4. PLANNING FUNDAMENTALS AND STRATEGY

4.1 SECTOR POLICY

Due to resource constraints and other reasons, it is not possible to focus concurrently on all of the problems that Yangon is facing on its water supply system in the current project. This leads to the selection of priorities for further planning. The overall sector priorities of the Master Plan are given in Table 4.1.

Table 4.1 Sector Priorities

Component	Priority
Township	33 Township with different service ratio
Supply sub-system	Pipe system
Method of supply	Individual connections with meter
Water Source and Treatment	Develop surface water source and reduce exiting tube well numbers. Supply priority is surface water in central block. Two new Water Treatment plants will be constructed to assure the water quality.
Existing Facilities	Rehabilitate aged pipes and facilities Unnecessary facilities under the new supply concept (zoning system) are abandoned.
Industrial Zones	Start to supply YCDC water

Working along the above priorities, the Master Plan has established six main goals for achievement by its target year of 2020 as listed below:

- Customer access to water from the current 37% service ratio will be increased to 70%.
- Current Leakage ratio (50 %) will be reduced to 25 % as a goal.
- Townships served with supply increased from current 26 to all (33) townships .
- Two new WTP (Water Treatment Plant) construction (One for river water and the other for reservoir water).
- Service condition in terms of supply pressure and duration will be improved by zoning system.
- Staff capability for planning, monitoring and implementation will have enhanced

4.2 WATER CONSUMPTION

4.2.1 Water Tariff

The current water tariff has 3 categories, namely, Domestic, Department, Commercial&Industry, as shown in Table 4.2. The bills are issued to un-metered domestic and commercial & industry customers each quarter. Water meter is read every month and the bills are issued every month. The un-metered department customers are issued bills once a year. It is YCDC policy to collect water charges from all types of customers except from these who enjoy free water (monastery etc). The total number of connections is 112,315 of which only 23 % (25,652 connections) are metered (Table 4.3).

Table 4.2 Water Tariff Rate

		Domestic	Dept.	Com.&Ind.	Others
Metered	(Kyats/1000 gallon)	30	20	135	-
	(Kyats/m^3)	6.60	4.40	29.70	-
Un-Metered	(Kyats/bill/month)	120	-	-	202

Table 4.3 Number of Metered and Un-metered Connections

	Domestic	Dept.	Com.&Ind.	Total
Metered	22,612	101	2,939	25,652
Unmetered	82,020	1,171	3,472	86,663
Total	104,632	1,272	6,411	112,315

In the year of 2000, the a total revenue of 308 million Kyats has been collected (84 million Kyats from metered customers and 224 million Kyats from un-metered customers).

4.2.2 Domestic Water Consumption

(a) Metered

According to YCDC data, the total metered domestic consumption is 5,648,000 m^3/year in 2000. The highest is 271 lpcd (l/capita/day) in Yankin and the lowest is 75 lpcd in Ahlone. The average lpcd for relatively better condition's townships in term of pressure and supply duration (Hlaing, Insein, Mayangone, Mingaladon, Tamwe, Yankin see Figure 4.5 or Table 4.10) is about 180 lpcd.

(b) Un-metered

The un-metered water consumption is estimated as 25,340,000 m^3/year in 2000, using the number of bills issued, estimated per capita consumption, and average household size (7 person/household).

4.2.3 Department Water Consumption

Meterd to un-metred ratio is about 1:12 (very low metered rate). Since the water tariff (un-meterd department is 4.4 kyats/m^3 and un-metered bill amount in 2000 is 72,302,579 Kyats, un-metered

customer's consumption is 16,432,000 m^3/year (2000). The total consumption for department is about 16,965,000 m^3/year in total.

4.2.4 Commercial & Industry Water Consumption

The estimated water consumption is as follows,

Metered	: 1,486,000 m^3/day (2000)
Un-metered	: 1,115,000 m^3/year (2000)
Total	: 2,601,000 m^3/year (2000)

The total water consumption data indicate that the domestic water use is the highest (61 % of total) followed by Department use (34 %). Current usage by Commercial & Industry category is only 5 %.

4.3 FUTURE DEMAND ESTIMATION

Per Capita Consumption for the target year (2020) is set to 200 lpcd. For the domestic, per capita consumption applied for different years is ; 200 lpcd at 2020, 140 lpcd :2000:current , 150 lpcd:2005, 170 lpcd :2010, 190 lpcd :2015. For the Department, the current ratio (except large users) to domestic (7 %) and the large users (as per present actual use) is used. For the Commercial & Industry, it is planned to use the current ratio to domestic (8%) and the conversion factor (2.12). Thus the 17 % of ratio to domestic is applied for future demand estimation. For the Industrial Zone (7 existing and 2 planned), the water demand is estimated using built up ratio (using plot number in the Industry Zones) and consumer surveys result (average water use for a industry: 598 m^3/month/company).

Table 4.4 shows estimated total demand.

Table 4.4 Estimated Demand

Year					2000	2005	2010	2015	2020
Total Population				(Persons)	3,887,000	4,403,000	4,955,000	5,541,000	6,159,000
Service Ratio				(%)	37%	50%	60%	65%	70%
Served Population				(Persons)	1,443,441	2,201,500	2,973,000	3,601,650	4,311,300
Daily Average Consumption	Domestic	Percapita		(lpcd)	140	150	170	190	200
		Total	Consumption	(m^3/day)	202,703	330,225	505,410	684,314	862,260
	Department	Total	Consumption	(m^3/day)	46,480	63,838	76,101	88,624	101,080
	Commercial & Industry		Consumption	(m^3/day)	7,123	56,138	85,920	116,333	146,584
		Industrial Zones	Consumption	(m^3/day)	0	44,930	65,581	81,467	85,532
		Total	Consumption	(m^3/day)	7,123	101,068	151,501	197,800	232,116
	Total			(m^3/day)	256,306	495,131	733,012	970,738	1,195,456
Leakage Ratio	Ratio			(%)	50	45	40	35	25
	Amount			(m^3/day)	256,306	405,107	488,675	522,705	398,485
Design Daily Average Demand				(m^3/day)	512,612	900,238	1,221,687	1,493,443	1,593,941
Design Daily Average Demand per capita				(lpcd)	355	409	411	415	370
Design Daily Maximum Demand				(m^3/day)	615,134	1,080,286	1,466,024	1,792,131	1,912,729
Design Daily Maximum Demand per capita				(lpcd)	426	491	493	498	444
Peak Factor					1.2	1.2	1.2	1.2	1.2

As can be seen in the table, the following Planning Policies are set as the goals for this Master Plan.

- 70 % of Service ratio is recommended at the target year, which is about twice as much as existing one (37 %).
- Current Leakage ratio is considered as 50 % which will be reduced to half (25 %) at the target year.
- As the result, the total Demand in the target year (2020) becomes 1,912,700 m^3/day, which is about 3 times than the current demand (2000: 615,134 m^3/day).

4.4 CURRENT WATER SOURCES

The existing water sources produce 439,440 m^3/day as of 2000.

Surface water (Reservoirs)	: 395,550 m^3/day
Groundwater	: 43,890 m^3/day

This actual production rate is only 71 % of the estimated demand in 2000 (615,134 m^3/day). To meet the demand of 2020 (target year), an additional water supply of 1,473,300 m^3/day is required.

4.5 WATER SOURCE POTENTIAL

4.5.1 Surface Water

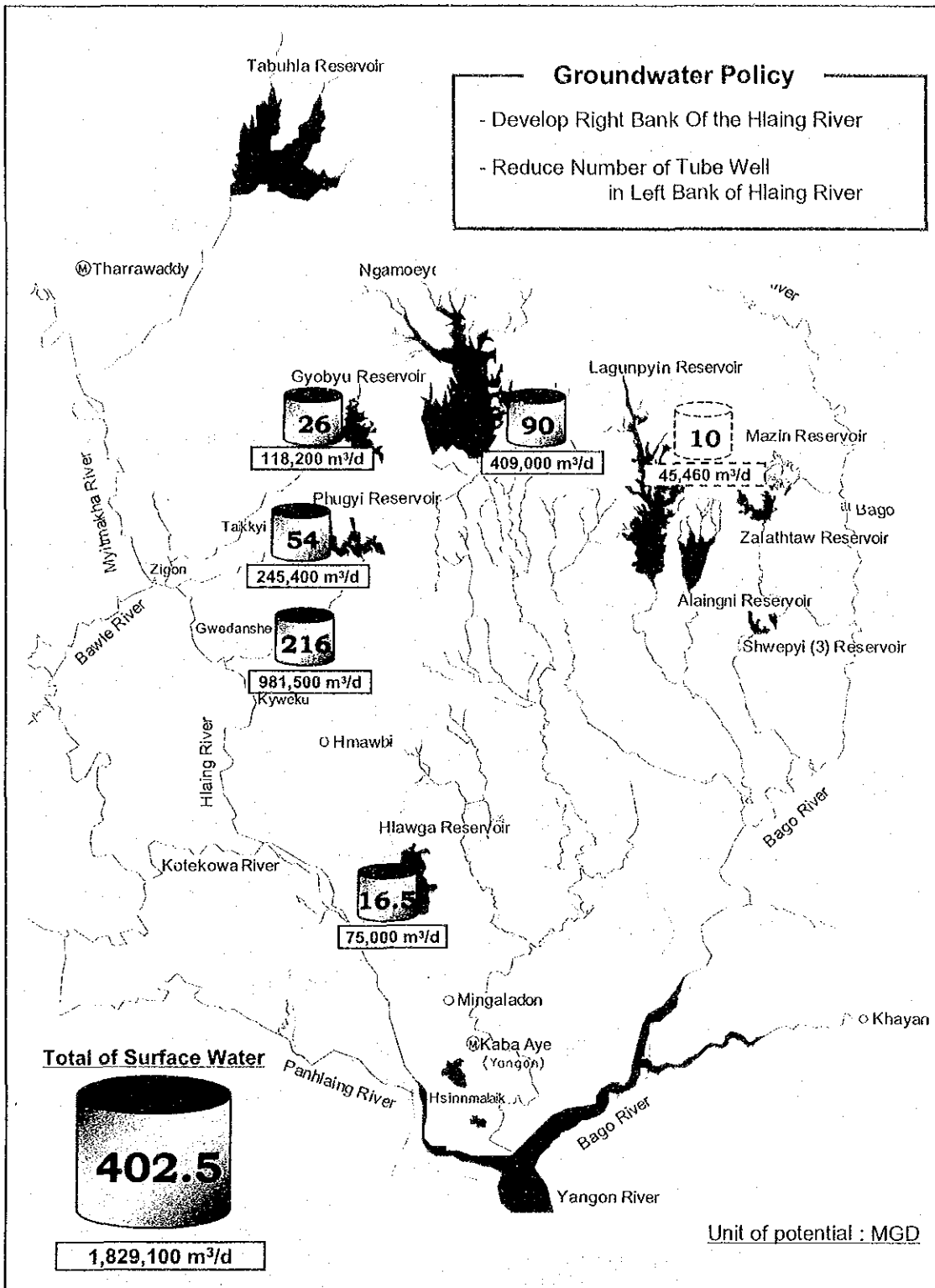
Water balance study was conducted at 5 reservoirs, namely Gyobyu Reservoir, Phugyi Reservoir, Hlawga Reservoir, Nagamoyeik Reservoir and Lagunbyin Reservoir. The results of analysis for the water balance study shows that the existing reservoirs could be developed as future water sources from 893,300 m^3/d in maximum to 868,300 m^3/d in minimum on condition of maintaining the low water level of each reservoir during the drought year.

