118,820	265,300	72	189,900	325,900	82	267,700

For the purpose of projection, the 1998 population is assumed to be equal the 2000 population.

The 1998 population of Atauro, Viqueque and Aileu are estimated values.

To provide base for forecasting water demand, the estimated service population was further categorized into two; population supplied via individual connections and community population via public taps. For the calculation of the water demand the following criteria was followed:

Table 4.2 PER CAPITA WATER CONSUMPTION ESTIMATES (in lpcd)

Year	Dili		Other Towns/Cities	
	Individual	Public Taps	Individual	Public taps
1998	80	30	70	30
2003	100	30	90	30
2010	120	30	110	30

Table 4.3 PERCENTAGE OF NON-DOMESTIC WATER DEMAND (in %)

City/Town Grouping	1998	2003	2010
G1 – Dili	30	30	40
G2 – Eleven district capitals	20	20	30
G3 – Three sub-district capitals	10	10	20

Table 4.4 PERCENTAGE OF UNACCOUNTED-FOR-WATER (in %)

City/Town Grouping	1998	2003	2010
G1 – Dili	60	40	25
G2 – Eleven district capitals	60	50	30
G3 – Three sub-district capitals	60	50	30

In case of East Timor, seasonal fluctuation in water demand is rather small. To estimate daily maximum water demand, a factor of 1.2 is considered appropriate for all towns. The daily maximum water demand in 2003 thus estimated is utilized as a design production capacity of the water sources.

Table 4.5 WATER DEMAND FORECAST

City/ Town	Year	Domestic (m^3/day)	Non-Domestic (m^3/day)	Water Losses (m^3/day)	Total Water Consumption			
					Daily Average		Daily Maximum	
					(m^3/day)	(L/sec)	(m^3/day)	(L/sec)
Dili	1998	5,310	1,593	10,355	17,258	200	20,709	240
	2003	10,686	3,206	9,262	23,154	268	27,785	322
	2010	18,090	7,236	8,442	33,768	391	40,522	469
District Capital								
Aileu	1998	280	56	504	840	10	1,008	12
	2003	403	81	484	968	1`1	1,161	13
	2010	573	172	319	1,064	12	1,277	15
Ainaro	1998	226	45	406	677	8	812	9
	2003	356	71	427	854	10	1,025	12
	2010	590	177	329	1,096	13	1,316	15
Baucau	1998	451	90	811	1,352	16	1,623	19
	2003	587	117	704	1,409	16	1,691	20
	2010	851	255	474	1,580	18	1,896	22
Gleno	1998	350	70	631	1,051	12	1,261	15
	2003	489	98	587	1,174	14	1,409	16
	2010	821	246	457	1,524	18	1,829	21

Liquica	1998	313	63	564	940	11	1,128	13
	2003	781	156	937	1,874	22	2,249	26
	2010	1,327	398	739	2,465	29	2,958	34
Los Palos	1998	346	69	622	1,037	12	1,244	14
	2003	663	133	795	1,591	18	1,909	22
	2010	1,392	418	776	2,585	30	3,102	36
Maliana	1998	433	87	779	1,298	15	1,558	18
	2003	828	166	994	1,987	23	2,385	28
	2010	1,375	413	766	2,554	30	3,065	35
Manatuto	1998	420	84	756	1,260	15	1,512	18
	2003	548	110	658	1,315	15	1,578	18
	2010	811	243	452	1,507	17	1,808	21
Same	1998	306	61	551	918	11	1,102	13
	2003	540	108	648	1,295	15	1,554	18
	2010	1,148	345	640	2,133	25	2,559	30
Suai	1998	429	86	772	1,286	15	1,544	18
	2003	662	132	794	1,589	18	1,907	22
	2010	1,145	343	638	2,126	25	2,551	30
Viqueque	1998	316	63	569	948	11	1,138	13
	2003	616	123	739	1,478	17	1,774	21
	2010	986	296	550	1,832	21	2,198	25
Sub-district Capital								
Atauro (Vila + Beloi)	1998	42	4	69	116	1	139	2
	2003	112	11	123	246	3	295	3
	2010	204	41	105	349	4	419	5
Ermera	1998	37	4	61	102	1	122	1
	2003	162	16	178	356	4	428	5
	2010	349	70	180	599	7	719	8
Maubisse	1998	84	8	139	231	3	277	3
	2003	135	14	149	297	3	356	4
	2010	239	48	123	410	5	492	6
TOTAL	1998	9,342	2,383	17,588	29,314	339	35,176	407
	2003	17,568	4,541	17,478	39,587	458	47,504	550
	2010	29,903	10,701	14,989	55,592	643	66,711	772

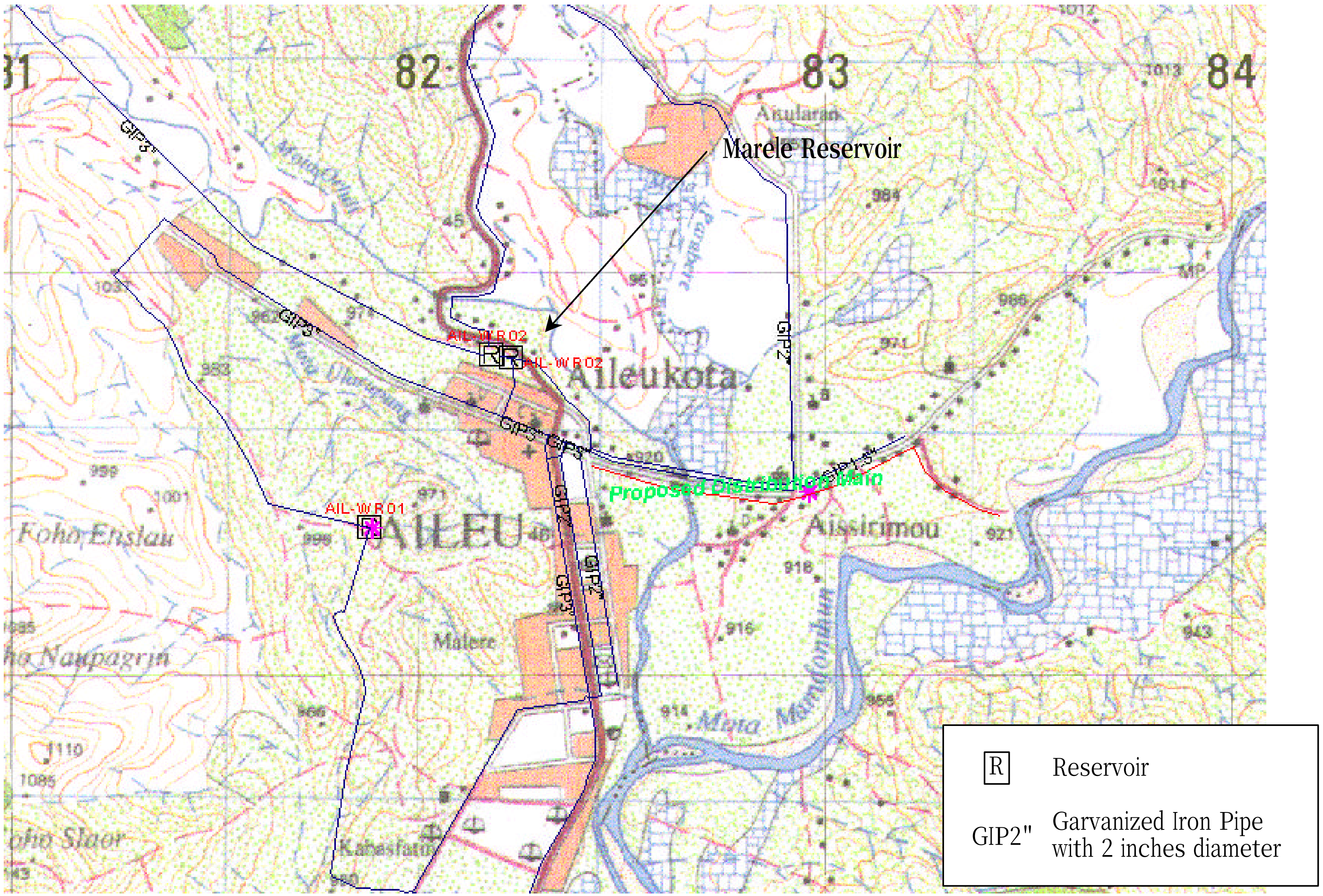
5. EXISTING WATER SUPPLY SYSTEMS

Field investigations of the existing water supply facilities were conducted in 15 towns of East Timor. The main purpose of the investigations is primarily to collect information and data on the existing condition of the water supply facilities necessary to evaluate the systems performance. The survey including topographical survey on the every main facility, which was carried out with the assistance of local staff covered extensively the urban water supply system of the 15 towns from the water sources down to the service connections. Data relative to the operation of the water system was also collected during the survey. Based on these data, Geographical Information System (GIS) of water supply facility was developed using ArcView® software. Topographical map of Dili drawn on a scale of 1:8000 by the JICA Topographical Map Study Team was used as base map. For other 14 towns, maps on a scale of 1:25000 prepared by the Indonesian Government were used as base maps. Locations of major water supply facilities (river intake facility, well (borehole), transmission mains, water treatment plant, reservoirs and distribution mains), ground plans, digital photos and their specifications are based on accurate data. The image output of GIS is shown in the following pages.

The water supply systems of the 15 towns in East Timor are currently in a less favorable condition delivering unreliable water supply service with insufficient supply and occasionally unacceptable water quality especially during rainy season. The facilities, which were first constructed during the Portuguese Period experienced several stages of development basically to meet the increase in water demand brought about by population growth and economic activity. However, the developments of the water supply system in most towns were done in a manner not acceptable to any standards. As a result, they are ineffective, unreliable, and most often damaged. Moreover, they are in poor condition and in a fast pace of deterioration due to lack of routine maintenance.

5.1 Water Sources and Intake Facilities

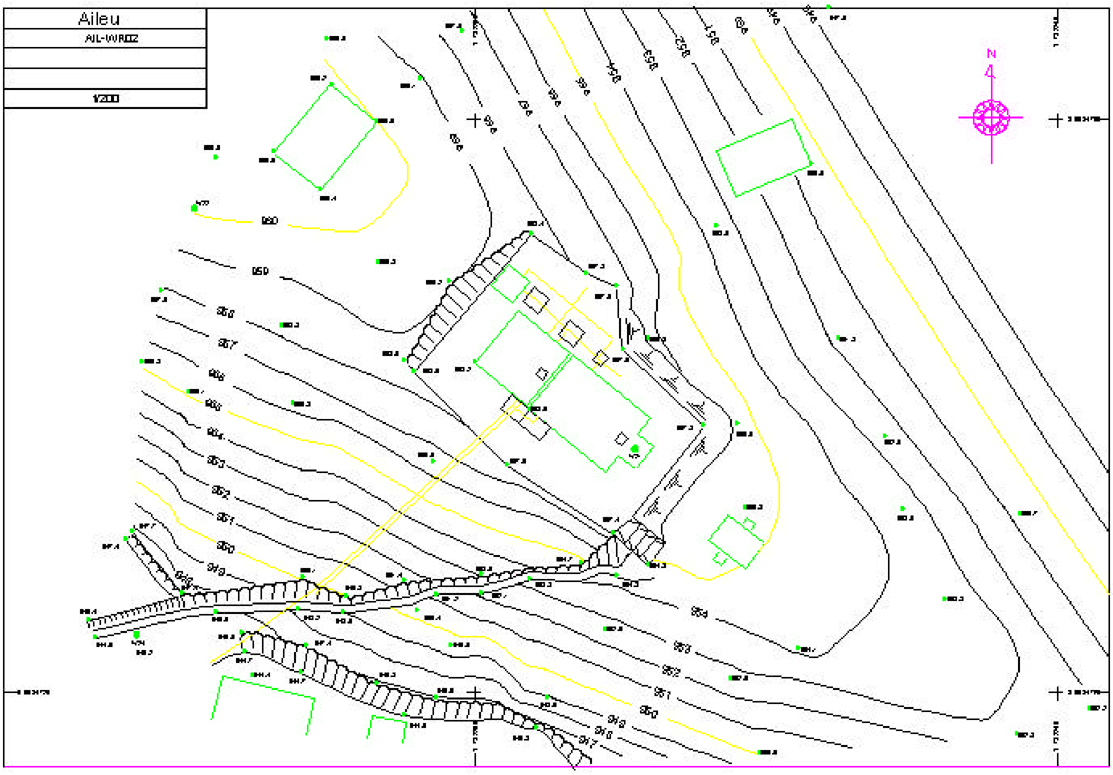
Except for the towns east of the country (Baucau, Los Palos and Viqueque), where spring sources with abundant potential supplies the water needs of the people, the rest of the 12 towns are getting water from a combination of sources such as surface water, spring and groundwater. The spring sources produces as high as 120 L/s to as low as 0.1 L/s and even nil flow during dry season. The water quality from the springs are generally good, however due to substandard water collection, the quality deteriorates especially after heavy rains. Most of these water sources are normally located in high elevations to allow gravity flow of water to the service area. On the other hand, surface water and stream flow



The Study onUrgent Improvement Project for the Water Supply System in East Timor

Figure 5.1

Image Output (1) of Geographical Information System (GIS)



Topographical Survey Map of Marele Reservoir （Aileu)

Town	No. & Facility:	Year of Construction	Financed by:
Aileu	08 - Marele Reservoir 2		

Existing Condition:	Photograph:
Facility: Sevice reservoir	
Structure: Reinforced concrete	
Shape: Rectangular	
Dimension:	
Capacity: 30m^3	
Function: Storage	
Source of Water: Sloi Kraik River	
Elevation (amsl):	
Accessories:	
	(Date:)

Photo Datasheet of Marele Reservoir （Aileu)

JICA	*The Study onUrgent Improvement Project for the Water Supply System in East Timor*	**Figure**
	Image Output (2) of Geographical Information System (GIS)	**5.2**

quality and quantity are normally subject to seasonal fluctuations. More yield with high turbidity levels occur during the rainy season and less yield with good water quality during the dry season. Surface water and springs are normally drawn via collection pipe connected to the intake boxes. Some of the intake facilities are equipped with weirs and grit chambers. Except in large towns/cities like Dili, Ainaro, Gleno Los Palos, and Maliana where water treatment facilities are provided, in the rest of the towns raw water collected from the intake flows by gravity to the service reservoirs for distribution to the service area. During rainy season, water quality deteriorates due to excessive soil erosion and most often creates serious problems to the water treatment plant and the pipelines. In worst cases, the intake structures and transmission mains are damaged that results to acute water shortage. Prior to the post-referendum violence abstraction of surface water through infiltration gallery was operational in Aileu where naturally filtered water from the riverbed of Mantane is pumped to the service reservoir for distribution. However, damages to the electrical facilities and appurtenances made the gallery unproductive. In Manatuto, the infiltration gallery constructed as part of the JICA Quick Project started its normal operation in December 2000. This infiltration gallery constructed in the Laclo River is designed to produce about 15 L/s.

The towns/cities that abstract groundwater to augment water production from other sources are Dili, Liquica and Suai. Except for the deep wells in Dili where they produce abundant groundwater, the rest of the wells located outside the capital are low yielding. Based on available records, the wells in Dili range from a depth of 78 m – 135 m producing about 5 L/s – 40 L/s. The Comoro well field located west of the city has abundant groundwater reservoir compared to the eastern well field of Kuluhun/Bidau. On the other hand, the deep wells drilled in Hera are low yielding and producing water from 3 L/s – 5 l/s. Water abstracted from these wells are normally pumped into the service reservoirs for distribution to the service area. In Dili, chlorination is done prior to distribution. To augment the water production in Dili, rehabilitation of Bidau 1 was attempted. However, due to land ownership dispute on the Bidau 1, drilled a new deep well on the site close to the existing one.