Based on the results, the following reservoir potential is used for this study.

Gyobyu Reservoir	: 118,200 m^3/day
Phugyi Reservoir	: 245,400 m^3/day
Hlawga Reservoir	: 75,000 m^3/day
Ngamoyeik Reservoir	: 409,100 m^3/day
Lagunbyin Reservoir	: 45,460 m^3/day

The surface water potential is schematically shown in Figure 4.1.

In addition, the other surface water sources which could possibly provide water to the City are Hlaing River and Bago River. The results of the investigations on these rivers reveal that:



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 4.1
	Surface Water Potential	

- It is difficult to intake water from Bago river.
- At Gwedanshe (Hlain river), 11.4 m^3/s (981,500 m^3/day) is considered as feasible intake amount.
- Two Water Treatment Plants will be planned; one for river water (Hlaing river) and the other for reservoir water.

4.5.2 Groundwater

The policy for groundwater development will be:

- Groundwater development will be planned in the right bank of Hlaing River, namely, Dala, part of Kyeemyinndaing, Seikkyi Kanaungto, and Hlaingthaya townships, on the other hands, existing tube well number is planned to be decreased.
- At the target year, about 157,800 m^3/day of water have to be supplied by Tube wells, which is about 8 % of total demand (1,912,729 m^3/day).

4.6 ZONING SYSTEM

The concept of zoning system has been introduced in an attempt to improve water supply system in terms of providing adequate pressure and quantity.

4.6.1 Zoning Fundamentals

(1) Separation of distribution system from transmission system

The followings are advantages of the system where distribution system is separated from transmission system.

- Easy monitoring of flow rate and pressure in the transmission system and the distribution system.
- Easy and fair allocation of water to each water zone.
- Smaller size and costs of the water supply facility.

Due to these advantages, it is proposed that the distribution system is separated from the transmission system. To achieve the separation, all off-takes should be disconnected from the transmission mains in future.

(2) Advantages of zoning system

There are several advantages of a zoning system listed below.

- Easy monitoring and control of flow rates and pressure in the zones
- Easy monitoring and control of leakages
- Easy operation and maintenance by zone

The conceptual layout of separation of distribution from transmission system and zoning

system is shown in Figure 4.2.

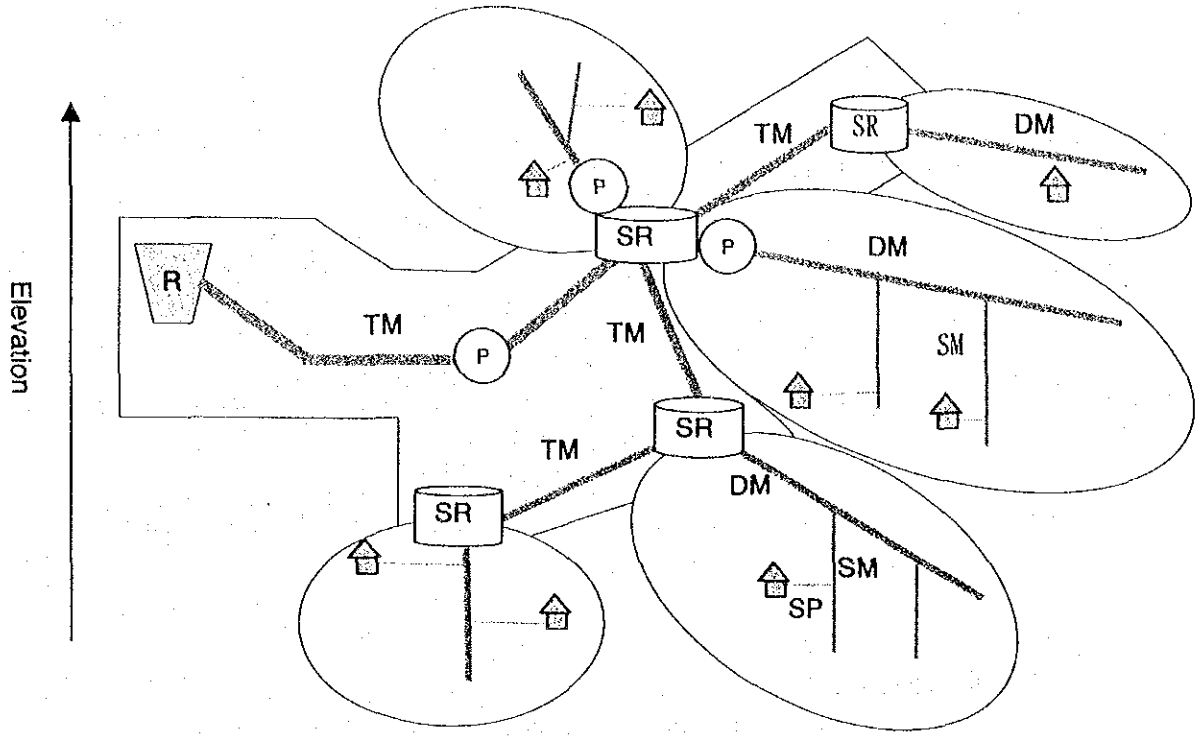


Figure 4.2 Proposed Water Supply System (Zoning System: A Transmission System and Several Distribution Zones)

4.6.2 Design Criteria

Design flows and formulas and conditions used in planning and designing the transmission and distribution systems are set up as below.

Design Flows and Formulas

(1) Daily average water demand (m^3/day):Qave

Daily average water demand is calculated by dividing annual total water demand by 365 days.

Qave = Annual total water demand / 365 days

(2) Daily maximum water demand (m^3/day): Qmax

This demand generally occurs during the hot season, when people consume maximum amount of water.

= Design capacity for water sources, intake, raw water main, treatment plant, transmission system (mains and pumps)

For Yangon City

Peak factor = 1.2 of the daily average water demand (Qmax = 1.2 x Qave)

(3) Hourly maximum water demand (m^3/day): Qhr

= Design capacity for distribution system (mains and pumps)

For Yangon City

Hourly Factor = 1.4 of the average hourly demand in the daily maximum water demand (Qhr = 1.4 x Qmax)

(4) Daily demand profile

= Design capacity for service reservoirs

For Yangon City

Storage volume = 8-hours demand of hourly average of the daily maximum demand

(5) Pressure requirement

A minimum distribution pressure in the mains is 15 m head (1.5 kg/cm^2), which ensures that water is supplied to the second or third floor.

(6) Pipe friction formula

Hazen-Williams formula is used to analyze the existing water supply system and to design the proposed new pipelines with Hazen-Williams C-factor of 120 for new pipes.

(7) Network analysis software

Info Works WS Ver.3.5, Water Research Center is used to analyze the present network system and to design future network systems.

4.6.3 Planning Conditions

(1) Water Demand

Table 4.5 shows summary of planned yearly water demand from 2000 to the target year of 2020.

Table 4.5 Summary of Water Demand

	2000	2005	2010	2015	2020
Population	3,887,000	4,403,000	4,955,000	5,541,000	6,159,000
Service Population	1,443,441	2,201,500	2,973,000	3,601,650	4,311,300
Service ratio (%)	37	50	60	65	70
Net consumption (m^3/day)	256,306	495,131	733,012	970,730	1,195,456
Leakage ratio (%)	50	45	40	35	25
Average water demand (m^3/day)	512,612	900,238	1,221,687	1,493,443	1,593,941
Maximum water demand (m^3/day)	615,134	1,080,286	1,466,024	1,792,131	1,912,729

(2) Water Source

The existing and proposed water sources for YCDC water supply system are given in Table 4.6.

Table 4.6 Water Sources Summary

Name of source	Existing or new	Source amount (m^3/day)
A. Reservoir		
a) Hlawga reservoir	Existing source	75,000
b) Gyobyu reservoir	Existing source	118,200
c) Pyujyi reservoir	Existing source	245,400
d) Ngamoiyeik reservoir	New source	409,000
Sub-total		847,600
B. Groundwater	Existing and new	158,500
C. Hlaing river	New source	981,500
Total		1,987,600

(3) Water Treatment Plant

All the water of the reservoir system are conveyed from the source to the Hlawga reservoir area and treated in bulk with direct filtration process (**Hlawga WTP**). On the other hand, Hlaing river water is drawn at Gwandansha and treated with coagulation and filtration process at the site (**Hlaing WTP**). Then the treated water is conveyed to the city area for distribution. Groundwater, especially right bank of Hlaing river, is withdrawn and treated with disinfection and injected into distribution system. However, groundwater in Hlaing-thaya township has high concentration of manganese and iron, which will be treated with appropriate treatment process and injected into distribution system.

4.7 PROPOSED TRANSMISSION AND DISTRIBUTION SYSTEM

Groundwater is small potion of total amount of the source and will be injected on the site where the water is withdrawn. On the other hand, reservoir and river sources are located in remote area of the city and need to convey to the city area for distribution. Therefore reservoir and river sources are mainly considered when transmission and distribution system is planned.

4.7.1 Transmission System Alternatives

(1) Alternative A: Combined System (CS)

The river system and the reservoir system are combined at the Terminal Reservoir and both source waters are mixed. Then mixed water is transmitted to service reservoirs and distributed at each service reservoir to customers. In this transmission system, two major pipelines will be laid along the central ridge of the city and in the eastern city.

(2) Alternative B: Separate System (SS)

The river system and reservoir system are separated and each system's water is separately transmitted to service reservoirs of the zones covered by each system. Then water is distributed from each service reservoir. In this transmission system, two major pipelines will be laid in the western low land and in the eastern city. The river system and the reservoir system cover the western city and the eastern city, respectively.

Upon comparison and weighing of merits and demerits of both system, it is proposed to adopt the combined system for the future water supply system of the Yangon city, because of the advantages in flexible source management, higher reliability, less complicated operation and maintenance, and large water supply areas in the transitional stage to the new system.

4.8 CREATION OF A ZONING SYSTEM

4.8.1 Preconditions

A zoning system is introduced to the existing system based on following conditions.

1) Natural system
2) Administrative boundaries
3) Artificial structures
4) Availability of land

4.8.2 Distribution Zoning Concepts

(1) Service reservoir

One service reservoir should cover one zone except the area covering existing service reservoirs and the location of service reservoir should be center of the zone as much as possible.

(2) Terminal Reservoir

Terminal Reservoir, where the treated water from both the river and reservoir system are mixed, will be located near the Hlawga No.1 Pumping Station. The elevation of the proposed site should be less than 45 feet to draw the Hlawga reservoir water with gravity.

(3) East Block

The elevation of this block ranges from about 3 m to 9 m. There is no high land where water can be supply with gravity flow. In this block, water must be supplied with pump. Considering township boundaries and the area and extent of the block, it is appropriate that three zones are established. To convey water to each zone from the Terminal Reservoir, a transmission main will be laid along the center of the Block.

(4) Central Block

The elevation of this block ranges from about 3 m to 37 m. To supply water with gravity in the most area in this block, service reservoirs should be located in the central ridge of the

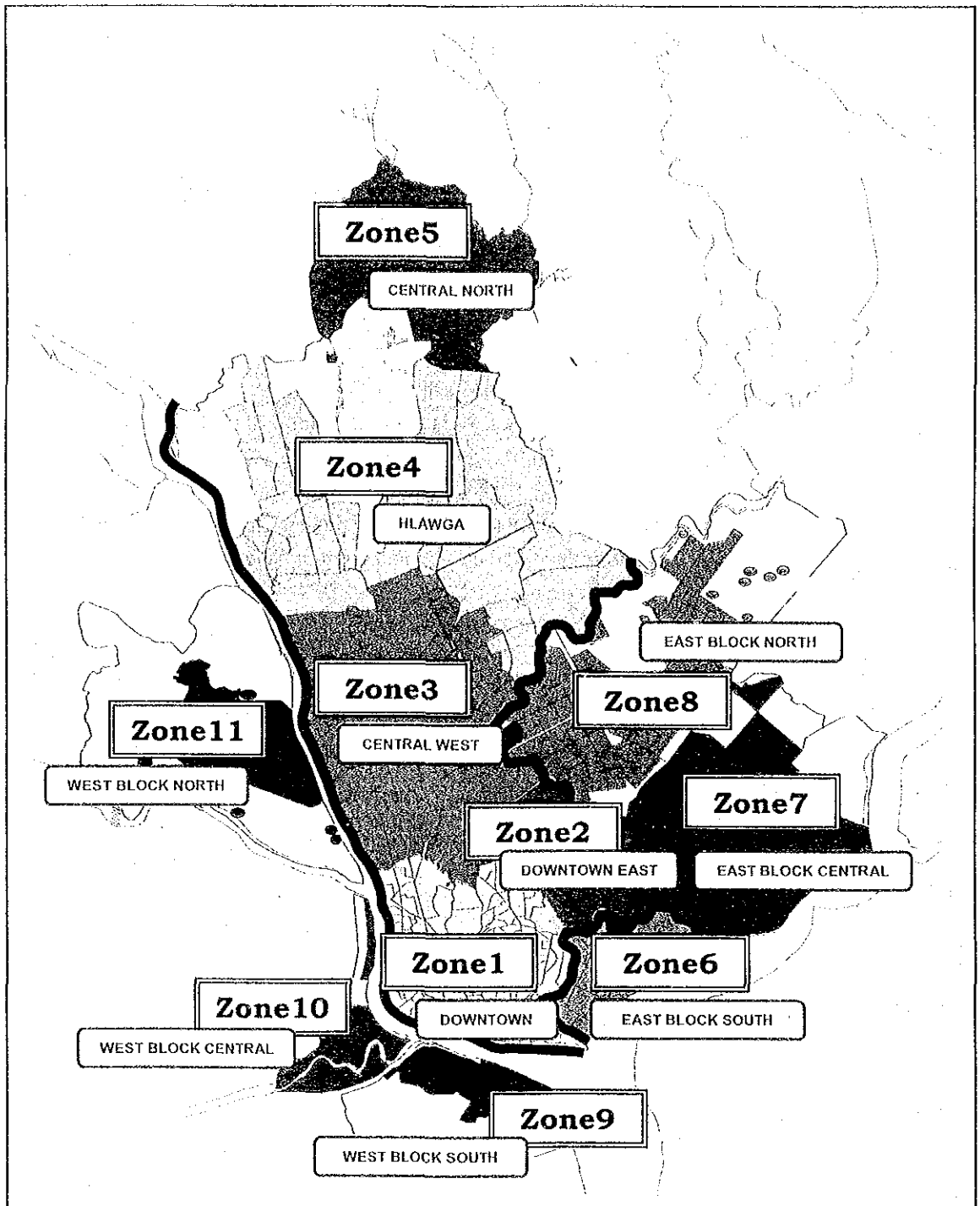
city and a transmission main also should be located along this ridge.

When zoning is designed in this block, the existing service reservoirs, Kokine, Central and Shwedagon cover a zone of the downtown area and existing transmission mains are used to fill these reservoirs. About 450,000 m^3 can be supplied from the existing reservoirs. A zone will be made for covering this demand in the downtown area. For the rest of the area, four (4) zones will be appropriate considering the topography and township boundaries.

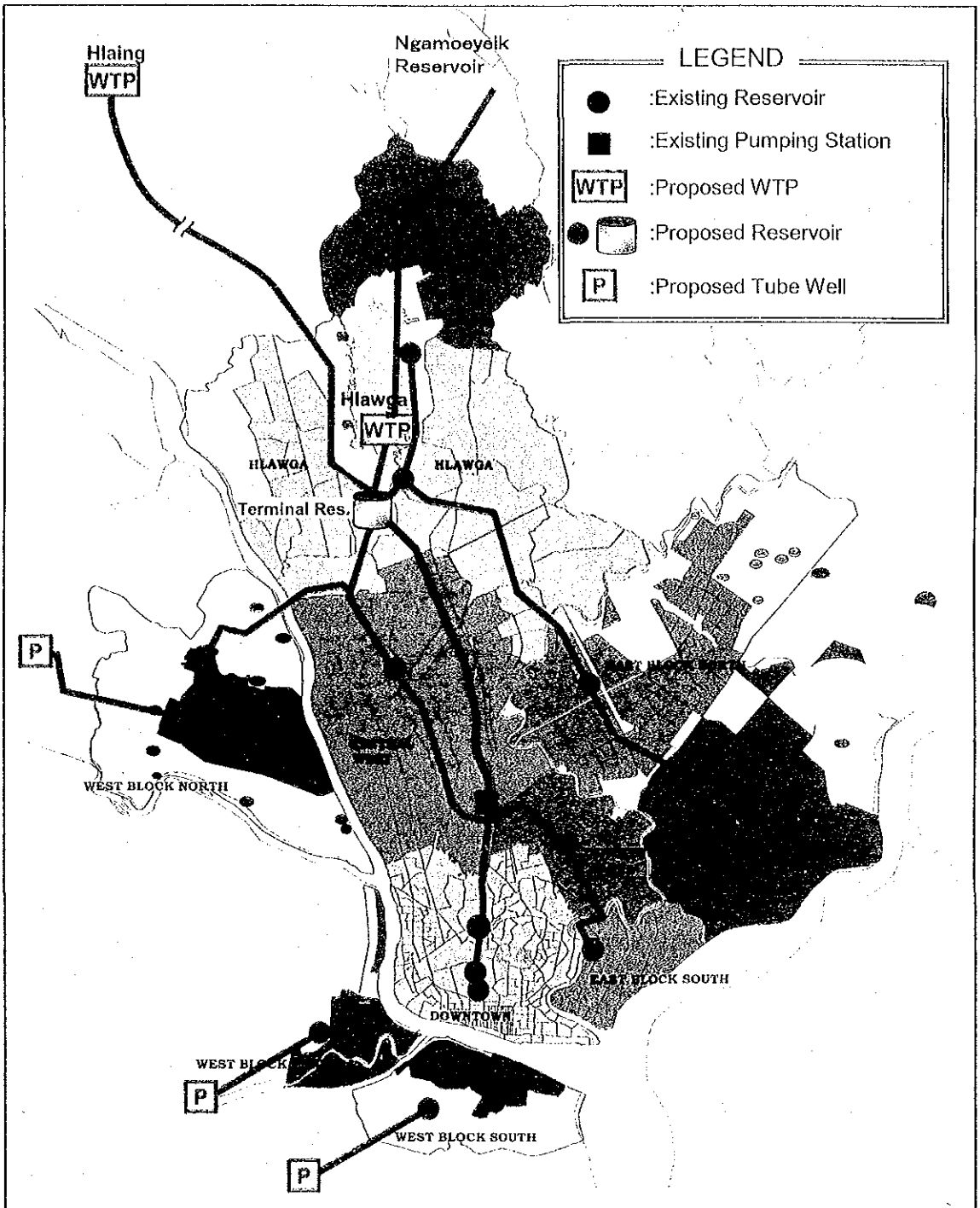
(5) West Block

The elevation of this block ranges from about 3 m to 9 m. Most of the West Block is supplied with the groundwater withdrawn in each area. Only in Hlaingthaya, the groundwater supply will be supplemented by surface water from the Central Block. A transmission main from the Central Block is required for this township.

Based on the conditions and concepts stated above, the total Yangon City is divided into 11 zones (See Figure 4.3). Proposed facilities based on the zoning system is shown in Figure 4.4 and their elevation map is shown in Figure 4.5.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 4.3
	Eleven (11) Zones	



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 4.4
	Proposed Facilities	

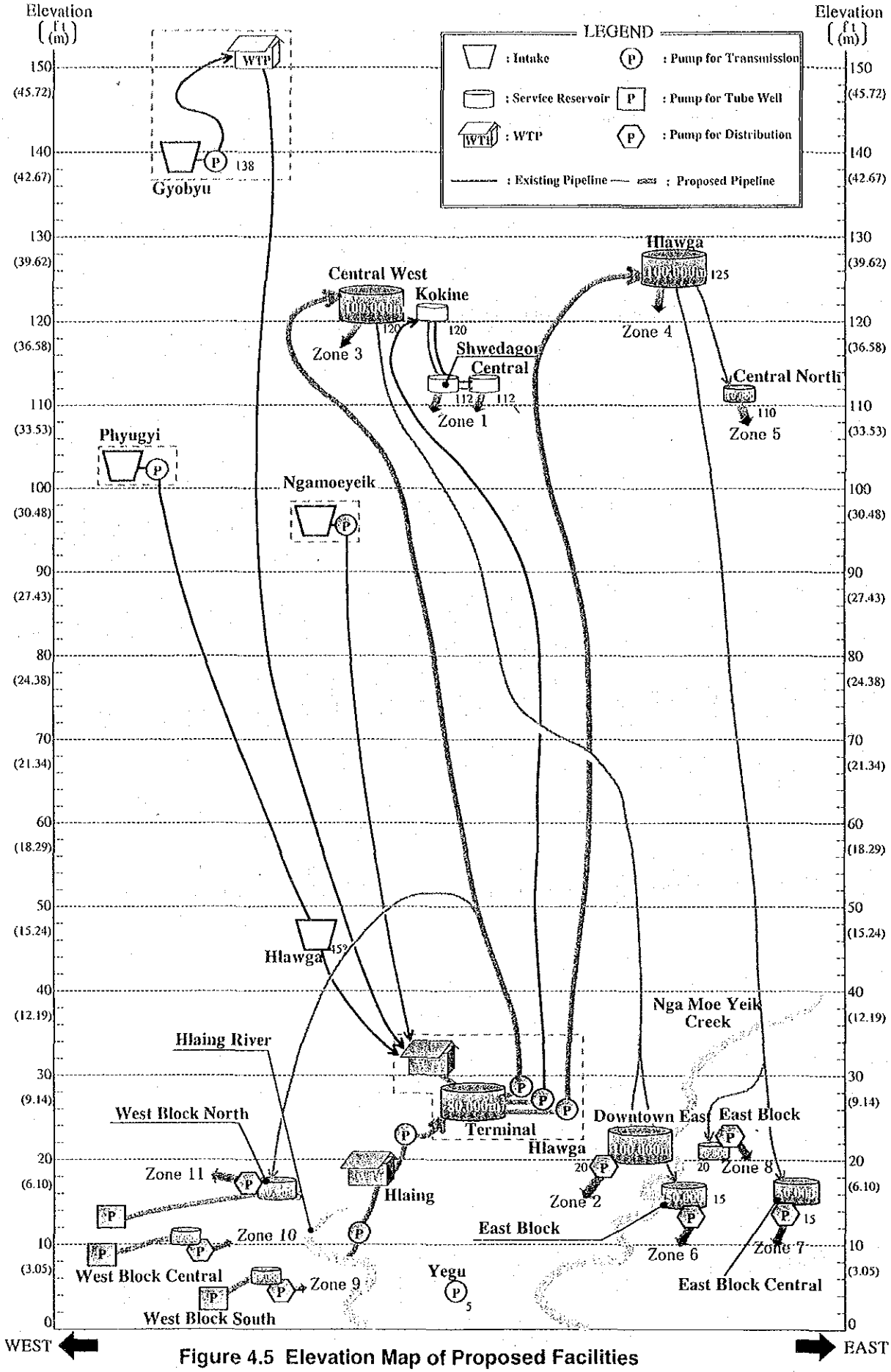


Figure 4.5 Elevation Map of Proposed Facilities

5. FACILITY PLANNING

5.1 WATER TREATMENT PLANT

Name of WTP	Treatment Method	Capacity
Hlaing WTP	Coagulated Sedimentation and Rapid Sand Filtration	940,000 m^3/day
Hlawga WTP	Biological Contact Aeration Process	820,000 m^3/day

Terminal Reservoir will be constructed within the site of proposed Hlawga WTP.