All the 4 wells in Liquica are not operational despite rehabilitation works attempted by many organizations such as Oxfam, PKF and UNTAET. Based on available records and information provided by local sources, the 4 wells in Liquica were drilled to depths ranging from 82 m – 84 m and designed to produce between 2.5 L/s – 10 L/s. However, neither well drilling data (stratigraphy and aquifer characteristics) nor operational records were made available to the JICA Study Team that would help evaluate ground water potential in the area. For the above reason and the shortage of water supply in Liquica, two exploratory/productive deep wells were constructed on the site recommended as a result of the geophysical survey conducted.

The 2 wells drilled to supply the water requirement in Suai were not spared with damages caused by the post-referendum violence. As a result, only one of them (Sukabilaran 1) was put back to normal operation due to the rehabilitation works of the NGO's such as Oxfam, Bia Hula and other donor agencies. Currently, this deep well produces about 6 L/s normally operating on a limited hours per day. Sukabilaran 2 remained unproductive for certain period due to severe damages on the pumping and electrical facilities. However, through the efforts made by the PKF, this well has been put back to operation on temporary basis. Table 5.1 shows the summary of the water sources and their potential.

Table 5.1 WATER SOURCES AND EVALUATION OF THEIR POTENTIAL

Town	Water Source	Measured Flow in Oct – Nov (L/s)	*Estimated Potential in Dry Season (L/s)	Yr.2000 Average Draw Off (L/s)	Yr. 2003 Max-Day Water Demand (L/s)	Remarks
1. Dili	Benemauk River	45	32	10	-	Supplies Benamauk & Lahane WTP
	Bemori River	29	20	30	-	Supplies Lahane WTP
	Bemos River	282	197	40	-	Supplies Bemos WTP
	Well @ Comoro A	40	40	40	-	Utilized
	" Comoro B	35	35	35	-	Currently used by PKF
	" Comoro C	-	-	-	-	Not presently used
	" Comoro D	31	30	30	-	Utilized
	" Comoro E	(20)	20	-	-	Not operational
	" Kuluhun A	16	16	15	-	Utilized
	" Kuluhun B	36	36	35	-	Utilized
	" Bidau 1	-	-	-	-	Abandoned
	" Bidau 2	-	-	5	-	Used by Dili Gen. Hospital
	T O T A L	514	426	240	322	Production deficit could be supplied from surface and groundwater sources.
	Well @ Hera A	-	5	-	-	Rehabilitation on going
	" Hera B	-	3	-	-	Rehabilitation on going
	" Hera C	-	5	-	-	Rehabilitation on going
District Capital						
Aileu	Mantane River Infiltration Gallery	370	370	0		Damaged pumping station
	Sloi Kraik Stream	4	2	2		
	Naufaisaran Spring	1.2	1	1		
	Hularema Spring	0.5	0.5	0.5		
T O T A L		375	373	4	13	ADEQUATE.
Ainaro	Sarai River	1,130	160	8		
T O T A L		1,130	160	8	12	ADEQUATE.
Baucau	Wailia Spring	55	44	15	-	Estimated current abstraction
T O T A L		55	44	15	20	ADEQUATE
Gleno	Mota Boot Stream	1,300	325	0		Damaged intake and pipes
	Mota Kiik Stream	80	10	3		
	Ergrogo Spring	10	7	0		Damaged transmission main
T O T A L		1,390	342	3	16	ADEQUATE.
Liquica	Dato 1	-	-	0		Damaged
	Dato 2	-	-	0		Damaged
	Maumeta 1	-	-	0		Damaged
	Maumeta 2	-	-	0		Damaged
	Laclo	2.3	2	0		Damaged intake pipes
	Lilabu	2	1.5	0		Damaged intake pipes
	Narlolo	0.7	0.5	1		
	Daulo	15.0	10.5	0		Damaged intake and pipes
	Eanlua	3.8	3	0		Damaged intake pipes
	Raisape	5	5	0		Damaged transmission main
	Metagou	2	1.5	2		
	Emilaloa	20	10	0		Damaged intake pipes

T O T A L		50	34	3	26	Production deficit could be supplied from new wells and rehabilitation of Daulo, Eanlua and Manlaka
Los Palos	Papapa Spring	99	99	5	-	Limited water due to damage Pumping Station 2 and WTP.
T O T A L		99	99	5	22	ADEQUATE
Maliana	Beamos Spring	-	1**	1**		
	Aikumu Stream	-	37**	1**		
	Dabucci Springs	-	-	2**		
	Beapelu Spring	-	-	2**		
	Beremau Stream	-	-	2**		
	Colegio Stream	-	-	0.5**		
	Irrigation Canal	-	50**	7.5**		
T O T A L			88**	16**	28	Production deficit could be supplied by new well and rehabilitation of surface water and spring sources
Manatuto	Manatuto Spring	116	104	-	-	Not in use
	Laclo River Infiltration Gallery	7,900	3,950	15	-	To be operational in December.
T O T A L		8,016	4,054	15	18	ADEQUATE.
Same	Carbulau (Darelau)	20	10	2		
	Kotalala Stream	1,120	280	6		
	Mirbute Spring	3	1.5	2		
T O T A L		1,143	291	10	18	ADEQUATE
Suai	Olivio Spring	-	1**	1**		
	Ameriko Spring	0.6	0.6	0.5**		
	Maugusu Spring	-	-			
	Kuluai Spring	-	1**	1**		
	Sukabilaran 1 Well	-	6**	6**		
	Sukabilaran 2 Well	-	6**	6**		
T O T A L			14.6**	14.5**	22	Production deficit could be supplied by new well and rehabilitation of surface water and spring sources
Viqueque	Builua (Loihunu) Spring	121	121	10		
T O T A L		121	121	10	21	ADEQUATE
Sub-district Capital						
Atauro	Eklai Spring	1	0.5	0.5	-	Utilized
	Tulai Spring	3	2.5	2.5	-	Utilized
T O T A L		4	3	3	3	Water shortage maybe experienced beyond 2003.
Ermera	Lubulala Spring	0.1	0.1	0.2		
	Ersoi Spring	0.6	0.6	0.5		
	Mota Bura Spring	1.0	1.0	1		
T O T A L		1.7	1.7	1.7	5	Production deficit could be supplied from surface water.
Maubisse	Raikuak Ulun	1.5	0.8	1		
	Bucana Spring	2	2	2		
	Filmou Spring	0.2	0.2	0.5		
	Erulu Spring	0.5	0.5	1		
T O T A L		4	3.5	4.5	4	ADEQUATE.

** Estimation based on the measured flow rate and interview with the local people.*

*** Values taken from previous reports and investigations made by local staff.*

5.2 Transmission Mains

Transmission mains are made up of galvanized steel pipes with diameters ranging from 10-inch to 2-inch. The length varies from a few hundred meters to several kilometers most often traversing in unstable mountain slopes. The pipelines are exposed above ground making them more vulnerable to damage. Some of the major problems that creates serious damage to the transmission mains are the following:

- Designed and constructed below standard
- Installed in areas vulnerable to damage both natural and made-made.
- Constructed without adequate protection
- In most cases, subjected to flooding, soil erosion, falling rocks and tree branches
- Illegal service connections
- Sand and mud accumulation
- Lack of routine maintenance

The unreliability of the transmission mains created by the above-mentioned factors often lead to the breakdown of the water supply systems in few of the towns of the study area.

5.3 Water Treatment Facilities

The water treatment facilities in East Timor vary from simple slow sand filter units to packaged-type water treatment units comprising of processes such as: flocculation, sedimentation and filtration. All of these WTP were constructed to treat raw water collected from surface water sources except for Los Palos, which treat raw water from Papapa Spring. The capacity of the WTP ranges from 40 L/s to 7 L/s. The WTP's in Dili and Maliana are of similar type and follow the same processes such as flocculation, sedimentation and filtration. Treatment chemicals are used such as aluminum sulfate for coagulation/flocculation, soda ash for coagulant aid and chlorination for disinfection of the water supply. Water testing laboratories with a set of analytical kit provided by JICA, are operational in Dili but in Maliana these facilities were completely damaged. Some plants have inadequate treatment capacities, therefore they cannot treat water to an acceptable level. On some occasion, even in the treatment plant with adequate capacity, the operation of the WTP is hampered by the lack of treatment chemicals and routine maintenance thereby reducing the treatment efficiency of the plant that results to the production of water with unacceptable quality. The WTP in Los Palos, Ainaro, Gleno and Liquica are slow sand filter units. In Aileu prior to the slow sand filter, a grit chamber is installed. During rainy season, sand and mud of substantial quantity create operational problems to the WTP that oftentimes lead to its breakdown. However, this problem can be solved mostly if the treatment plants were properly designed. In adequately designed Lahane WTP, treated water quality is mostly acceptable while inadequately designed Bemos and Benamauk WTPs give unacceptable quality water during high turbid raw water.

5.4 Storage Reservoirs

In East Timor, the service reservoirs are rectangular storage structures made up of reinforced concrete constructed during the Portuguese and Indonesian Administrative Periods. However, the reservoirs constructed lately through the assistance coming from AusAID are circular tanks made of steel with vinyl coating. Large capacity reservoirs are constructed for the Dili water supply system and smaller reservoirs could be found in small towns. Generally, the reservoirs are located in high elevations to allow gravity flow of water to the service area. The storage capacities of the existing reservoirs in East Timor including Dili are well below the desired storage requirement for a normal water supply system. Some of these reservoirs are always empty and do not function as demand moderators because of insufficient water production or excessive water wastage/leakage. Except for the AusAID-funded reservoirs and few reservoirs in Dili, most of them are not well equipped with operational devices such as control valves, water meters, water level gauge. Devices such as ventilation, drains and overflow are sometimes not installed in the storage reservoirs creating problems in maintenance. With the lack of regular maintenance and neglect, some of these facilities are in poor condition and in a fast pace of deterioration.

5.5 Distribution Network and Service Connections

The distribution and reticulation pipe network in East Timor contains the old and the new network constructed during the Portuguese and the Indonesian period, respectively. The old network is composed of AC and GSP with diameters ranging from 2-inch to 7-inch. Because these pipes are relatively old, water leaks normally occur. The new network constructed during the Indonesian time is made up of GSP with diameters ranging from 2-inch to 10-inch. There are towns in East Timor, such as in Baucau and Los Palos, where the installations of the distribution network are not complete and left without fittings resulting to fast deterioration of the pipelines and are subject to vandalism. Most of the distribution and reticulation systems are in constant repair mainly due to the poor workmanship and unacceptable standards employed during construction. Most of these pipes were laid too shallow and above ground making them vulnerable to damage. This situation shortens the economic life of the material.

There exist a large number of illegal connections on the distribution mains. Because these connections are non-registered and not billed, large volume of water is wasted. The existence of illegal connection makes it difficult to attain optimum flow control in the pipe distribution network. Thus, the water supply condition in critical areas of the distribution network has become miserable.

6. REHABILITATION PLAN

6.1 Concept of Rehabilitation

The rehabilitation plan was formulated based on the general idea of rehabilitation with minimal recurrent cost even though big capital investment is incurred. Accordingly, 5 general concepts were proposed such as follows:

- Reliable transmission pipelines
  This is the most upstream part of the water supply system so that failure of this leads to complete shutdown of water supply as experienced in entire Manatuto and Liquica and most part of Aileu, Baucau and Los Palos. Reflecting steep terrain of the transmission lines, they are vulnerable to flood. Protection against it must be ensured though requiring relatively high pipe laying cost. Once the transmission pipelines are laid safely, the water supply systems can be run without electricity, giving low operation cost.
- Adequate water treatment facilities
  Treatment plant was previously installed with few attentions to raw water quality in each water source. In designing treatment plant, we must consider characteristics of each water source quality such as abrupt change of raw water quality and occasionally high turbidity that results from steep terrain of the river and deforestation in the upstream. Proper design to treatment plants will assure acceptable treated water quality.
- Efficient water distribution management
  Water distribution was not controlled in the past. Water is flowing down from reservoir according to hydraulic characteristics. This gravitational flow is a good system if properly designed so that we will maintain the gravitational flow. But, if production is smaller than demand or wastage is larger than production, some hydraulically inferior areas are always victims; they are not supplied with water. Therefore, to manage distribution system, we propose zoning system with some control devices. We can control, to some extent, water flow with keeping gravitational flow. Zones are carefully divided considering elevations of areas, existing layout of pipe and reservoir, size of zone etc.
- Reduction of unaccounted-for-water through leakage control
  Water distribution is in a miserable stage in most of the towns. We have noticed this immediately after the Study starts so that we conducted leakage survey in Dili as one of Quick Project. We have found many clogged pipes and broken pipes even in the distribution mains. (Pipe clogging results from combination of mud outflow

from the treated plant and intermittent water supply. This will be solved by improvement to treatment plant.)

Illegal connections are made by unskilled workers and lead to considerable amount of wastage of water. The leakage survey, however, indicates that traditional simple leak detection/repair method employed elsewhere cannot solve the problem. Repaired illegal connections will be 'rectified' immediately by residents to seek water source points for their daily lives. Residents have long been frustrated with unreliable water supply; low pressure, intermittent water supply etc. As a result, they themselves sought relatively reliable water source points, often transmission pipes and distribution mains, which aggravated the downstream users. The household survey clearly indicates that they do not abandon their own shallow wells with poor water quality, preparing interruption of water supply. So we must acquire confidence to the water supply system from the residents through provision of water anytime and anywhere. After we are successful in giving them confidence, illegal connection will be reduced and then traditional leakage control can succeed.

House meters are also proposed to conserve water.

- Maximize service coverage

  Within the service areas, we will give as many as residents. In most towns, neither water source exploration nor additional distribution main is required. Needed are mostly service pipes with house meters.

The priority schedule for the project was prepared based on the parameters such as, unserved population, condition of the water supply, contribution to socio-economic aspect, health risk to water borne-diseases, cost effectiveness and the status on non-JICA rehabilitation projects.

6.2 Rehabilitation Plan of the Water Supply System

The rehabilitation plan of the water supply system for the 15 towns of East Timor is summarized below according to the purpose of the rehabilitation concept.