5.2 TRANSMISSION PIPELINES

Ngamoeyeik transmission pipeline was planned to convey Ngamoeyeik reservoir water to Hlawga reservoir. The following clear water transmission pipelines were planned as well.

Name of Transmission Pipeline	
Ngamoeyeik Res. to Hlawga Res.	Terminal R. to CB West S.R.
Terminal R. to Kokine S.R.	CB West S.R. to CB DT East S.R.
Terminal R. to CB Hlawga S.R.	EB North S.R. to EB Central S.R.
CB Hlawga S.R. to CB North S.R.	CB DT East S.R. to EB South S.R.
CB Hlawga S.R. to EB North S.R.	Terminal R. to WB North S.R.

5.3 PUMPING STATIONS

Pump replacement due to deterioration, abolishment and additional new pump installation for the existing pumping stations were planned. New transmission pumping station was also planned.

Name of P/S	Contents
Gyobyu P/S	Three pumps will be replaced
Phugyi P/S	Additional one pump will be installed
Hlawga No.1 P/S	This P/S will be abolished when Terminal Reservoir P/S is completed.
Hlawga No.2 P/S	Ditto
Yegu P/S	Ditto
Ngamoeyeik P/S	New P/S

Terminal Reservoir P/S will be constructed within the site of proposed Hlawga WTP to pump clear water to the existing and proposed service reservoirs.

Pumped to
Terminal R. to Kokine S. R.
Terminal R. to CB Hlawga S. R.
Terminal R. to CB West S. R.

Upon completion of "Terminal R. to Kokine S. R."P/S, clear water will be directly pumped to the existing Kokine service reservoir and therefore, the existing Hlaing No.1, No.2 and Yegu P/S, which are currently boosting water to the said service reservoir, will be abandoned accordingly.

5.4 SERVICE RESERVOIRS AND DISTRIBUTION PUMPING STATIONS

The following new service reservoirs were planned. Due to the topographic condition of the sites, water will be served by gravity or by pump.

Service Reservoirs	
CB Hlawga S.R. (Gravity)	EB Central S.R. (Pump)
CB North S.R. (Gravity)	EB South S.R. (Pump)
CB West S.R. (Gravity)	WB South S.R. (Pump)
CB DT East S.R. (Pump)	WB Central S.R. (Pump)
EB North S.R. (Pump)	WB North S.R. (Pump)

Although the existing Central service reservoir has not been operated because of heavy leakage, it shall be rebuilt after abolishment of the existing reservoir to fully utilize its favorable hydraulic condition.

5.5 PRIMARY MAINS AND SECONDARY DISTRIBUTION PIPES

PVC pipe was adapted to the diameter less than 200 mm and DCIP was employed for the diameter larger than 250 mm. Planned as follows.

Facility	Diameter (mm)	Total Length (km)
Primary Mains	300 - 1,500	87.7
Secondary Distribution Pipes	75 - 400	291.7

5.6 GROUNDWATER DEVELOPMENT

5.6.1 Left Bank of Hlaing River

There are 204 units of YCDC tube wells in left bank of Hlaing River and they can be classified into two categories;

1) Regular Wells (104 units) which were connected to the existing surface water supply pipeline network and will be utilized through the future
2) Independent Wells (100 units) having own pipeline network, not belonging to the surface water supply pipeline network

Until the target year of 2020, some tube wells were anticipated to abandon due to their capacity deterioration and groundwater quality. Remaining well number was estimated as follows;

- Regular Wells : 75 units (29 wells are abandoned)
- Independent Wells : 10 units (90 wells are abandoned)

As to these remaining wells, well cap and concrete base will be installed and pumped groundwater will directly injected into the surface water supply pipeline network. Further, daily pump operation time will be increased from eight hours to 16 hours to multiply the production volume. 20 submersible pumps will also be purchased as spare unit.

5.6.2 Right Bank of Hlaing River

Since the introduction of surface water to the right bank of Hlaing River will take longer time period, available source must be fully optimized until then. New tube well construction was planned for the townships in right bank area as follows;

Dala T/S	SK + KY T/S	Hlaingthaya T/S	Total
21	21	78	120

However, well construction in Hlaingthaya T/S shall be conducted in advance because of rapid population and water demand growth projection.

5.7 REHABILITATION OF AGED PIPELINES

Most of the existing water supply pipelines within the City Area, especially in downtown area, are estimated as "heavily deteriorated". These pipelines are regarded as major cause of water leakage and therefore, these pipelines shall be replaced immediately from view point of rational water use.

6. UNACCOUNTED FOR WATER CONTROL PLAN

6.1 BACKGROUND

Unaccounted for water (UFW) is defined as the difference between the 'Net production' and 'Consumption' and is usually expressed as a percentage of net production. UFW control plan is one element of the overall Master Plan for improvement of water supply in Yangon and therefore its planning horizon also extends to the target year 2020. This is a long period for consideration of UFW control as a separate activity. Practice of UFW control applies only to piped water supplies distributed through a network and not to ground water only and point sources.

The calculation of UFW requires the collection and analysis of a great deal of data. Accurate estimate of UFW cannot be expected without detailed, reliable, and accurate data on various components of a water supply system. The collection and analysis of data and resulting UFW control action is a continuing, repeating sequence. If this sequence is stopped then the losses will soon rise and the situation deteriorates again.

UFW can be divided into two components, the 'Phycical Losses' and the 'Non-Physical Losses'. Physical losses include the most apparent reasons such as network leakage, customer pipe leakage, transmission main and service reservoir leakage. Non-physical losses are not losses in real sense but seem to be losses from the perspective of a water system manager. Non-physical losses include meter error, un-assessed consumption by customers, illegal connections, unaccounted for legitimate uses such as free supplies and institutional supplies, and operational uses.

Flow measurement around the network is the single most important factor that can furnish essential information on various elements of water use. Flow measurement requires installation and maintenance of flow measuring equipment. UFW control is a complicated process affected by and inter-related with many components of a water supply system.

Extents of actions to control UFW should always be cost effective. The target should not be an arbitrary level but the "economic level of losses" determined on a cost benefit basis. The level may vary and should be reviewed periodically.

A framework plan prepared as a first step to introduce UFW control in Yangon is outlined as follows:

- Present context (Baseline)
- Justification for UFW control plan
- Outline and general approach
- Proposed sequencing

- Specific activities checklist and timeline
- Identification of priority projects and preliminary cost estimates

6.2 BASELINE SITUATION

Yangon City Development Committee (YCDC), the sole government institution with responsibility of providing water to the City population, lacks basic data. It does not have reliable data on water production and consumption. Non-of its sources of water are metered and a negligible amount of the water supplied to the public is metered. Water is supplied to many military installations pumped directly from principal transmission mains.

The water supply system in Yangon is old. There is no systematic effort to identify and repair leaks. Valves are not operated or repaired and many valves are known to be inoperable or leaking. House connections are often made by private contractors, without authorization or supervision.

6.2.1 Baseline Summary

Network condition

- Ageing with over 50% of the network more than 50 years old
- Cast Iron-approx. 80% of the network is cast iron
- Joints- most joints are leak prone lead caulked joints
- Lack secondary mains and sections valves etc.
- Long term lack of capital investment
- Lack of O & M resources
- Lot of leakage on service pipes

Service level

- Only 37% population served
- Most areas have very low pressure
- Large areas have intermittent supplies
- Valve operation limit supply to some areas
- Demand exceeds supply both for total population and population served

Water supply department operations

- No UFW control plan & activity
- Repair teams under-equipped
- Passive leakage control
- Lack of regulation and or enforcement for consumers
- Unclear metering plan

Flow measurement

- No production or supply zone metering

Consumers

- Low level of metering

- Problems with meter failures from sediment etc.
- Unaccounted for consumption from large connections
- Many non-domestic consumers not metered

Network data

- Maps incomplete, inaccurate and out of date

6.2.2 UFW Estimate

Present UFW of Yangon is estimated at around 65%, divided in the similar order of magnitude between physical and non-physical losses. Physical losses at present is limited by lack of pressure and intermittent supply. Physical losses will be much greater if the network is supplied 24 hrs a day at reasonable pressure.

6.3 JUSTIFICATION FOR UFW CONTROL

UFW control is an element of demand management in the sense that the water saved from losses is equivalent to a supply side increase and can be used to meet the additional demand. This saves the additional capital that otherwise need to be invested to build new facilities for supplying more water. However, the nature and the extent of interventions should always be justified on a cost-benefit basis. In undertaking these assessments of financial benefit, it is important to ascribe costs equitably, since many of the costs in setting up UFW control measures are also related to other activities. The detail of the strategy is not part of a long-term development plan. It is subjected to constant review and modification as the cost-benefit balance changes.

There are two main justifications for minimizing Non-Physical Losses (NPL); to account for water consumed properly so that investment is not wasted seeking Physical losses that do not exist, and to ensure that income is maximized by collecting revenue for water actually consumed.

The principal justification for minimizing Physical Losses (PL) is that it represents lost efficiency in transfer of water from point of supply to end user. These losses create a need to supply more water to meet customer demand, to build bigger facilities, and increase operating cost for a given demand level.

Thus, the aim of leakage control is to reduce these losses to the level where further reduction in losses costs more to achieve than the cost of supplying the extra water.

When looked only at the operating expenditure (OPEX), the balance is between the cost of production in terms of consumables and direct cost and the potential revenue gains from the saved water. The UFW control can be more effective if the capital expenditure (CAPEX) is

deferred or avoided, because it is usually cheaper to delay building reservoirs and water treatment plants as long as possible and may be include staging of the capacity.

An example calculation of benefit from UFW reduction for Yangon

6.3.1 Operating Cost

With operating expenditure (59.91 million Kyats) and water revenue (318.91 million Kyats) of year 2000/2001, and under estimated UFW of 65%, calculation shows that there would be a net benefit of 246 million Kyats if the UFW is brought down to 30% at a cost of 0.5 Kyat/m^3 of volume saved. This calculation only covers the operating expenses and revenue. Inclusion of capital expenditure in the calculation would be likely to greatly increase the benefits of "deferred CAPEX".

6.3.2 UFW Benefits to Demand Management

Calculation shows that with present level (65%) of UFW in 2020, even the maximum yield of surface water (1500 mld) will only meet 40% of total demand. This illustrates the importance of UFW control to Yangon. If UFW is not reduced by a large amount, it will never be possible to fully satisfy demand with the present scope for exploiting water resources. To increase supply further will require development of very expensive solutions.