6.2.1 Reliable Water Source and Transmission Line

1) Dili

   Rehabilitation of Bemos intake, Bemori intake and Benamauk intake

   New transmissio pipe from Bemos to new water treatment plant

   Expansion of Comoro A well and Comoro E well

   Replacement of pump at Kuluhun A well

New well at Kuluhun C and Bidau 3

2) Atauro

Tulai spring security fence, concrete box, intake box

Transmission main 75mm x 5km to Beloi

3) Manatuto

Realignment of transmission pipe

4) Baucau

Pumping Station No.1 Replacement of pump and generator

Pumping Station No.2 Replacement of pump and generator

Pumping Station No.3 New pump and generator

Completion of transmission main

New transmission main 100mm x 1.5km, 75mm x 1.0km

5) Los Palos

Pumping Station No.2 New pump and generator (for raw water and treated water)

6) Viqueque

Realignment of transmission pipe including pipe bridge

7) Same

Realignment of transmission pipe including pipe bridge

8) Ainaro

Repair of raw water transmission conduit

9) Aileu

Rehabilitation of Mantane river infiltration gallery including collection pipe, generator

10) Maubise

Repair of 100mm transmission pipe from Erulu spring

Replacement of transmission pipe from Bucana spring (75mm x 1.7km)

Rehabilitation of Raikuak Ulun intake including collection chamber, collection weir

Replacement of transmission pipe (75mm x 0.1km)

11) Gleno

Rehabilitation of Mota Boot intake including collection pipe, generator

Repair of transmission pipe (150mm)

12) Ermera

Reconstruction of Ersoi spring intake

Reconstruction of Lubulala spring intake

New intake at Mota Bora river with new transmission pipe (100mm x 6km)

13) Liquica

Reconstruction of Daulo intake

Reconstruction of Eanloa intake

Realignment of transmission pipe from Emilaloa intake (150mm x 4km)

New transmission pipe from new deepwell (150mm x 1.5km)

14) Suai

Sukabilaran No.1 well Replacement of pump and generator

Sukabilaran No.2 well Replacement of pump and generator

New well construction with transmission pipe (75mm x 1.3km)

15) Maliana

Rehabilitation of Beremau intake

Replacement of transmission pipe to 150mm x 75m

6.2.2 Reliable and Safe Water Supply

1) Dili

New water treatment plant (6,000 m^3/day)

2) Atauro

Haronglerang sercice reservoir flow control and measuring devices etc.

Tolelona I & II and Cementerio service reservoir flow control and measuring devices, chlorinator etc.

3) Manatuto

4) Baucau

Main reservoir flow control and measuring devices, chlorinator etc.

Samadiga reservoir flow control and measuring devices, chlorinator etc.

5) Los Palos

Pumping station No.1 Replacement of pump and generator

Expansion of water treatment plant

Elevated service reservoir flow control and measuring devices, chlorinator etc.

6) Viqueque

Builua spring Security fence

Break pressure tank Security fence

Service reservoir flow control and measuring devices, chlorinator etc.

7) Same

Darelau spring Security fence

Posto reservoir flow control and measuring devices, chlorinator etc.

8) Ainaro

Water treatment plant repair and new chlorinator

Service reservoir flow control and measuring devices, chlorinator etc.

9) Aileu

10) Maubise

Erulu spring Security fence, drain, public tap

Service reservoir at Erulu spring flow control and measuring devices, chlorinator etc.

Pousada reservoir flow control and measuring devices, chlorinator etc.

11) Gleno

Water treatment plant repair and new chlorinator

12) Ermera

New water treatment plant from Mota Bora river

13) Liquica

14) Suai

15) Maliana

Water treatment expansion additional 10L/s

Rehabilitation of WTP laboratory

6.2.3 Adequate Storage

1) Dili

Additional storage 1,000m^3 at Aspal Goreng, 600m^3 at Becusi and 200m^3 at Bidaumasau2

2) Atauro

Beloi reservoir additional 30m^3

3) Manatuto

Additional 330m^3

4) Baucau

New reservoir 100m^3 at high zone

5) Los Palos

Additional 400m^3 at water treatment plant

6) Viqueque

7) Same

Hularua reservoir additional 160m^3

Merbati reservoir additional 200m^3

8) Ainaro

None

9) Aileu

Additional 85m^3

10) Maubise

Additional 30m^3

11) Gleno

Additional 300m^3

12) Ermera

Additional 80m^3

13) Liquica

Additional 140m^3

14) Suai

Hospital reservoir additional 100m^3

Leogore reservoir additional 20m^3

15) Maliana

Sta. Cruz reservoir additional 20m^3

6.2.4 Efficient Water Distribution

1) Dili
2) Atauro
3) Manatuto

   Distribution main rehabilitation and leakage control
4) Baucau

   Replacement of 100mm x 1.3km
5) Los Palos

   Distribution main rehabilitation and leakage control
6) Viqueque

   Distribution main replacement 75mm and 100mm
7) Same

   Distribution main replacement
8) Ainaro

   Installation of 150mm x 2.7km (from reservoir No.1)

   Installation of 150mm x 1.2km (from reservoir No.2)

   Installation of 75mm x 0.4km (from reservoir No.1)
9) Aileu

   Upgrade to 75mm pipe
10) Maubise

    Replacement of distribution main (75mm x 0.7km and 50mm x 0.5km)
11) Gleno

    New pipe installation (150mm, 100mm)
12) Ermera

    New pipe installation (100mm x 1km)
13) Liquica

    New distribution main (150mm x 5km, 100mm x 4km)
14) Suai
15) Maliana

    New distribution main (150mm x 1.5km)

6.2.5 Service Coverage Target

In 15 towns, in order to extend water supply service within the existing service area or adjacent the existing service area, installation of public tap, service connection, water meter is required. Number of these appurtenances is shown in Appendix H.

6.3 Costs for the Project and its Operation and Maintenance

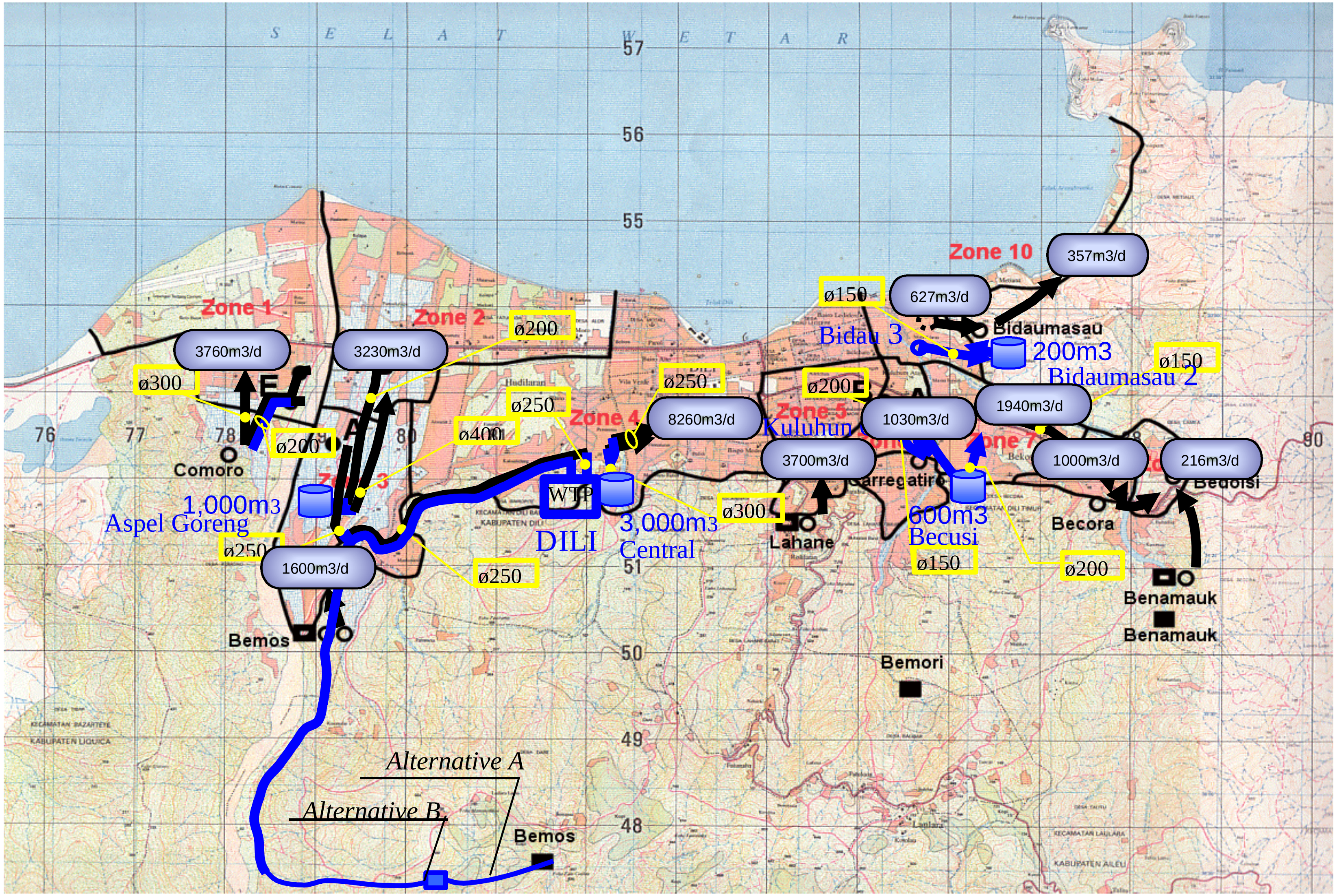
The costs for the present project are summarized as follows:

Project Costs	(Thousand US$)
Construction Costs:	21,001
Engineering Fee:	2,100
Contingencies:	3,465
Total:	26,566

The total project costs for 15 towns is US$ 26.6 million, of which Dili part needs US$ 14.9 million.

Annual costs for operation and maintenance are summarized as follows:

O&M Costs	(Thousand US$)
Personnel Costs:	231
Vehicles:	87
Power:	487
Chemicals:	37
Repair	210
Other Costs:	151
Total:	1,204



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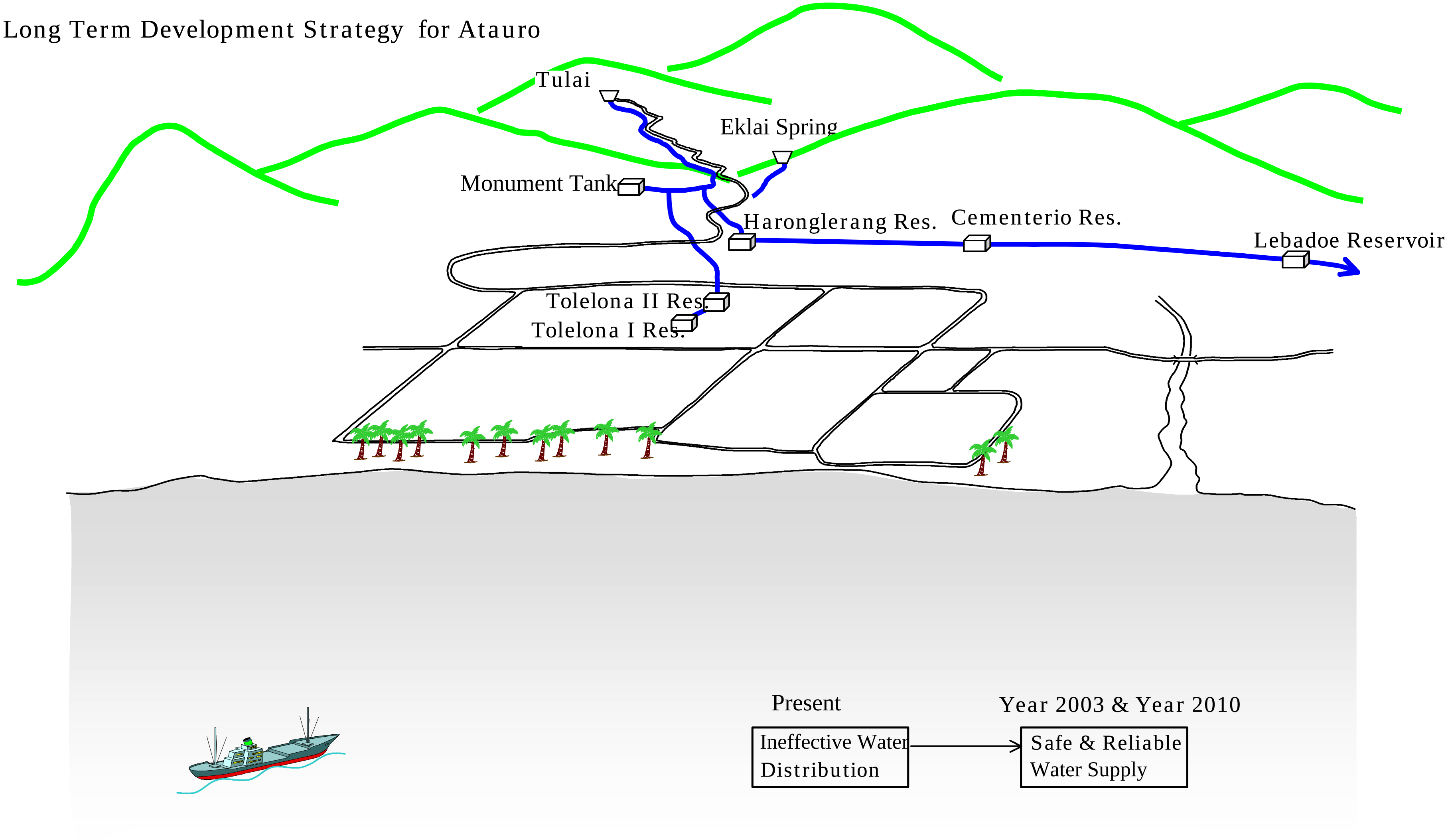
The Study onUrgent Improvement Project for the Water Supply System in East Timor

Figure 6.1

Long Term Development Strategy for Dili

Long Term Development Strategy for Atauro



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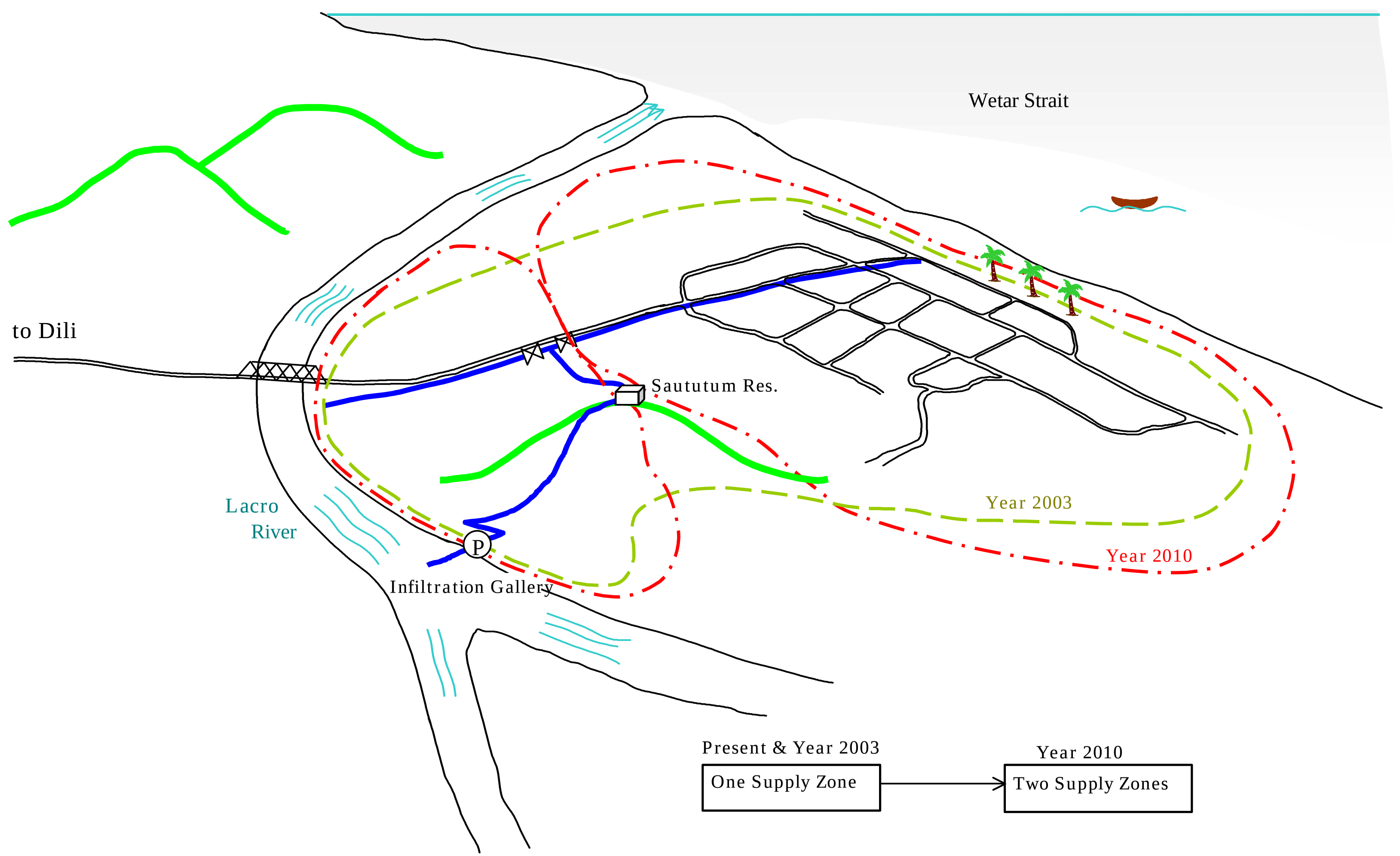
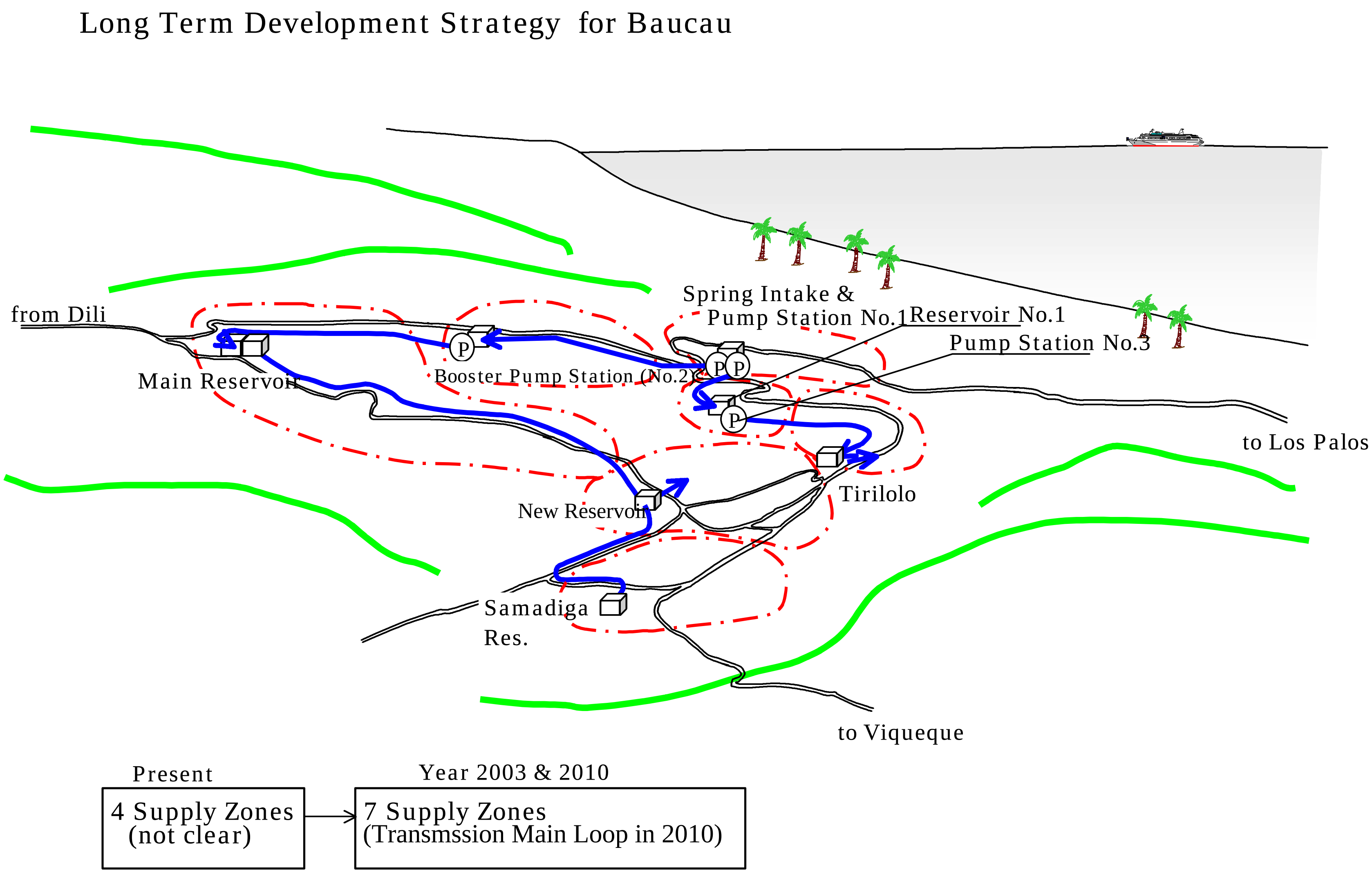
Long Term Development Strategy for Atauro

Figure 6.2

Long Term Development Strategy for Manatuto



JICA *The Study onUrgent Improvement Project for the Water Supply System in East Timor*		**Figure**
Long Term Development Strategy for Manatuto		**6.3**



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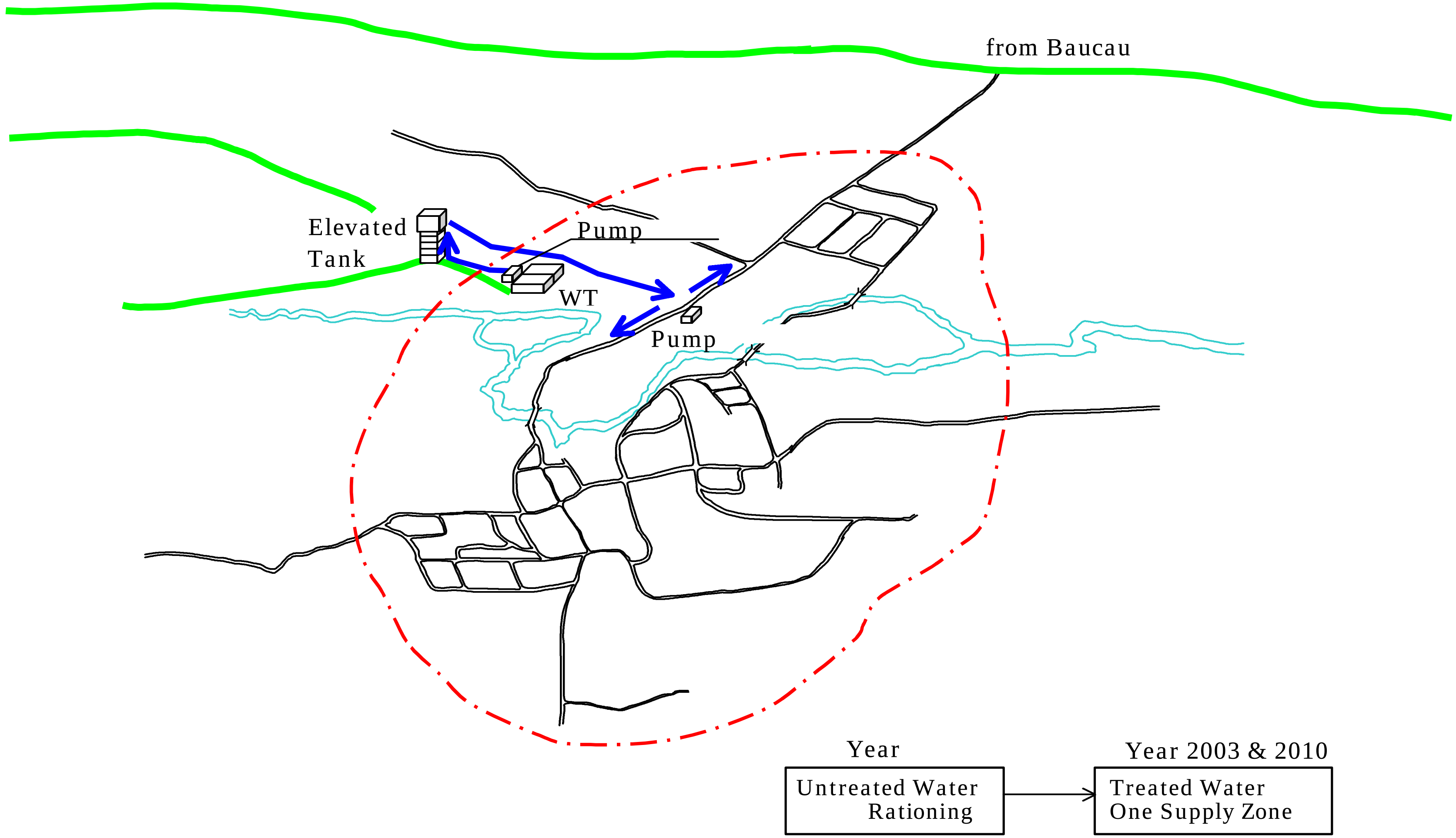
Long Term Development Strategy for Baucau

Figure 6.4

Long Term Development Strategy for Los Palos



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Long Term Development Strategy for Los Palos