6.4 OUTLINE APPROACH OF UFW CONTROL PLAN

The UFW control plan for Yangon has the following four underlying principles:

1. YCDC have to get involved in action on all fronts of UFW control
2. It is not possible to do everything at once and immediately, so the approach will be to start small and expand progressively until the entire network is effectively covered
3. A general strategy is proposed, which will need to be adapted and modified to suit changing circumstances
4. Economically justified action

6.4.1 General Approach

The UFW will need to focus on large users and high leakage areas first. To have the most effect, especially in the early years, work will commence for all UFW control tasks in those areas that have "good" service (i.e. continuous supply and "high" pressure) and once they have been "controlled" then they will be maintained in that state. Initially, there will also be a lot of work to be done to get all systems set up and operational, including; installation of equipment (mainly flow meters), surveys, data collection and analytical procedures.

6.5 PROGRESSION AND SEQUENCE OF UFW CONTROL PLAN

For a plan with a final horizon of 2020, the UFW control plan may best be divided into three phases as defined and described below.

Phase 1: Preliminary

- Initiation and start up of all activities across the board
- Training and practice of basic techniques and methods
- Installation of equipment especially, production and zone flow meters
- Surveying
- Mapping of network
- Establishment of UFW control unit and team
- Work on trial "pilot" areas
- Technical assistance-intensive effort for detailed planning, implementation and technology transfer

Phase 2: Medium term

- Establishing routing procedures
- Review UFW levels and adapt control efforts
- Progressively repeat and expand task to cover more and more of the network
- Continue and complete survey
- Reduce and phase out technical assistance as UFW unit becomes self-sufficient
- Priorities and direct UFW control activities

Phase 3: Long term

- Review UFW levels and control measure strategically
- Modify and prepare a plan and revised objectives
- Continue and repeat UFW control, prevention and monitoring
- Continue expansion of area covered until complete
- Continue to increase level of detail, specificity of data by progressive sub-division of the network into smaller areas (to the extent justified)

General

One or several "pilot" areas will be set up in the good service areas (possibly based on the wards) and subject to the gamut of activities, including but not limited to:-

- Mapping and consumer survey
- Large user identification and monitoring
- Meter repair and replacement
- Leakage survey and detection (applying different techniques as appropriate)
- Timely repair of leaks

When the pilot area has been completed, a lower level of activity will be continued to maintain the UFW control in the area. A new set of pilot areas will be set up and the intensive efforts directed in these new areas. This sequence continues, building up the area of coverage until a complete district or zone has been done. Then the next district is started.

6.6 UFW WATER DEMAND PLANNING

Non-Physical losses will be reduced to more or less constant level, less than or equal to 10% of net production within 5 years. It will be further lowered to 5% in the last stage of the plan as the consumer consumption data is made more specific. This factor will be greatly influenced by the final decision on metering policy for consumers.

Physical losses or leakage will quickly become very predominant as unaccounted for consumption issues are resolved. As for the expected pattern, the leakage will raise initially or plateau with the combined effects of leakage control and improvement in service duration and pressure, then leakage levels will stay fairly high for a while, next; leakage level will reduce markedly as the leakage control measures take effect, latterly; leakage will reduce more and more slowly as results become increasingly difficult and less cost-effective to achieve, and finally; UFW will be reduced to an asymptotic level as it approaches the hypothetical "economical level of leakage".

6.7 PLANNED UFW CONTROL ACTIVITIES

As outlined earlier, the UFW control activities are divided into three phases. Phase 1 and Phase 2 share most of the activities and sub-activities listed as follows:

- General management and UFW control planning
- Physical loss activities
- Non-Physical loss activities
- Measuring and prioritizing of UFW activities
- Associated activities
- Technical assistance program

There will not be a major change of approach or activity in Phase 3, but rather a continuation and adaptation of those being followed in the Phase 1 and Phase 2. Five years is an appropriate period for long term projections of UFW control activities. It is proposed that UFW plan will be detailed, reviewed and modified periodically (e.g. annually) to achieve the overall objectives set. Thus, the strategic review at the beginning of Phase 3 will be repeated every five years which will include particular items as listed below but not limited to:

- Organisational aspects
- Rechecking data
- Pressure reduction
- Updating district and waste metering
- Application of new techniques and technologies
- Renewal/calibration of metering and other equipment
- Updating and improving active leakage control
- Public relations
- New works and repairs

6.8 RESOURCES AND ORGANIZATION

In order to be effective over a sustained period, it is essential that adequate financial resources and budgets are available for this. The followings are the five main aspects to be considered:

6.8.1 Organization for UFW Control

A separate, dedicated unit headed by a manager with sufficient authority and requisite autonomy is essential. The unit must be set up immediately on starting the programme and it should be considered as a permanent unit, not a time limited temporary one.

6.8.2 Personnel to Staff the Team

The unit should be staffed with a UFW project manager, a team leader, three engineers to head NPL controller, PL controller, and data analysis & recording, and at least six technicians and one draughts person. All other manpower needed for the field surveys, and field operation and works are to be taken from relevant other departments.

6.8.3 Training and Skills Acquisition for the Staff

To start with, about three employees should be trained for a period of up to three months from a specialized training center in developed country that include theory of leakage control, practical experience in use of a wide variety of equipment, maintenance of and simple repairs to all equipment as its formal courses. In addition, the technical assistance consultants should provide on-the-job trainings.

6.8.4 Technical Assistance to the Organization

Since the leak control is a long-term activity requiring sustained effort, need for appointing a competent, long-term consultant to assist the authority should be seriously considered.

6.8.5 Material and Equipment Resources

Much equipment and material will be needed, but in the three main categories:
Office-based drawing and data records and functional equipment for staff
Equipment and transport for fieldwork including specialist leak detection equipment
Repair materials, tools and equipment of the type and quantity necessary to get repairs in a timely and effective manner

6.9 COST ESTIMATES AND IDENTIFICATION OF PRIORITY PROJECTS

Project cost has been divided in to the following headings/sub-headings:
Project control: UFW control unit, Active Leak Control (ALC) teams, UFW repair unit
Metering and data collection: production metering and bulk supply zones, district/zone metering, pilot area/waste metering, network preparation

Physical loss control: ALC teams, pressure management, repair materials, service pipe repairs

Non-physical loss control: large users, non-domestic consumers, domestic consumers, meter repair workshop

Related activities: information system, byelaws & technical standards, district inspectors, mapping of networks, mapping of customers

Technical assistance: UFW consultants

For all of these activities until 2020, the estimated cost is summarized in Table 6.1.

Table 6.1 UFW Control Plan: Project Cost Estimate (1,000 US $)

	Setup 02		03 to 05		05 to 10		10 to 15		15 to 20	
	F	L	F	L	F	L	F	L	F	L
Period Totals	6,143	1,197	5,944	1,740	7,500	5,932	8,588	4,642	8,780	4,642
Total per year	6,143	1,197	1,981	580	1,500	1,186	1,717	928	1,756	928

F: Foreign, L: Local

6.10 RECOMMENDATIONS

The key recommendations and conclusions are:

- UFW is a big problem in Yangon and should be properly addresses
- UFW control efforts should be integrated with general water supply improvements
- A team should be set up and trained as soon as possible and charged with the task of beginning to deal with the problem
- Similarly, repair teams shuld be set up trained and supplied with proper repair mateials
- UFW control will require a long and sustained effort over many years
- Cost-benefit analysis will determine the level of UFW to be aimed for

The key target and sequence objectives for preliminary planning are:

UFW now: 65%

Overall target: 30%

Leakage ratio target:

45% in year 2005

40% in year 2010

35% in year 2015

25% in year 2020

7. INSTITUTIONAL AND ORGANIZATIONAL DEVELOPMENT PLAN

The purpose of institutional and organizational development component of the Master Plan (MP) is to determine the organizational structure as well as institutional / organizational arrangements needed for improvement of City water supply. Based on an institutional and organizational analysis conducted, the MP identifies a set of institutions and organizations that may need modifications and rearrangements. The broader institutional and organizational framework covering the period from 2002 to 2020 is thus presented in the MP.

One of the important findings of the analysis is the presence of a large variety of institutions and organizations involved in City water supply with complex arrangements. The Plan recognizes the need for strengthening the entire institutional landscape (including organizations) in order to propose realistic recommendations for City water supply improvement. Due mainly to resource limitations, the focus of the analysis was however, confined to YCDC as the lead institution and other organizations which may help this larger institution to carry out its water distribution role. The Plan identifies Water Supply and Sanitation (Engineering) department (WSS) within YCDC as the focus institution.

The MP recommends that institutional and organizational development plan should consist of three main components namely, (a) re-organization of the WSS department (b) organizational changes within the department and (c) an enhanced outlook for human resources management. The recommendations concentrate on these three areas.

With regard to the re-organization of the department, the MP recommends that one division is re-structured, one new division created with the overall structure of the department remains intact. The key to re-organization it is recommended is the creation of a new division to take charge of planning and monitoring roles which are not satisfactorily undertaken at present. It is also suggested that planning units be established in each of the 32 township offices. The scope and functions of the Water Distribution division it is suggested to be expanded by adding new sections such as for customer/client relations, data management and to institute effective system of repair of the network.

It is recommended that the above proposals are further studied and modified when more information on the type of improvements are made available during the feasibility study stage.

Several organizational changes are proposed the aim of which is to facilitate satisfactory performance for all staff as well as arrangements within the department. The main proposals are to introduce and streamline planning and co-ordination, bring about monitoring culture based on proper collection, recording and analysis of data.

The reorganization demands new staff with a better balance, new roles and functions as well as work styles. These changes, it is proposed are to be effected by providing a new outlook for human resources management (HRM) within the department. The main recommendations in regard to HRM are, (a) staffing including filling current vacancies (b) provide and institutionalise job descriptions for staff and (c) professional development for the staff. The Plan recognizes the over whelming importance of staff training which it is recommended to be accomplished by undertaking a training needs assessment followed by the preparation of a training Master Plan.

The MP recommends that all the important work areas of the department would benefit if the above proposals were included for detailed review in the feasibility study for subsequent implementation.

Other areas identified in the MP for strengthening are network operation and maintenance, development, up-dating and management of a database, effective arrangements for customer/client relations building, production of education and communication materials, development of legislations on water resources as well as water supply byelaws and regulations, communal water supply facilities such as communal tanks and ponds and, streamlining ward boundaries.

The proposed development plan that forms the final section of the MP provides a list of components that should receive priority attention during the FS. They are human resources strengthening, training, organizational development and legislative support in that order.

8. PROJECT COST

8.1 CONDITIONS FOR COST ESTIMATE

The project cost was estimated based on the preliminary design of water supply facilities. Unit prices and lump sum prices were established considering local construction conditions, availability of construction materials and equipment, suitability of the construction method as well.

Assumptions and conditions applied for the cost estimate were as follows;

Price Level : as of November 2001

Foreign Exchange Rate : 500 Kyat = 1.00 US$ = 120 Japanese Yen

8.2 PROJECT COST

The project implementation period was divided into two (2) phases and each phase was separated into two (2) stages as follows;

Phase	Implementation Year
Phase 1	2003 to 2010
Phase 2	2011 to 2020

Based on the phased project implementation plan shown in the previous sections, project cost was calculated. Summary of total project cost is shown in Table 8.1.