Figure 6.5

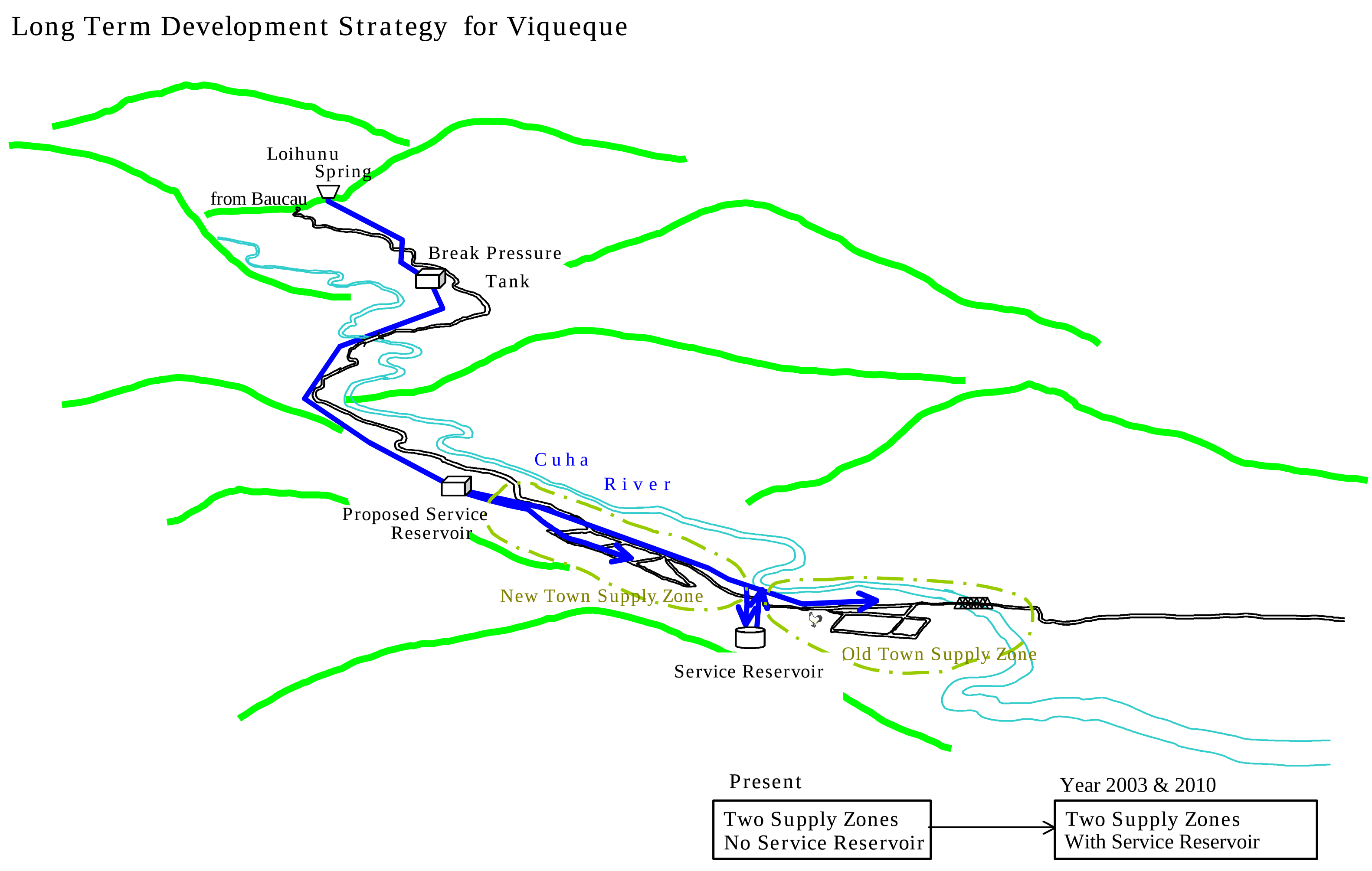

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Figure 6.6

Long Term Development Strategy for Viqueque

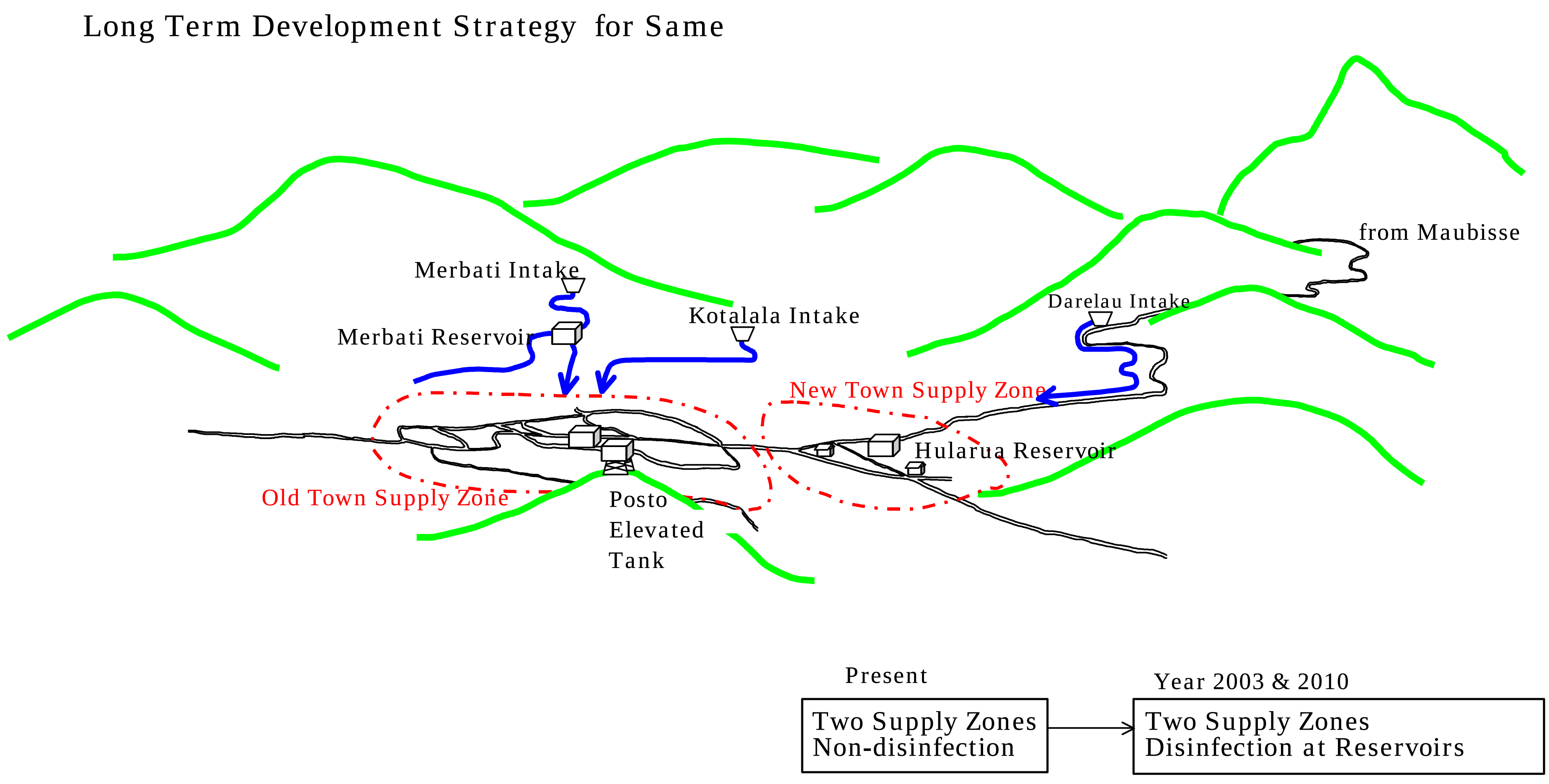

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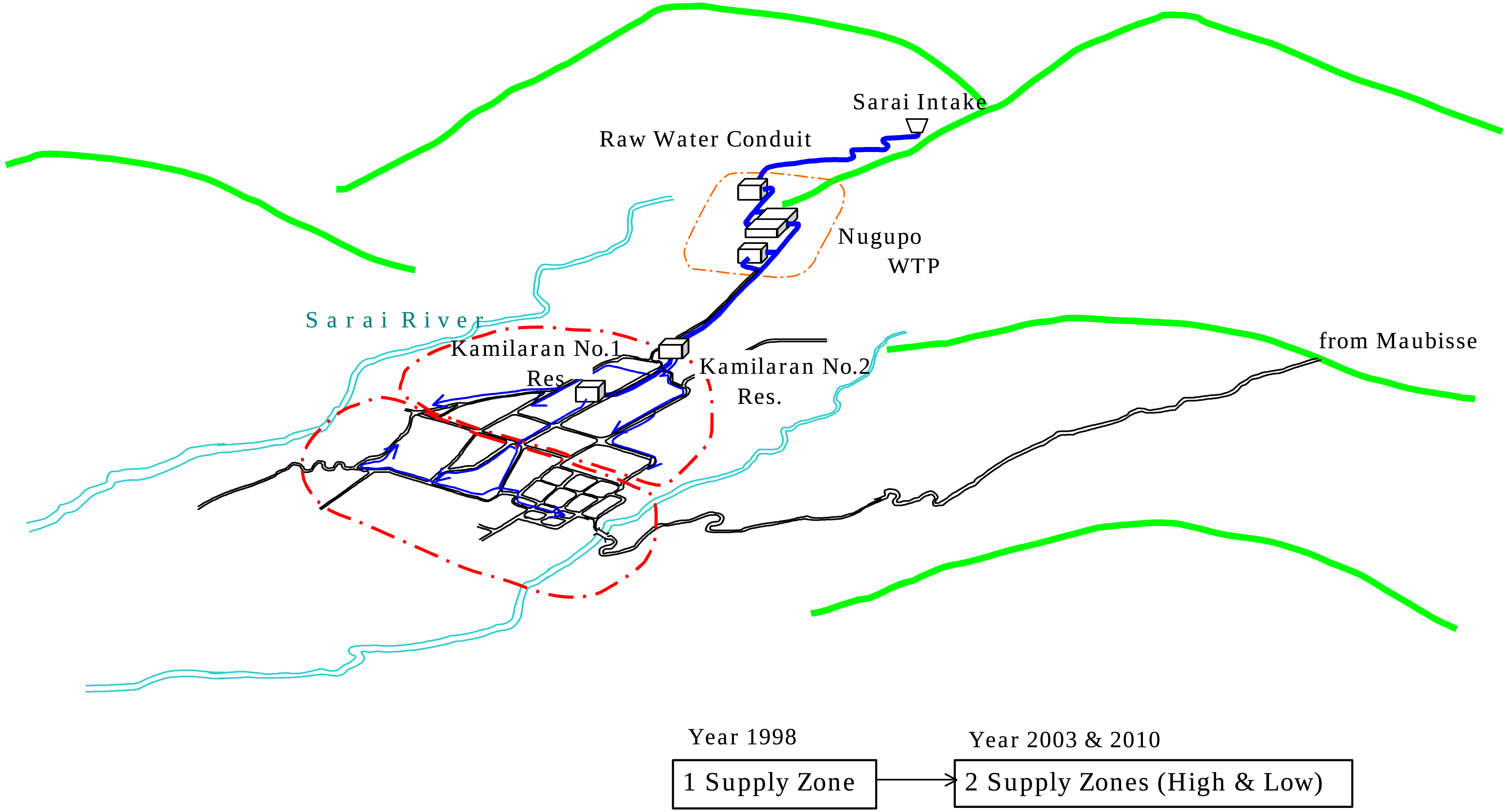
Figure 6.7

Long Term Development Strategy for Same

Long Term Development Strategy for Ainaro



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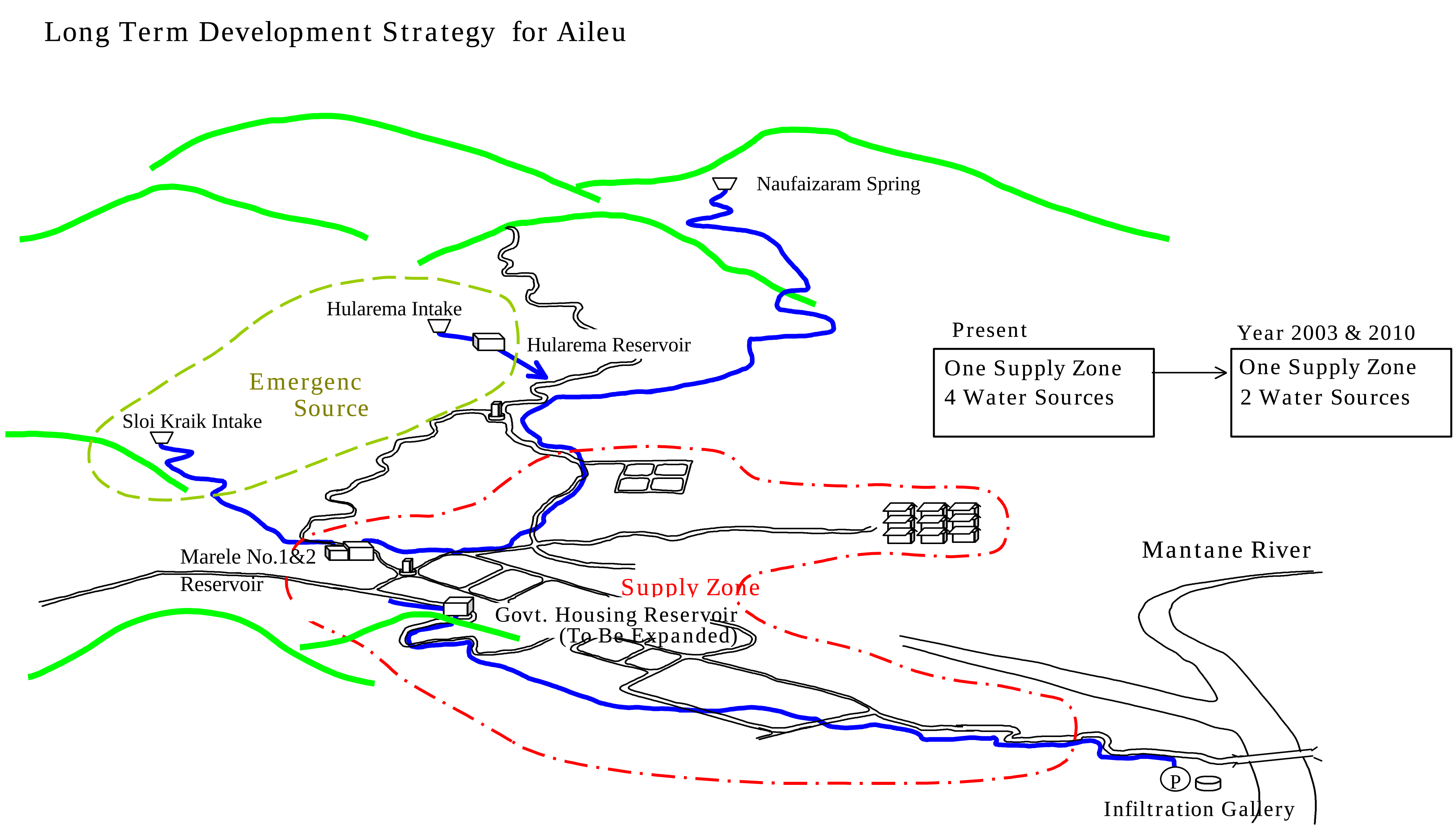
Long Term Development Strategy for Ainaro

Figure 6.8



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Long Term Development Strategy for Aileu