Table 8.1 Summary of Project Cost (Unit : US$)

	L/C	F/C	Total
Phase-1	110,075,000	720,173,000	830,248,000
Phase-2	111,708,000	541,083,000	652,791,000
Total	221,783,000	1,261,256,000	1,483,039,000

Table 8.1 Project Implementation Schedule (1/2)

No.	Facility	Dimension
1	**Rehabilitation**	Dia. 75 to 450 mm, L = 348,900 m
1.1	**Replacement of aged distribution pipe < 80 years old**	
1.1.1	Botataung, Kyauktada, Lanmadaw, Latha, Pabedan, Pazundaung	
1.1.2	Tamwe	
1.1.3	Ahlone, Kyeemyindaing	
1.2	**Replacement of aged distribution pipe < 80 and > 50 years old**	
1.2.1	Sanchaung	
1.2.2	Mingalartaungnyunt	
1.2.3	Dagon, Bahan, Yankin	
2	**Development of Reservoir System**	
2.1	**Ngamoeyeik reservoir System**	
2.1.1	Transmission line	Dia.1800 x 30.75 km
2.1.2	Pumping station	409,000 m3/d
2.1.3	Duplication of dia.1100 mm line	Dia.1100 x 13.28 km
2.2	**Strengthen of existing reservoir system**	
2.2.1	Gyobyu pump rehabilitation (3 pumps)	9,930 m3/hr
2.2.2	Phugyi additional 1 pump	5,160 m3/hr
3	**Hlaing River System**	
3.1	**Intake facility**	
3.1.1	Intake facilities	
3.2	**Hlaing river system (1/2)**	
3.2.1	Raw water main	Dia.2500 x 7 km
3.2.2	Pumping station	491,000 m3/d
3.2.3	Water treatment plant	470,000 m3/d
3.2.4	Transmission pumping station	470,000 m3/d
3.2.5	Transmission main	Dia.2000 x 33.3 km
4	**Terminal System**	
4.1	**Connections**	
4.1.1	Intake facilities and raw water main	
4.1.2	Gyobyu connection pipe	Dia.1400 x 4.2 km
4.1.3	Connection to existing transmissions	Dia.1650 x1.0 km, Dia. 1100 x 1.3 km
4.2	**Terminal reservoir (TR)**	
4.2.1	TR (2/4)	40,000 m3
4.2.2	TR (1/4)	20,000 m3
4.2.3	TR (1/4)	20,000 m3
4.3	**Transmission pumping station**	
4.3.1	PS for Downtown	400 m3/min
4.3.2	PS for Central West, DT East, East South	480 m3/min
4.3.3	PS for Central North, Hlawga and East North and Central	640 m3/min
5	**Transmission and Distribution System**	
5.1	**Downtown (Zone 1)**	
5.1.1	Strengthening of transmission line	Dia. 1400 x 1.35 km
5.1.2	Rehabilitation of central reservoir	45,450 m3 (10 MG)
5.1.3	Distribution network	
5.2	**Downtown East (Zone 2)**	
5.2.1	Transmission line (from Central West SR)	Dia. 1800 x 12.2 km
5.2.2	Service reservoir	50,000 m3
5.2.3	Distribution pumping station	474 m3/min
5.2.4	Distribution network	
5.3	**Central West (Zone 3)**	
5.3.1	Transmission line (From TR)	Dia. 2700 x 7.5 km
5.3.2	Service reservoir	50,000 m3
5.3.3	Distribution network	
5.4	**Hlawga zone (Zone 4)**	
5.4.1	Transmission line (From TR)	Dia. 2200 x 3.9 km
5.4.2	Service reservoir	50,000 m3
5.4.3	Distribution network	
5.5	**Central North (Zone 5)**	
5.5.1	Transmission line (From TR)	
5.5.2	Service reservoir	
5.5.3	Distribution network	
5.6	**East South (Zone 6)**	
5.6.1	Transmission line (From DT East)	Dia. 1200 x 7.6 km
5.6.2	Service reservoir	25,000 m3
5.6.3	Distribution pumping station	210 m3/min
5.6.4	Distribution network	
5.7	**East Central (Zone 7)**	
5.7.1	Transmission line (From East North)	
5.7.2	Service reservoir	
5.7.3	Distribution pumping station	
5.7.4	Distribution network	
5.8	**East North (Zone 8)**	
5.8.1	Transmission line (From TR)	
5.8.2	Service reservoir	
5.8.3	Distribution pumping station	
5.8.4	Distribution network	
5.11	**West North (Zone 11) - Hlaingthaya**	
5.11.1	Groundwater development	
5.11.2	Transmission line for groundwater	
5.11.3	Transmission line from central system	
5.11.4	Service reservoir	30,000 m3
5.11.5	Distribution pumping station	188 m3/min
5.11.6	Distribution network	
6	**Connections**	
6.1	Connection to Hlawga No1 PS to 36 inch pipe now under construction for Dagon Myothit area	Dia. 1200 x 2.0 km
7	Groundwater management in Central Block	
	Annual Construction Cost (million US$)	**Total 830 million $**

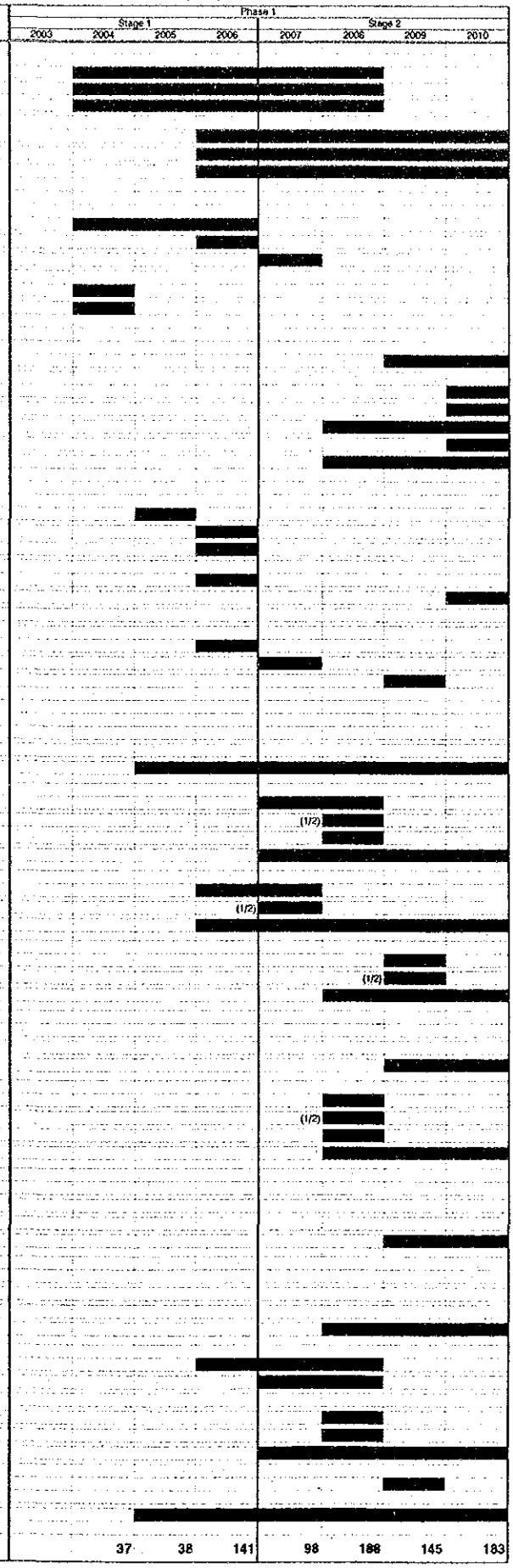


Table 8.1 Project Implementation Schedule (2/2)

No.	Facility	Dimension	Phase 2									
			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
3	**Hlaing River System**											
3.3	**Hlaing river system (2/2)**											
3.3.1	Raw water main											
3.3.2	Pumping station											
3.3.3	Water treatment plant											
3.3.4	Transmission pumping station											
3.3.5	Transmission main	Dia.2000 x 33.3km										
4	**Terminal System**											
4.2	**Terminal Reservoir**											
4.2.1	TR (1/4)	20,000 m3										
4.2.2	**Water Treatment Plant**	820,000 m3/d										
4.3	**Transmission pumping station**											
4.3.1	PS for Downtown											
4.3.2	PS for Central West, DT East, East South	160 m3/min										
4.3.3	PS for Central North, Hlawga and East North and Central	80 m3/min										
5	**Transmission and Distribution System**											
5.1	**Downtown (Zone 1)**											
5.1.1	**Strengthening of transmission line**											
5.1.2	Rehabilitation of central reservoir	45,450 m3 (10 MG)										
5.1.3	Distribution network											
5.2	**Downtown East (Zone 2)**											
5.2.1	Transmission line (from Central West SR)											
5.2.2	Service reservoir	50,000 m3					(2/2)					
5.2.3	Distribution pumping station											
5.2.4	Distribution network											
5.3	**Central West (Zone 3)**											
5.3.1	Transmission line (From TR)											
5.3.2	Service reservoir	50,000 m3				(2/2)						
5.3.3	Distribution network											
5.4	**Hlawga zone (Zone 4)**											
5.4.1	Transmission line (From TR)											
5.4.2	Service reservoir	50,000 m3						(2/2)				
5.4.3	Distribution network											
5.5	**Central North (Zone 5)**											
5.5.1	Transmission line (From TR)	Dia. 900 x 6.1 km										
5.5.2	Service reservoir	10,000 m3										
5.5.3	Distribution network											
5.6	**East South (Zone 6)**											
5.6.1	Transmission line (From DT East)											
5.6.2	Service reservoir	25,000 m3				(2/2)						
5.6.3	Distribution pumping station											
5.6.4	Distribution network											
5.7	**East Central (Zone 7)**											
5.7.1	Transmission line (From East North)	Dia. 1,350 x 7.3 km										
5.7.2	Service reservoir	50,000 m3										
5.7.3	Distribution pumping station	195 m3/min										
5.7.4	Distribution network											
5.8	**East North (Zone 8)**											
5.8.1	Transmission line (From TR)	Dia. 1,400 x 15.2 km										
5.8.2	Service reservoir	20,000 m3		(1/2)				(2/2)				
5.8.3	Distribution pumping station	120 m3/min										
5.8.4	Distribution network											
5.9	**West South (Zone 9)**											
5.9.1	Groundwater development											
5.9.2	Service reservoir	10,000 m3										
5.9.3	Distribution pumping station	48 m3/min										
5.9.4	Distribution network											
5.10	**West Central (Zone 10) - S.khanaungto**											
5.10.1	Groundwater development											
5.10.2	Service reservoir	10,000 m3										
5.10.3	Distribution pumping station	46 m3/min										
5.10.4	Distribution network											
5.11	**West North (Zone 11) - Hlaingthaya**											
5.11.1	Groundwater development											
5.11.3	Transmission line from central system	Dia. 500 x 9.8 km										
5.11.4	Service reservoir											
5.11.5	Distribution pumping station											
5.11.6	Distribution network											
	Annual Construction Cost (million US$)	**Total 653 million $**	54	51	33	12	27	28	100	145	191	12

9. ECONOMIC AND FINANCIAL EVALUATION

9.1 ECONOMIC EVALUATION

The Table 9.1 shows a summary of water volume to be supplied and economic benefit of potable water supply (the economic benefit derived from saving the cost for alternative water resources, namely the cost of private tube well) due to completion of the works in each phase of the Project.