Figure 6.9

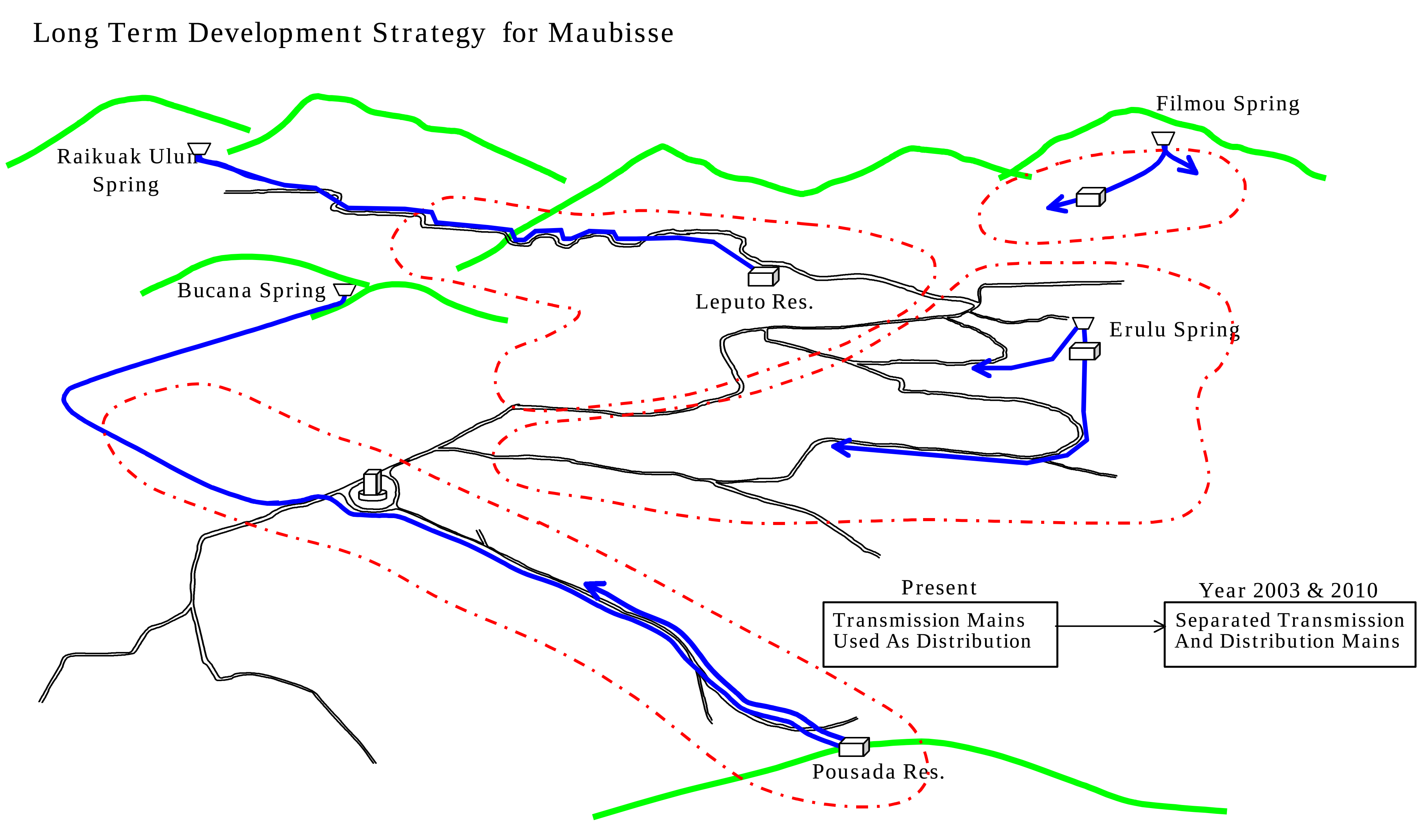

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Figure 6.10

Long Term Development Strategy for Maubisse

Long Term Development Strategy for Gleno

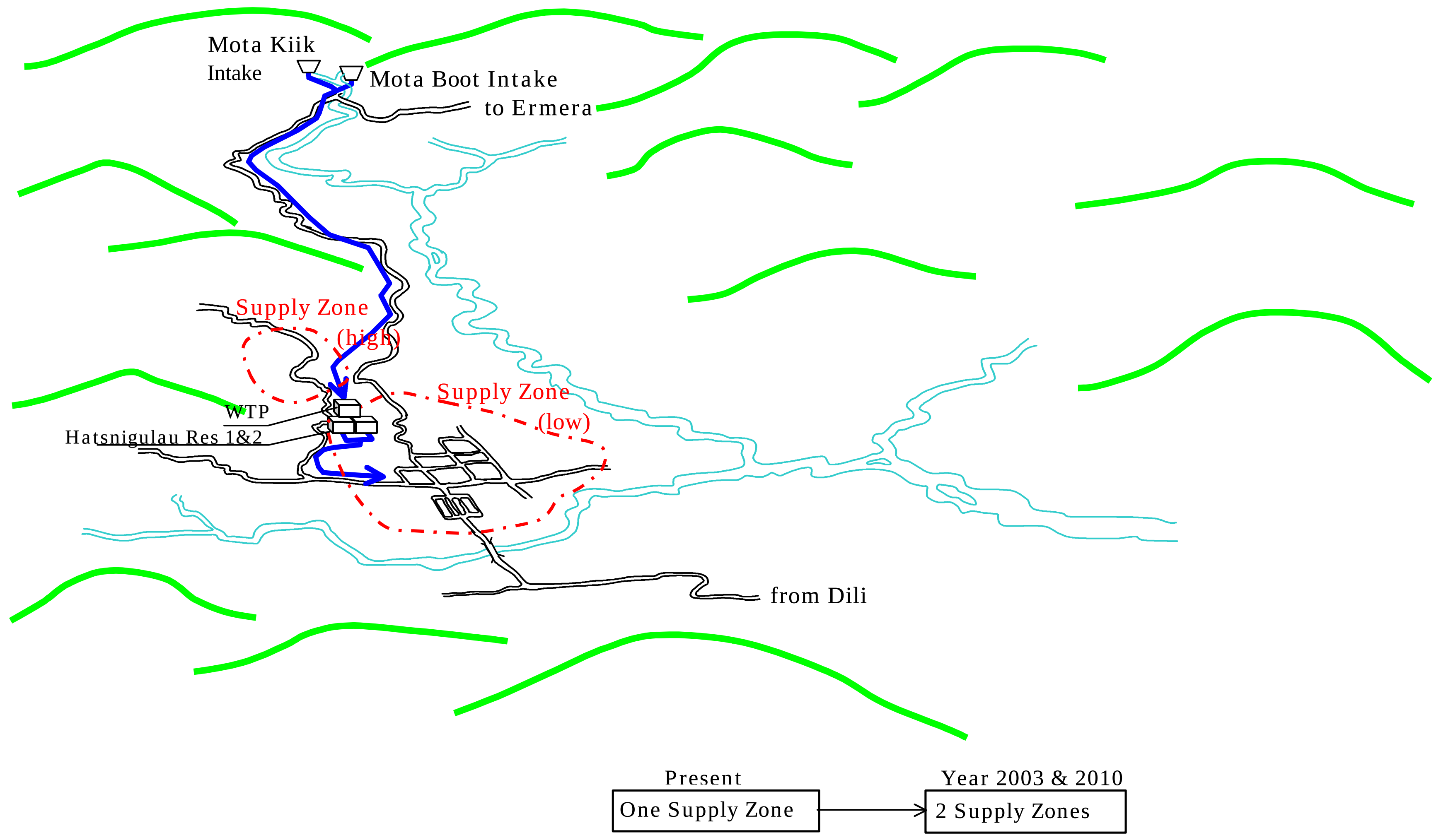

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Figure 6.11

Long Term Development Strategy for Gleno

Long Term Development Strategy for Ermera

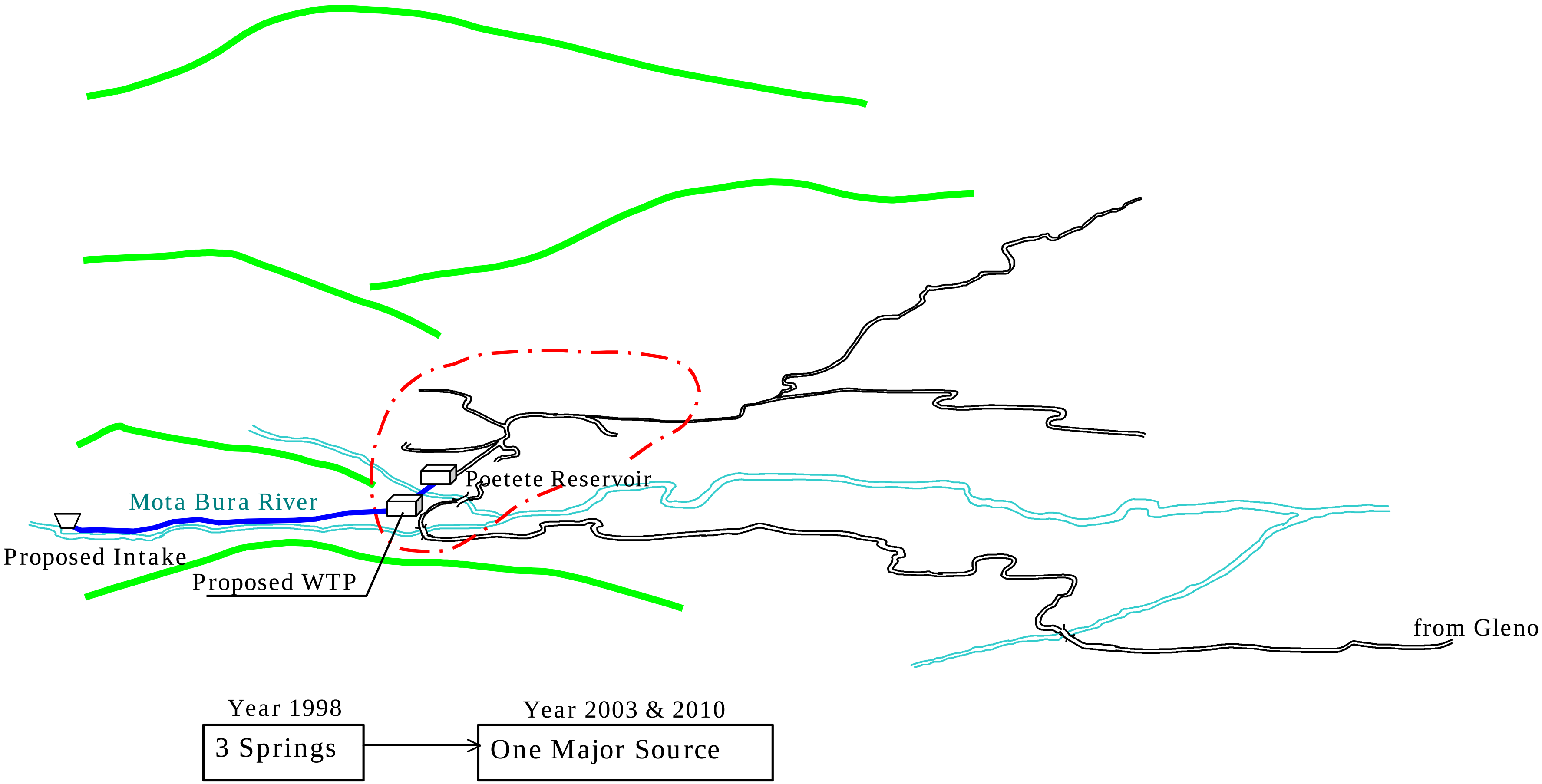

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Figure 6.12

Long Term Development Strategy for Ermera

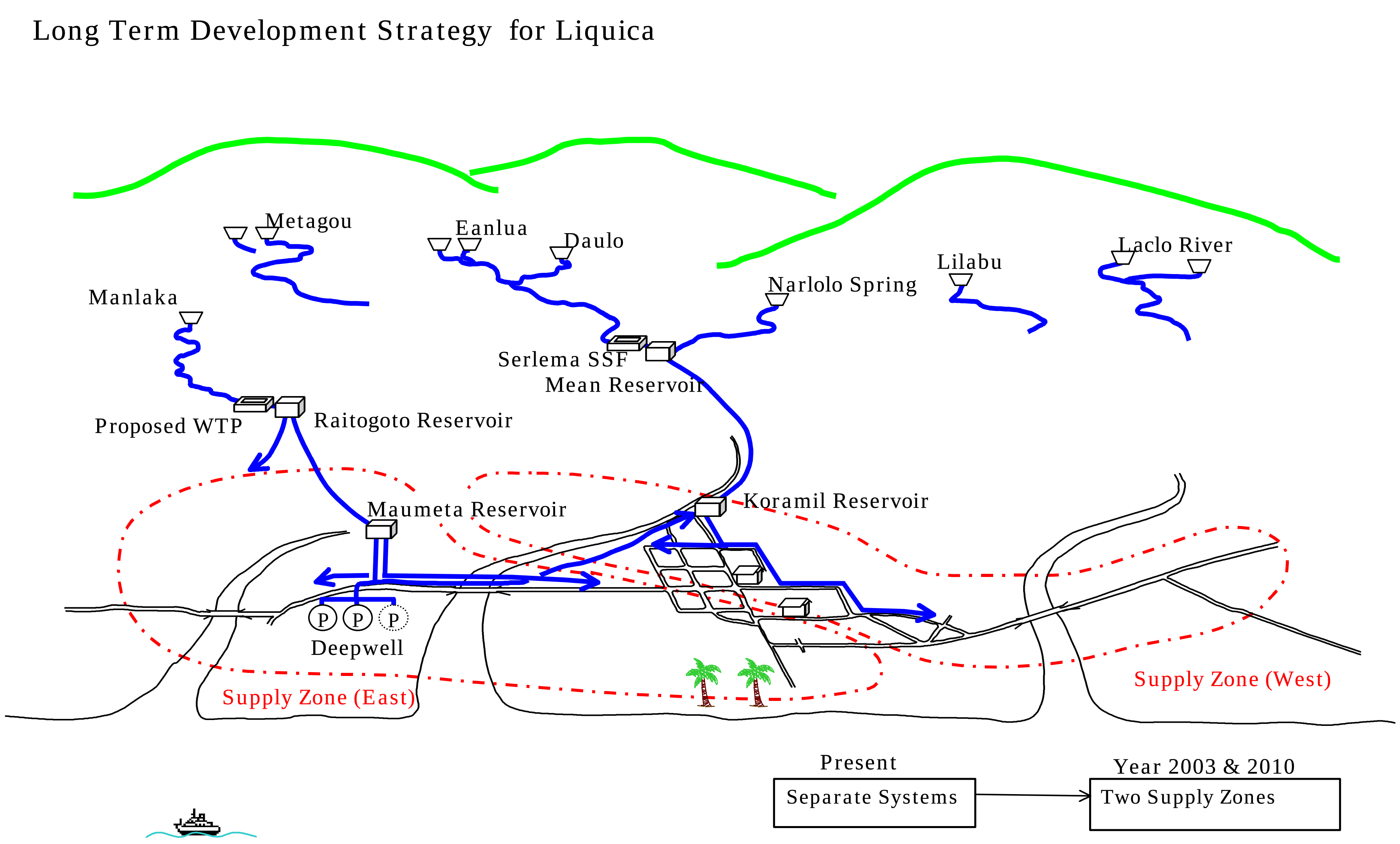

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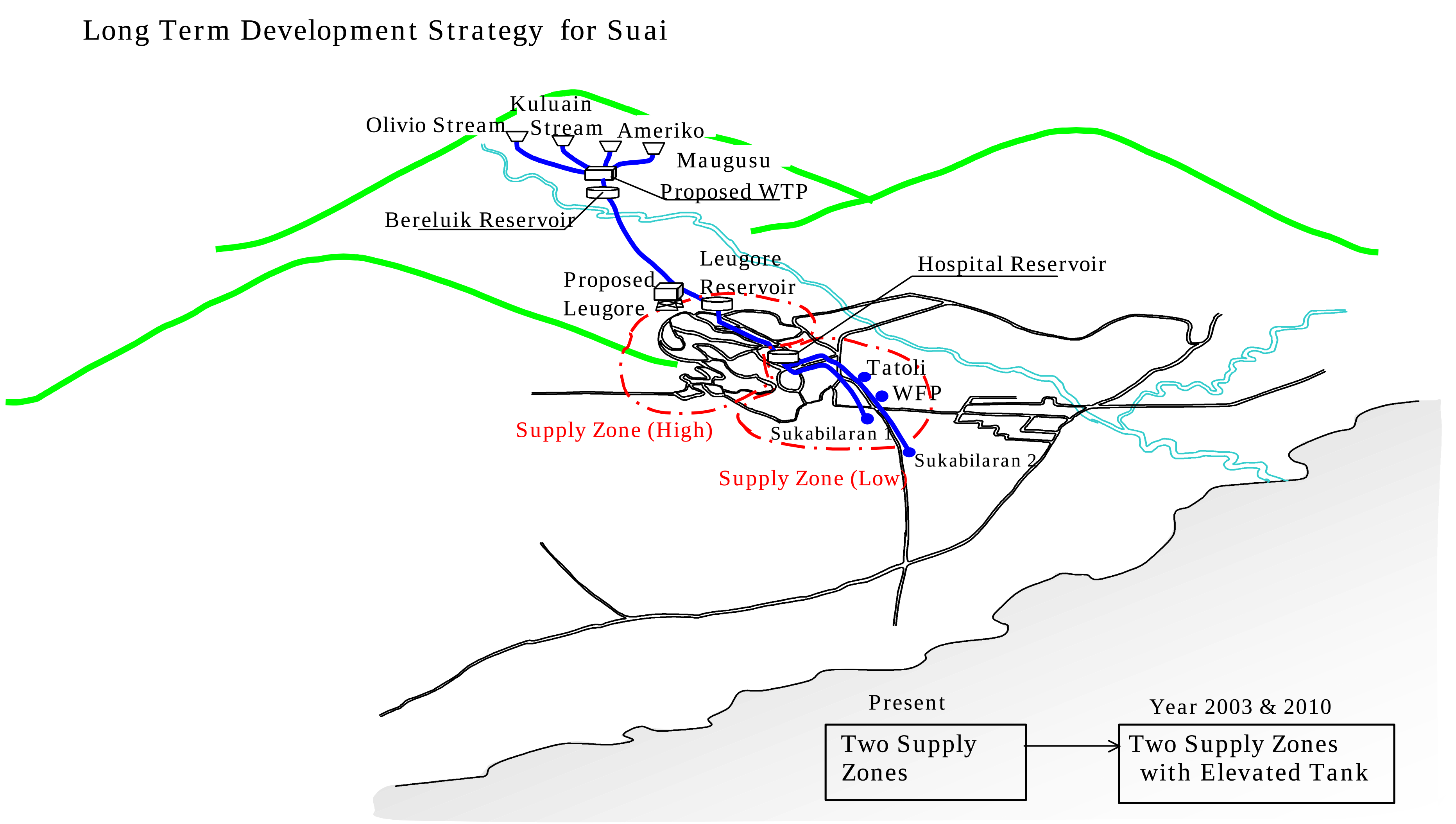
Figure 6.13

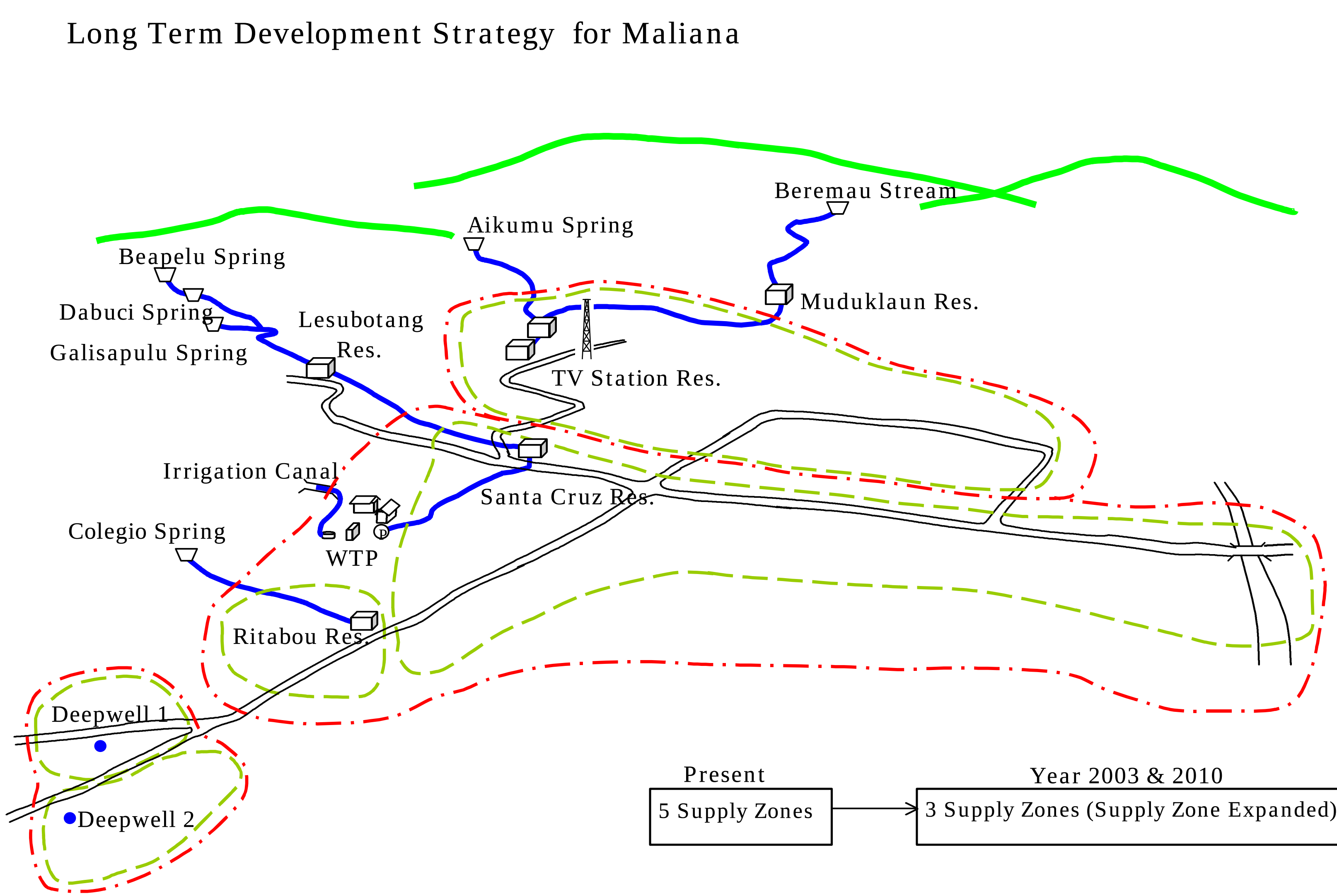
Long Term Development Strategy for Liquica



The Study onUrgent Improvement Project for the Water Supply System in East Timor

Long Term Development Strategy for Suai

Figure 6.14



The Study onUrgent Improvement Project for the Water Supply System in East Timor

Long Term Development Strategy for Maliana

Figure 6.15

7. INSTITUTIONAL DEVELOPMENT

Water and Sanitation Service (WSS) of East Timor Transitional Administration was established and expected to launch the services as nation building is being accelerated. However, constraints are:

- Globally deteriorated water supply facilities,
- Limited financial resources,
- Total lack of technical and management disciplines, and
- Lack of comprehensive laws and regulations to define the services.

With the halved personnel despite the minimum required 300, WSS had to start its organization building and daily operations as well. Its tentative organizational arrangement was envisaged to operate the services with the 150 national and some international personnel. It will be operated for the time being with a heavy central core in Dili, district subcenters with several intermediate functions and mere system operators at each system site. This centralized organization may be a product of under-resourced circumstances and yet to be tested by a longer time application.

With the present project targeted in 3 years of time, the water supply facilities in 15 towns will be significantly upgraded and a quarter of the national population is to enjoy safe and ample water at their house or with an easy reach. The TFET funded Project Management Unit will also help restore the facilities, enhance technical and managerial capacities and develop regulatory requirements.

As a particle of the unprecedented nation building efforts, the course of WSS's institution building will not be obviously streamlined. The target, however, would be clear. It should evolve itself to a public service provider managed and operated in accordance with modern utility efficiency standards and practices. To achieve this, various trainings, planning exercises and upgrading the operating systems are requisites. In addition, daily field operations are required to check escalating aggravation of the supply facilities. Now, exercise in the immediate action should be brought in. But, which action to be done at first?

The prime mover is the execution of the universal tariff.

- Bill by volume that is metered.
- Low collection rate may be allowed, but should be improved.

- Flexible cross subsidization will ease development of tariff collection.
- Tariff collection can be easily started when system is effectively renovated.
- Let everybody know that someone must pay the cost of water supply.
- Ban, preferably criminally, the unauthorized tapping of water pipes.
- Sell water from the public taps as well.
- Enact all the necessary laws and regulations.

This exercise is a challenge and the shortest path to the eventual cost recovery. It will bring about a forceful evolvement of organization, operation and manpower of the water supply service provider.

In case that the institution does not grow as expected, the institutional review to expedite its enhancement will be required.

8. FINANCIAL PLANNING

The fundamental issues when we develop a financial plan of water supply in East Timor are current economic turmoil and low per capita GDP. During Indonesian era, average per capita GDP of Indonesia was USD 1070 (1997) while the per capita GDP of East Timor was USD 339 (1994) and USD 428 (1996). Eighty five percent of financial resources of East Timor provincial government were subsidized from central government. Among 15 cities of study area, only the water supply in Dili collected water tariff at insufficient level to cover the water cost.

After above situation, the East Asian financial crisis and post-referendum violence attacked East Timor. The economy of East Timor became terrible situation. According to recent ADB survey (June 2000), per capita GDP of East Timor was estimated as USD 113.

But with assistance from international organizations and foreign countries and self-effort of residents, the economy is showing a trend to be stabilized and grow. We expect that the per capita GDP will recover to the before financial crisis level at the target year of 2003.

As for economic forecast, we considered two stories. The one is that the GDP per capita in 2003 will recover to the one in 1996. The other is it will recover to the one in 1994 because the GDP in 1996 was inflated with bubble economy of that time. Regarding real economic growth rate, we adopted two cases (6% or 4%). Population will increase at 1.5% annually (= Indonesian era) and inflation rate will be 3% annually.

Applying above assumption we have developed three cases, which is shown in Figure 8.1. Case A is standard case. Case B is conservative case. Case C is worst case.

The scope of financial planning is same as our proposed plan. It covers only rehabilitation works of 15 cities targeting the year of 2003. It does not include further development after 2003, rural water supply or sewerage service.

In case of typical financial analysis, we develop fund flow tables, loan repayment schedule and pro forma financial statements including balance sheet and FIRR. But, as it is very clear that financially it cannot be independent for substantial period, we compare only the tariff revenue from the proposed systems with the cost associated with the proposed systems (O&M cost and depreciation cost).

Our plan proposes the installment of water meter to individual connection and to collect water tariff by volume. In Dili water tariff collection will start on July 2001. We recommend tariff collection in other 14 cities at early stage when it becomes possible.

As to tariff level, we assumed 1.4 % (= water charge of Dili in Indonesian era) of per capita GDP as whole water revenue. The examination of tariff structure will be done during 2001. We expect the accommodation of cross subsidy among residents and among districts and application of progressive tariff rate and the separation of domestic tariff and institutional and commercial tariff. Collection rate will increase as time goes.

The facility life is 50 years (civil works) and 15 years (mechanical and electrical works). On average facility life in our project is 40.9 years. Depreciation expense is computed by 41 years straight-line method with 10% salvage value.

The result of revenue and cost estimate are shown in Figure 8.2 (Case A, standard case), Figure 8.3 (Case B, conservative case) and Figure 8.4 (Case C, worst case).

The year that tariff revenue exceeds O&M cost will be 2014 in Case A and 2022 in Case B. Even in 2030, subsidy from general budget or other resources is required in Case C.

The year that tariff revenue exceeds whole water cost including depreciation expense will be 2021 in Case A and 2026 in Case B.

Therefore, regarding financial prospect of proposed plan, the crucial factor is the level of GDP per capita. The tariff level and collection rate are important also but not the key to the financial sustainability.

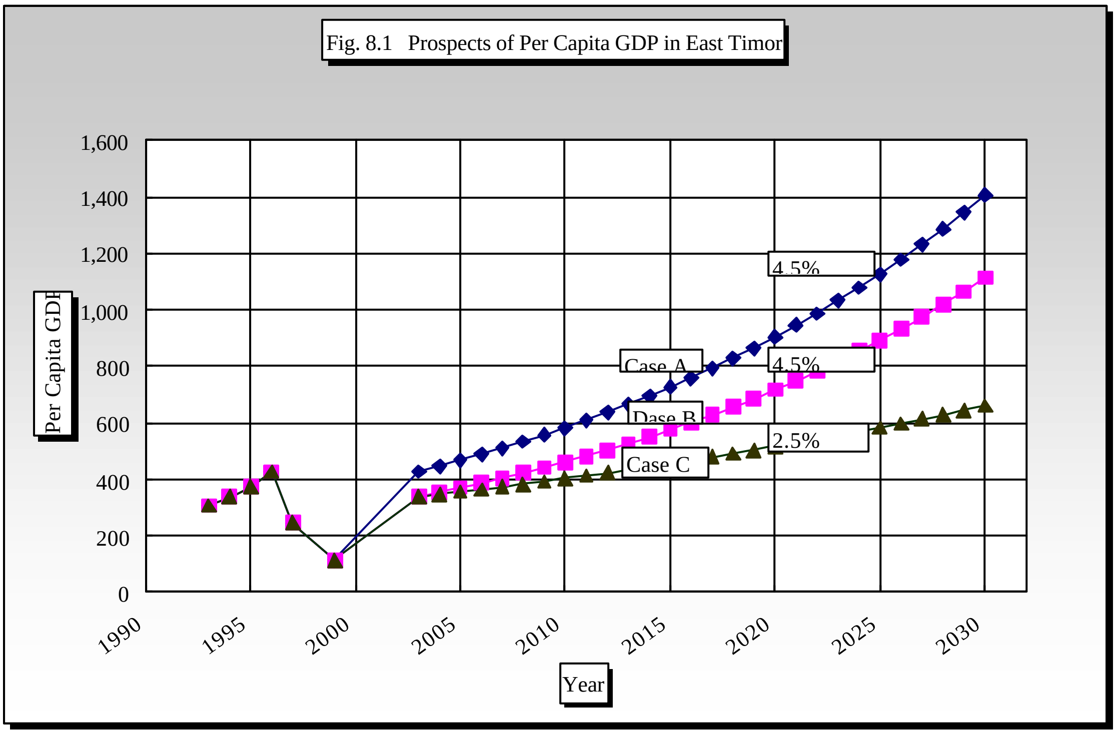


Fig. 8.1 Prospects of Per Capita GDP in East Timor
Per Capita GDP
1,600
1,400
1,200
1,000
800
600
400
200
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
4.5%
Case A
4.5%
2.5%
Case C

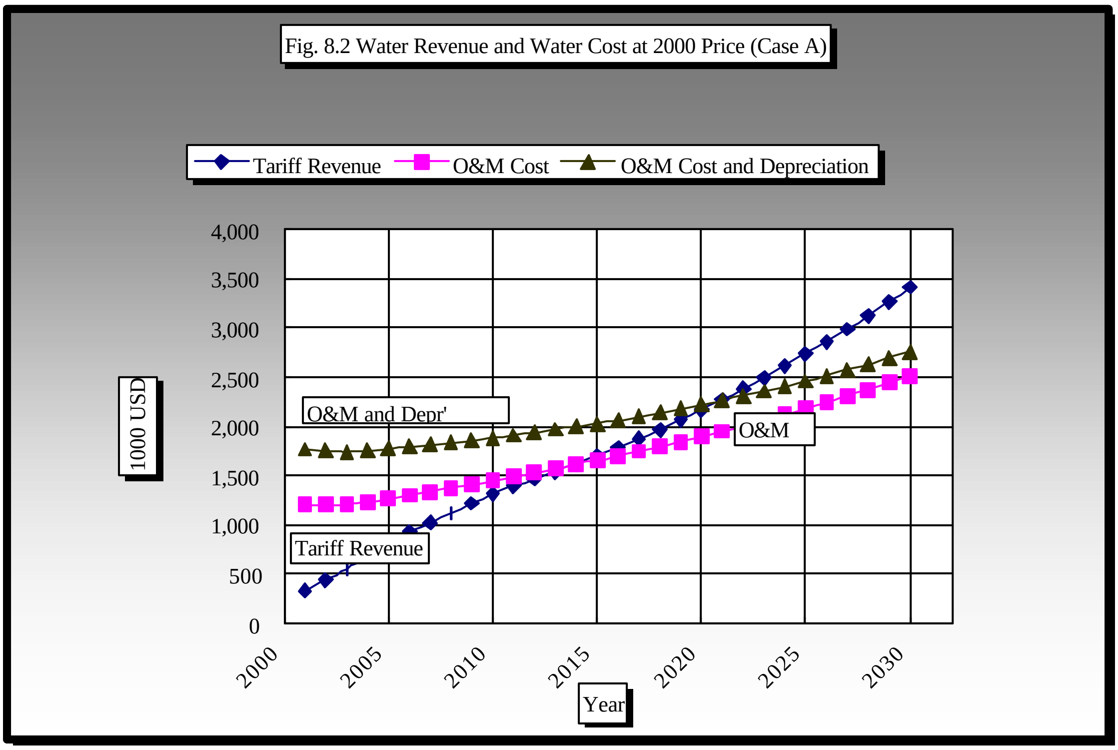


Fig. 8.2 Water Revenue and Water Cost at 2000 Price (Case A)
Tariff Revenue
O&M Cost
O&M Cost and Depreciation
1000 USD
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
O&M and Depr'
O&M
Tariff Revenue
2000
2005
2010
2015
2020
2025
2030
Year

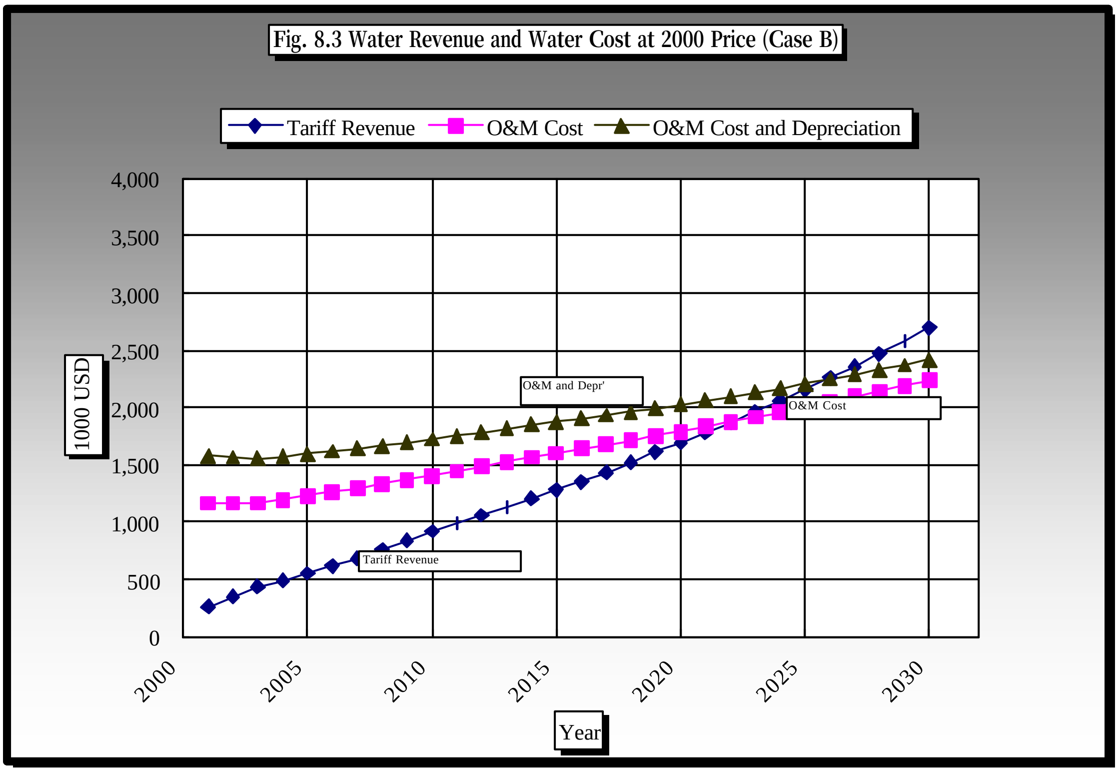


Fig. 8.3 Water Revenue and Water Cost at 2000 Price (Case B)
Tariff Revenue
O&M Cost
O&M Cost and Depreciation
1000 USD
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
O&M and Depr'
O&M Cost
Tariff Revenue
2000
2005
2010
2015
2020
2025
2030
Year