Table 9.1 Water Volume and Economic Benefit of the Project

Phase	Year	Water volume to be supplied due to the completion of the works (m^3/day)	Incremental water volume to be supplied due to the completion of the works (m^3/day)	Leaked volume to be improved (m^3/day)	Total	Incremental annual water volume to be supplied (m^3/annum)	Annual economic benefit	
							(Million Kyats)	(Equivalent to US$1,000)
	2003	219,700					0	0
Phase-1	2004	232,900	13,200	150,145	163,345	59,620,938	4,352	8,705
	2005	277,900	58,200	160,063	218,263	79,666,047	5,816	11,631
	2006	512,000	292,300	169,976	462,276	168,730,851	12,317	24,635
	2007	521,100	301,400	179,885	481,285	175,668,851	12,824	25,648
	2008	530,200	310,500	189,788	500,288	182,605,050	13,330	26,660
	2009	539,400	319,700	199,686	519,386	189,575,950	13,839	27,678
	2010	823,000	603,300	209,580	812,880	296,701,051	21,659	43,318
Phase-2	2011	836,700	617,000	219,468	836,468	305,395,500	22,294	44,588
	2012	850,400	630,700	229,352	860,052	310,396,000	22,659	45,318
	2013	864,100	644,400	239,230	883,630	315,396,500	23,024	46,048
	2014	877,800	658,100	249,104	907,204	320,397,000	23,389	46,778
	2015	908,400	688,700	258,973	947,673	331,566,000	24,204	48,409
	2016	936,300	716,600	268,837	985,437	341,749,500	24,948	49,895
	2017	964,300	744,600	278,696	1,023,296	351,969,500	25,694	51,388
	2018	992,200	772,500	288,550	1,061,050	362,153,000	26,437	52,874
	2019	1,020,200	800,500	298,400	1,098,900	372,373,000	27,183	54,366
	2020	1,221,200	1,001,500	308,244	1,309,744	445,738,000	32,539	65,078

(Note 1) Unit value of benefit: 73 (Kyats/m^3)
(Note 2) Exchange rate: 500 Kyats = US$1.00

In addition to the above indicated benefit in case of overall Project, following benefits are taken into account due to the improvement of water environment, namely, (a) saving of medical expenditure due to decrease of water borne diseases of people living in Yangon City, and (b) saving of income loss of working members of households also due to decrease of water borne diseases:

Table 9.2 Saving of Medical Expenditure

(Figures are incremental ones and after completion of works of each phase)

Phase	Incremental annual water volume to be supplied (m^3/annum)	Service population (persons)	Number of patients*		Medical expenditure by water borne diseases (Million Kyats)	Annual saving amount of medical expenditure	
			Overall diseases	Water borne diseases		(Million Kyats)	(Equivalent to US$1,000)
Phase-1	296,701,051	4,064,398	527,965	38,225	42	6	13
Phase-2	149,036,949	2,041,602	265,204	19,201	21	3	6

(Note 1) Average volume of water consumption 140 (l/day)
(Note 1) Share rate of water consumption of domestic suctomers 70% (of the total water volume)
(Note 2) Suffering rate of overall diseases 12.99% (to the total population)
(Note 3) Suffering rate of water borne diseases: 7.24% *(to the overall diseases)*
(Note 4) Unit value of medical expenditure: 1,104 (Kyats/patient per year)
(Note 5) Contribution rate of the Project to water borne diseases: 15.00% (to the total water borne diseases)
(Remarks) *Number of patients consist of outpatients and inpatients.

Table 9.3 Saving of Income Loss

(Figures of water volume to be supplied are incremental ones and after completion of works of each phase)

Phase	Incremental annual water volume to be supplied (m^3/annum)	Service population (persons)	Working population (persons)	Number of inpatients*		Number of outpatients*		Income loss in total (Million Kyats/annum)			Annual saving amount of income loss	
				Overall diseases	Water borne diseases	Overall diseases	Water borne diseases	Inpatients	Outpatients	Total	(Million Kyats)	(Equivalent to US$1,000)
Phase-1	296,701,051	4,064,398	1,319,654	84,943	6,150	266,349	19,284	50	47	97	15	29
Phase-2	149,036,949	2,041,602	662,880	42,668	3,089	133,791	9,686	25	23	49	7	15

(Note 1) Average volume of water consumption 140 *(l/day)*
(Note 2) Suffering rate of overall diseases 12.99% (to the total population)
(Note 3) Average number of inpatients per year: 237,573 (persons/annum)
(Note 4) Average number of outpatients per year: 241,871 (persons/annum)
(Note 5) Suffering rate of water borne diseases: 7.24% (to the overall diseases)
(Note 6) Unit value of income: 1,017 (Kyats/day per capita)
(Note 7) Contribution rate of the Project to water borne diseases: 15% (to the total water borne diseases)
(Note 8) Number of days to be needed to visit hospitals for outpatients: 2.38 (days/annum)
(Note 9) Average duration to stay in hospitals for inpatients: 8.01 (days/annum)
(Remarks) * Number of patients consist of outpatients and inpatients.

The estimated annual economic costs for construction is given in Table 9.4. Financial costs of overall Project are summarized by phase in Table 9.5.

Table 9.4 Estimated Annual Economic Cost of Construction

(US$1,000)

Phase	Year	Overall Project	
		Finan-cial	Eco-nomic
Phase-1	2003	0	0
	2004	33,585	29,293
	2005	35,264	30,594
	2006	129,892	111,774
	2007	97,844	84,967
	2008	187,693	157,302
	2009	144,989	121,934
	2010	183,101	154,949
Phase-1 total		812,366	690,813
Grand total		1,465,161	1,237,415

(US$1,000)

Phase	Year	Overall Project	
		Finan-cial	Eco-nomic
Phase-2	2011	54,073	45,284
	2012	50,622	42,143
	2013	33,002	28,338
	2014	12,359	10,186
	2015	27,393	22,581
	2016	28,117	22,895
	2017	99,678	83,861
	2018	144,697	120,497
	2019	190,733	160,815
	2020	12,120	10,001
Phase-2 total		652,795	546,602

Economic costs for operation/maintenance (OM cost) is summarized as shown in the following tables until the 2020 during the construction period, and this cost will be a burden to the Project (namely, YCDC) until the end of the project life of 50 years after completion of the works.

Table 9.5 Economic Costs for Operation / Maintenance

(US$1,000)

OM work items	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Personal cost	5	5	5	5	6	6	6	6	7	7	7	7	7	7	7	9	9
Electricity cost	10	10	89	117	144	144	216	216	216	233	233	233	239	239	239	239	295
Chemical cost	192	192	600	600	928	928	8,666	8,666	8,666	8,666	8,666	8,677	8,677	8,677	8,677	8,677	16,324
Inspection/repairing cost					0			0	0		0	0	0		0	0	0
Financial total	207	207	694	723	1,078	1,078	8,888	8,888	8,889	8,906	8,906	8,917	8,923	8,923	8,923	8,925	16,627
Economic cost	104	104	348	362	936	540	4,451	4,624	4,990	4,460	4,955	4,666	5,007	4,468	4,964	8,126	15,483

Remarks:

Gyobyu:	167	Phugyi:	400	Terminal-Kokine:	7,042	Terminal CBW:	8,217	Ngamoyeik:	6,900	CBDT East:	4,708	
East Block S:	983	Terminal to CB:	6,517	Hlaing WTP:	5,342	Transmission:	7,042	West Block N:	875	East Block N:	558	
West Block S:	225	East Block C:	900	West Block C:	217							

Furthermore, it is assumed that replacement works will be made every 20 years interval.

The economic evaluation is made using cash flows based on the above benefit and cost. The resulted EIRR is around 5.0 % for Phase-1 Works and 3.7 % for overall Project.

Generally by the way, EIRR of the project under study should be higher than the applied discount rate as an opportunity cost of capital. As suggested by such international institutions as the World Bank, an EIRR is expected to at least be cleared a hurdle of 5.0 % of EIRR from a viewpoint of basic human needs even such a project in developing countries. From this viewpoint, the resulted EIRR is cleared right on the said hurdle in Phase-1. Namely, the Project is economically sound from the viewpoint of basic human needs in case of executing the Phase-1 Works.

9.2 FINANCIAL EVALUATION

9.2.1 Financial Evaluation Based on WTP and ATP at Present

As a conventional method of financial evaluation first of all, it is assumed following 3 options of water price for financial evaluation according to Willingness of People to Pay and Affordability of People to Pay at present as:

1. Option-1 380 Kyats/month per household (equivalent to 12.93 Kyats/m^3 and US¢2.59/m^3) as the minimum rate of WTP of people in Yangon City for 24 hours drinkable water supply.

2. Option-2 690 Kyats/month per household (equivalent to 23.47 Kyats/m^3 and US¢4.69/m^3) as the affordability of people to pay in case of minimum income level at present.

3. Option-3 800 Kyats/month per household (equivalent to 27.21 Kyats/m^3 and US¢5.44/m^3) as the maximum rate of WTP of people in Yangon City for 24 hours drinkable water supply.

Based on the above-mentioned conditions in each option, the financial benefit is estimated in 3 options as shown in Table 9.6.

Table 9.6 Financial Benefit

Construction package	Water volume to be supplied due to the completion of the works (m^3/day)	Effective water volume to be supplied (m^3/day)	Annual water volume to be supplied due to completion of the works (m^3/annum)	Annual financial benefit by option					
				Option-1		Option-2		Option-3	
				(Million Kyats)	(Equivalent to US$ 1,000)	(Million Kyats)	(Equivalent to US$ 1,000)	(Million Kyats)	(Equivalent to US$ 1,000)
Phase-1	603,300	812,880	296,701,051	3,835	7,670	6,963	13,927	8,073	16,147
Phase-2	398,200	496,864	181,355,521	2,344	4,688	4,256	8,513	4,935	9,870
Overall Project	1,001,500	1,309,744	478,056,572	6,179	12,358	11,220	22,439	13,008	26,017

(Note 1) Unit value of benefit: 13 (Kyats/m^3) 380 (Kyats/m.HH) for option-1.
23 (Kyats/m^3) 690 (Kyats/m.HH) for option-2.
27 (Kyats/m^3) 800 (Kyats/m.HH) for option-3.
(Note 2) Exchange rate: 500 Kyats = US$1.00
(Note 3) Effective water volume includes existing water supply volume.

Using these benefits and the above mentioned financial cost, the financial evaluation is made. The results are summarized as below:

Table 9.7 Results of the Financial Evaluation

Package	Option-1			Option-2			Option-3		
	NPV (US$1,000)	FIRR	B/C	NPV (US$1,000)	FIRR	B/C	NPV (US$1,000)	FIRR	B/C
Phase-1	-402,571	Uncountable	0.10	-365,870	Uncountable	0.18	-352,847	Uncountable	0.21
Phase-2	-163,889	Uncountable	0.09	-151,416	Uncountable	0.15	-146,990	Uncountable	0.18
Overall works	-562,056	Uncountable	0.09	-515,296	Uncountable	0.17	-498,704	Uncountable	0.19

(Note 1) Unit value of benefit: Option-1 13 (Kyats/m^3) 380 (Kyats/month.HH)
Option-2 23 (Kyats/m^3) 690 (Kyats/month.HH)
Option-3 27 (Kyats/m^3) 800 (Kyats/month.HH)

As indicated in the above Table, FIRRs are impossible to calculate because almost of all cash balances are negative in any options. It means that the Project is not viable in case of applying Willingness of People to Pay and Affordability of People to Pay at present.

9.2.2 Financial Evaluation Based on New Tariff System to Be Recommended

As mentioned above, the Project is not viable in case of applying Willingness of People to Pay and Affordability of People to Pay at present. Then, the other financial evaluation of the project is to be made based on the new tariff structure by sector to be recommended taking envisaged increasing of income level of the people over the future into account.