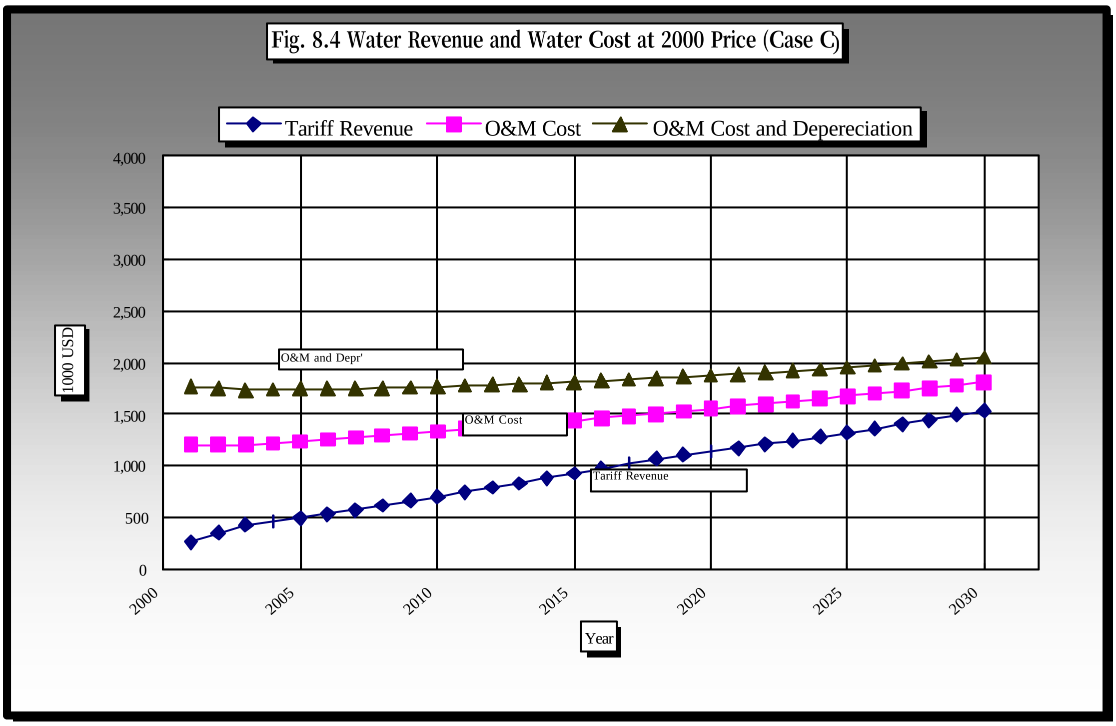


Fig. 8.4 Water Revenue and Water Cost at 2000 Price (Case C)
Tariff Revenue
O&M Cost
O&M Cost and Depereciation
1000 USD
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
O&M and Depr'
O&M Cost
Tariff Revenue
2000
2005
2010
2015
2020
2025
2030
Year

9. OVERALL EVALUATION AND RECOMMENDATIONS

9.1 Overall Evaluation

To prepare for the national government of East Timor, UNTAET is developing the institutions for public administration and the public infrastructure including water supply. With substantial absence of natural resources and industry other than agriculture, political and economic independence of a country of small land and population is greatly challenging. In the Study, the rehabilitation plan was formulated on the water supply system in 15 towns, which were either damaged directly after a post-referendum violence or not adequately functional due to the low-standards of planning and construction. In the formulation of the rehabilitation plan, due consideration was taken to select water source by avoiding drawdown of groundwater aquifer, and also socioeconomic consideration was duly made by adopting the gravity flow that is energy-saving, and by reducing the cost of facility, which would be possible when the proposed leakage control is undertaken. Therefore, implementation of the rehabilitation plan will bring about the stable water supply, resulting in the following socio-economic and environmental effects:

9.1.1 Socioeconomic Evaluation

The service areas of the 15 towns rehabilitation plan include the national capital and 11 district towns, which are major population centers of East Timor. A quarter of East Timorese population, i.e., approximately 200 thousand will be the direct beneficiaries. These service areas are centers of the regional socioeconomic activities. Populations from their hinterlands, who come to their marketplaces, are assumed indirect beneficiaries. Supply of clean and safe water does not only provide a basic human need, reduce the water-fetching labor and improve the sanitation, but also contribute to stabilize and promote regional economies by helping production and supply of the better food products, etc. It is thus expected to provide a basis for economic development of the entire land. Since rehabilitation of facility and operation thereof were designed on the basis of the lease cost, a large benefit/cost ratio is expected.

High unemployment rate in the towns where the industrial activity is poor will be positively reduced with increased employment opportunity generated by implementation of the rehabilitation programs. Populations who are thus participating in the program and its construction work will be exposed to the modern working standards, where the organized management is required. They may be provided with opportunities to learn such modern institutional behaviors. This may help establish the modern institutions, which are most needed in building the independent national government.

It is also proposed to let the people know that the water supply is provided for the price of costs, by means of the awareness raising activity or through the community participation. If this knowledge is propagated to everyone, decreased default of water bill and reduction of illegal connections are expected and the sound utility service will be brought about.

9.1.2 Environmental Evaluation

The water supply rehabilitation program as such is intended to improve the sanitation environment, and therefore improve environmental features of the region. During the implementation, however, some adverse impacts are temporarily possible. Environmental consideration on the following issues are desirably taken:

- Relocation of residents
  Facilities were located to the places where relocation was not necessary. Important impacts are not foreseen.

- Traffic hazards
  Distribution pipelines are often laid under the road. As traffic is not so dense in towns other than Dili, impacts will not be decisively significant. During construction, however, every caution should be taken.

- Water pollution
  Water pollution in drains and other waterways as well as groundwater aquifer is anticipated, since wastewater will increase as volume of water supply increase. Significant impact is less possible in towns, where volume of wastewater is not sizable. Regarding wastewater of the capital city, UNTAET is considering the needed measures on the basis of the sanitation master plan being undertaken by the Portuguese government. In the near future, wastewater treatment will be required in the larger urban centers.

- Residents participation
  Local communities in East Timor are solid and their members are closely linked. In implementing the plan, dialogue with residents is indispensable before and during construction works. It should be known by the residents that the water supply is installed for them and employment opportunities are provided to them.

9.2 Recommendations

The water supply sector, as well as other sectors of public infrastructure, has various problems as stated in the preceding chapters. To overcome these problems and to structure sustainable water supply system, recommendations suggested in the other chapters are hereby reiterated for integration.

9.2.1 Establishment of Organization

Regarding the institutional and operational setup of the water supply services of East Timor, the JICA Study Team has been discussing among itself, and with the Water and Sanitation Service (WSS) of UNTAET, with Project Management Unit of Asian Development Bank that is implementing the "Trust Fund for East Timor (TFET)," and with personnel of AusAID, who are helping mainly in capacity building.

As an overall consensus, water supply systems in district towns are to be operated by the government. Because of difficulty to operate small water supply systems in other local communities, it was confirmed that they would be entrusted to the self-help endeavor of the concerned residents. Because of difficulty to realize a sustainable water supply management system in each town, the management of water supply of Dili and district towns was unified under one service authority. Under this conception, most of the local staffs, whose budget ceiling is 153 members, have already been employed by WSS under supervision of international staff and UN volunteers.

9.2.2 Development of Human Resources

All Indonesian engineers and officers who were at the management of the former water supply authority have left East Timor after the referendum. Most of the local staff remained and employed by WSS is junior operators, plumbers and laborers. There is no senior engineer and managerial staff who can manage institutional and organizational development. It is urgently required to train staff for the administrative and engineering posts.

To strengthen organization/management capacity and to develop human resources, the Project Management Unit (PMU) was established within the WSS. PMU will prepare a fiscal budget of 4.0 ~ 4.5 million US dollars in coming three years for restoration of essential facility, and procurement of equipment. Moreover, institutional/human resources development including several training programs, development of legal and financial arrangements is scheduled to be implemented in cooperation with Australian technical assistance.

If the rehabilitation projects of water supply facility in 15 towns are implemented, and house connections and public taps are popularized widely, population served is expected to go up to about 25% of the total population. In addition, other donors and NGOs will also be implementing different rehabilitation projects during next few years. After completion of the projects, activity of WSS will be expanded manifold. Therefore, it is necessary to urgently strengthen its organization in the short term. To achieve this, exercises are required not only by the classroom training but also by training in actual application.

9.2.3 Development of Laws, Regulations and Standards

Under the UNTAET administration, legislation is frozen. It is, however, required to develop laws and regulations that define the water supply services during the transition to establishment of the East Timorese national government. In that a water supply service provider operated under the modern technical standards and the efficient operational practices shall be targeted, and eventually financial self-sustainability shall be pursued. Here, the following three principles are emphasized:

- Quality and quantity of distributed water – operation control
- The least cost – cost control, primarily leakage control
- Financial autonomy – cost recovery through tariff collection

The water supply service provider should acquire most effective means to eliminate leakages, check unauthorized connections, collect tariff by volume-based billing and thereby minimize unaccounted-for water and wasteful water use. To achieve these exercises, the service provider needs to be regulated, technically upgraded, ethically esteemed and publicly monitored. It should be suggested that the financially autonomous service provider be eventually pursued as the modern public utility standards. It would be also essential that it should be monitored by and accountable to the public.

9.2.4 Financial Planning

Although, operation and maintenance costs of water supply business are borne by UNTAET, it will be shifted to a new government after independence. The national government is expected to make a start in a few years. The government's revenue will not be optimistic. It is necessary to make the water supply service be operated without depending the government's subsidy. It is, therefore, proposed to initiate the tariff collection in the early stage.

Under current economical situation of East Timor, tariff collection rate is expected extremely low in the beginning. To solve this issue, it is necessary to improve O&M ability and organizational structure. In adopting a tariff system that rises in proportion to the consumption, burdens on poorer segment of people would be reduced. An acceptable rate for poverty area would be set up by introducing a regional tariff system, and so on.

Execution of tariff collection throughout the country is important. Even in a small-scale water supply operated by local community, the costs for operation and maintenance and also for replacement of equipment should be collected. For example, water supply from a public tap should be charged, too. In short, it should be understood by everyone that piped water supply has price and someone has to pay it. For propagation of this principle, comprehensive publicity activity is required and should be started right now.

Also, to achieve the least cost, leakage control program should be carried out frequently and continuously to reduce cost by minimizing the unaccounted-for water.

9.2.5 Sustainable Water Supply Facilities

It is thought that enthusiasm of water supply pervasion in the Indonesian era was substantial. Judging from the Japanese water supply standard, plenty of unsatisfactory structures were made. However, the Indonesian Government had provided water supply system not only to district town but also to smaller communities (over 60 places) throughout East Timor. Moreover, most structures were so designed as to minimize the operation costs. To obtain water without electric power and chemicals, water sources were located far beyond the mountain jungles and transmission pipes were laid up to the town struggling steep landforms.

At the stage when designed water supply capacity became unable to meet the demand that was increased by urban concentration of population, water treatment plant became necessary, but with sources from rivers that required minimum electric power. As and when the river water became insufficient in volume, then borehole well that required electric energy was installed. Rehabilitation plans of the present Study also followed these ideas wherever it was possible. Therefore, reconstruction and protection of transmission mains that tends to be damaged by flood or landslide were selected in the rehabilitation plan. In Urgent Grant Aid Project, the Study Team proposed rehabilitation of transmission mains in Dili. The Project will be completed in October 2002.

From the viewpoint of the sound water supply services, the existing systems do not have the proper control on water distribution. Everywhere in East Timor, there are many leakage points and illegal connections. Due to lack of maintenance of distribution system, damage and clogging in the distribution mains occur and it is hard to supply water properly. Illegal connections with low-skilled job have been constructed at cheerful mains that preferred beforehand. As a result, new leakages are taking place and it is more and more hard to secure portable water. Consequently, considerable sum of money will be required for taking measures to leakage control/illegal connections. Water distribution control system must be adopted into the rehabilitation plan in terms of sound management of water supply services.

General concepts of rehabilitation plan are as follows:

- Reliable transmission pipelines
- Safe and acceptable water quality
- Efficient water distribution management
- Maximize service coverage

9.2.6 Flexibility of Project Management and Possibility of Japan's Cooperation

It is essential to ensure proper operation and maintenance of facilities in implementing the water supply rehabilitation projects for 15 towns. This implies that success of the rehabilitation projects depends on the success of the capacity building programs being planned and carried out by PMU. To follow up this, institutional, organizational and financial reviews shall be made during stages of rehabilitation project, and if it is found necessary, technical and financial experts will be inputted and additional organization strengthening measure will be suggested.

Among suggested proposals, the following will be the ones for that Japanese cooperation may be possible and such may bring positive effects:

(1) Preparation of Water Service Ledger in Dili

In Dili, which is largest town, it is necessary to start tariff collection for stable management as soon as possible. Concretely, using water supply GIS system, house connection data are processed into the system as ledger data. After completing all data input, basic water service data, such as whether connected or not, issue a bill statement to the customer, payment condition are available. It is recommended that East Timor shall request the Japanese Government to dispatch concerned experts to assist the project.

(2) Operation of Treatment Process and Water Quality Analysis

Presently, for larger towns, water sources are rivers. In the case of heavy rain, turbidity of river water increases and needs proper water treatment. But due to lack of O&M skills, the treatment is not done satisfactorily. By dispatching not only expert of O&M of Water Treatment Plant but also expert of water quality analysis, it is possible to supply stable and safe water. East Timor is advised to officially request the dispatch of such experts.

(3) Leakage Control

An unaccounted-for water in East Timor water supply system is high same as in other developing countries. To improve this, facility expansion and new installation should be postponed and at the same time capital cost is saved. If unaccounted-for water reduces 20 ~ 30 %, it is cost-effective for the moment. Leakage detection and repair was carried out within the Study. Intensifying and continuing leakage control program by dispatching an expert is essential. East Timor shall also request the Japanese Government to dispatch such an expert.

(4) Awareness Uplifting Activity

There are many residents who do not recognize costs of construction, operation and maintenance of water supply facility. Moreover, because of lack of understanding about water supply facility, many illegal connections and poor-constructions take place all over the country. Hygiene education was experimented in the Study tentatively but effectively. An extensive awareness-uplifting activity is required to let more people to understand water supply and its costs. Propagation of awareness to be undertaken by an expert or specialist is effective to raise rate of tariff collection and proper use of water supply facility. Therefore, East Timor is again advised to officially request dispatch of such expert.