First of all, The unit price of water to be supplied as a necessary amount of expenditure for water supply (in other word, the unit cost of water) is estimated at amount of US¢29.87/m^3 (equivalent

to 149 Kyat/m^3) as a specific cost (levelized cost)* of capital (namely, the initial investment cost of entire works) and operation and maintenance for the whole works completed assuming that per capita water volume to be consumed is 140 ℓ/day and average family size is 7 persons/HH.

On the other hand, it is assumed that the water volume to be consumed by domestic customers is to be 70 %, government offices: 10 %, and commercial/ industries: 20 % according to a result of questionnaire survey to all the townships in Yangon City.

Based on the unit price of water and assumption, following water price schedule by sector to be revised by every 5 years is set.

Table 9.8 Sectrowise Water Price Schedule

Water Price to Be Applied (US¢/m^3)

Sector	2005	2010	2015	2020	Share rate
Domestic sector	8.47	12.65	15.62	17.92	70%
Public sector	5.65	8.43	10.41	11.95	10%
Industrial/commercial sector	38.11	56.93	70.29	80.65	20%

Using this unit price of water and the above mentioned financial cost, the financial evaluation is made. The results are summarized as below:

Table 9.9 Results of the Financial Evaluation

Package	Evaluation result		
	NPV (US$1,000)	FIRR	B/C
Phase-1	-70,463	8.03%	0.84
Phase-2	-66,806	3.89%	0.63
Overall works	-128,230	7.24%	0.79

The result of financial evaluation in case of the new tariff schedule indicates rather higher FIRR than those of the above conventional way, but a rather low feasibility as shown in the above Table for Phase-1, Phase-2 and overall works.

However, as suggested by such international institutions as the World Bank as mentioned in economic evaluation of the project, an FIRR is expected to at least be cleared a hurdle of 5.0 % from a viewpoint of basic human needs even such a project is in developing countries and even in case of non-commercial projects. From this viewpoint, the Project under study satisfies this expectation with the resulted FIRR in Phase-1 and in overall case as 8.03 % and 7.24 % respectively as indicated in the above Table. Namely, the Project is financially sound too from the

* "*The costs of Generating Electricity in Nuclear and Coal Fired Power Stations*" – A Report by an Expert Group of the Nuclear Energy Agency, OECD, 1983, and Kam W. Li and A. Paul Priddy Ed. "*Power Plant System Design*" John Wiley & Sons, Inc., 1985, USA.

viewpoint of the basic human needs.

In this financial evaluation, basic unit amount of financial benefit, namely basic unit amount of revenue due to water charge collection according to the revised tariff system, is revised every 5 years from the year 2005. According to this revision, water expenditure per household per month rise with the rate of 542 % up (namely, 6.4 times against previous year) in 2005 against previous household expenditure corresponding the existing tariff system, 49 % up in 2010, 23 % up in 2015 and 15 % up in 2020. In the year 2020, the amount of household monthly expenditure will rise up to 13 times comparing with that corresponding to the existing tariff system, and this amount is continued until the end of the 50 years of the Project life. In other words, revenue of YCDC is increased with the same rate.

9.3 AFFORDABILITY OF PEOPLE TO PAY FOR WATER

Following table (Table 9.10) and figure (Figure 9.1) show relationships between income and expenditure for water of the households applying the above mentioned water price as a water tariff revision schedule in case of households belonging to the minimum income level according to the Consumer Survey:

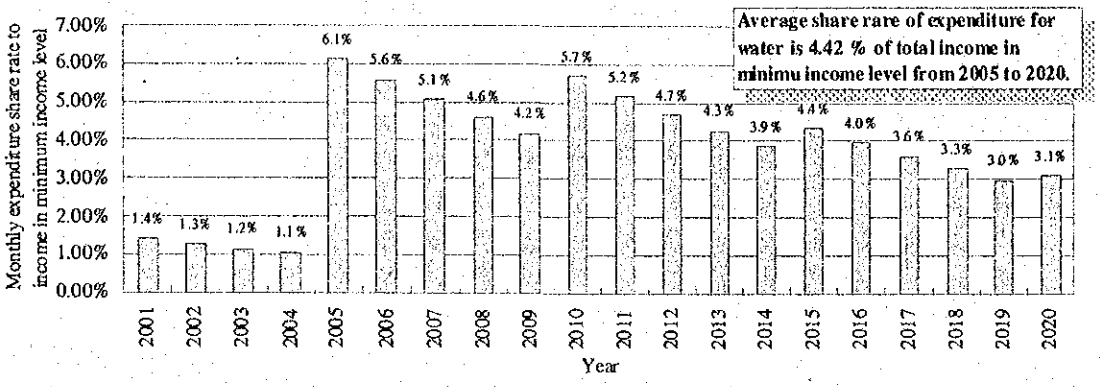
Table 9.10 Relationship Between Income and Expenditure for Water

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
A. Household income*1											
(1) Minimum level	Kyats/HH/month	13,844	15,228	16,751	18,426	20,269	22,295	24,525	26,978	29,675	32,643
(2) Maximum level	Kyats/HH/month	85,464	94,010	103,411	113,752	125,127	137,640	151,404	166,544	183,199	201,519
(3) Average	Kyats/HH/month	39,260	43,186	47,505	52,255	57,481	63,229	69,552	76,507	84,158	92,574
B. Water consumption	m^3/HH/month	29	29	29	29	29	29	29	29	29	29
	gallons/HH/month	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467
C. Water teriff	US¢/m^3	1.32	1.32	1.32	1.32	8.47	8.47	8.47	8.47	8.47	12.65
	Kyats/m^3	6.60	6.60	6.60	6.60	42.35	42.35	42.35	42.35	42.35	63.26
	Kyats/10^3 gallon	30	30	30	30	193	193	193	193	193	288
Revised rate						541.71%					49.38%
D. Expenditure for wat	US¢/HH.month	38.80	38.80	38.80	38.80	249.01	249.01	249.01	249.01	249.01	371.97
(4)	Kyats/HH.month	194	194	194	194	1,245	1,245	1,245	1,245	1,245	1,860
Expenditure share rate: (4)/(1)		1.40%	1.27%	1.16%	1.05%	6.14%	5.58%	5.08%	4.62%	4.20%	5.70%
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. Household income*1											
(1) Minimum level	Kyats/HH/month	35,907	39,498	43,448	47,792	52,572	57,829	63,612	69,973	76,970	84,667
(2) Maximum level	Kyats/HH/month	221,671	243,838	268,222	295,044	324,548	357,003	392,703	431,973	475,171	522,688
(3) Average	Kyats/HH/month	101,831	112,014	123,216	135,537	149,091	164,000	180,400	198,440	218,284	240,113
B. Water consumption	m^3/HH/month	29	29	29	29	29	29	29	29	29	29
	gallons/HH/month	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467	6,467
C. Water teriff	US¢/m^3	12.65	12.65	12.65	12.65	15.62	15.62	15.62	15.62	15.62	17.92
	Kyats/m^3	63.26	63.26	63.26	63.26	78.10	78.10	78.10	78.10	78.10	89.61
	Kyats/10^3 gallon	288	288	288	288	355	355	355	355	355	407
Revised rate						23.45%					14.74%
D. Expenditure for wat	US¢/HH.month	371.97	371.97	371.97	371.97	459.21	459.21	459.21	459.21	459.21	526.88
(4)	Kyats/HH.month	1,860	1,860	1,860	1,860	2,296	2,296	2,296	2,296	2,296	2,634
Expenditure share rate: (4)/(1)		5.18%	4.71%	4.28%	3.89%	4.37%	3.97%	3.61%	3.28%	2.98%	3.11%

*1 Increasing ratios of income level is assumed at 10 % based on CPI taking moderate case into account comparing with per capita GDP increasing ratio. The base income level is based on the Consumer Survey as shown in Appendix M.1.

*2 Per capita water consumption: 140 *l* /day.capita
Average family size: 7 /HH
Conversion rate: 4.546 *l* /gallon

Figure 9.1 Relationship Between Income and Expenditure for Water



Five (5) % of total income is the upper limit of affordability of people to pay for water according to the suggestion of international financing institution as the World Bank and Asian Development Bank. As indicated in the above table and figure, monthly share rates of expenditure for water against monthly income level exceed the 5 % at 5 times in 2005 (6.1 %), 2006 (5.6 %), 2007 (5.1 %), 2010 (5.7 %) and 2011 (5.2 %) in case of minimum income level. However, the average share rate during the period from 2005 to 2020 is lower than 5 % as 4.42 %. It means that said recommended tariff system is within safety side of the affordability of people to pay for water.

In this case, it is assumed that the people's income level will be increased by 10 % every year over the future taking consumer price index and increasing ratio of per capita GDP.

9.4 REPAYMENT ABILITY OF THE PROJECT

Because that the analysis of repayment ability for Phase-1 may be enough for making clear the repayment ability of the Project (namely, YCDC) from the viewpoint of the economic evaluation too, the analysis for repayment ability of YCDC is made for Phase-1.

In this Project, the price escalation rates are applied as 1.0 % per annum for FC portion and specified rate of 0.5 % per annum for LC portion tentatively according to the similar projects in developing countries in south-east Asia. In this case, an amount of annual equal payment including interest and principal is calculated at US$ 48,225 $\times$ 10^3 with an interest rate of 1.30 % per annum and 30 years of repayment period including 10 years of grace period. Following table shows the repayment schedule.

Table 9.11 Repayment Schedule

(US$1,000) (US$1,000)

Year in order	Year	Outflow: Construction cost: Loan portion	Outflow: Construction cost: Local portion	Outflow: Foreign borrow: Interest	Outflow: Foreign borrow: Principal	Outflow: OM cost	Outflow: Total	In flow: Foreign borrow	In flow: Revenue in total	In flow: In flow in total	Cash balance	Subsidy to the Project from YCDC or Central Government of Myanmar
-1	2001	0	0	0	0	0	0	0	0	0	0	0
0	2002	0	0	0	0	0	0	0	0	0	0	0
1	2003	0	0	0	0	0	0	0	0	0	0	0
2	2004	31,875	2,361	0	0	207	34,444	31,875	1,870	33,745	-699	699
3	2005	33,380	2,908	414	0	207	36,910	33,380	14,318	47,699	10,788	
4	2006	121,799	13,105	848	0	694	136,446	121,799	26,380	148,179	11,733	
5	2007	94,693	7,943	2,432	0	723	105,790	94,693	26,849	121,541	15,751	
6	2008	168,339	29,994	3,663	0	1,869	203,865	168,339	27,318	195,657	-8,208	8,208
7	2009	132,470	22,193	5,851	0	1,078	161,592	132,470	27,792	160,262	-1,331	1,331
8	2010	171,576	25,656	7,573	0	8,888	213,693	171,576	63,343	234,919	21,226	
9	2011			9,804	0	8,888	18,691		63,343	63,343	44,652	
10	2012			9,804	0	9,963	19,767		63,343	63,343	43,576	
11	2013			9,804	33,260	8,888	51,951		63,343	63,343	11,392	
12	2014			9,371	33,692	8,888	51,951		63,343	63,343	11,392	
28	2030			1,637	41,427	8,888	51,951		89,724	89,724	37,772	
29	2031			1,098	41,966	8,888	51,951		89,724	89,724	37,772	
30	2032			553	42,511	9,963	53,027		89,724	89,724	36,696	
Total		754,131						754,131				

(Note)
(1) Interest rate of foreign loan: 1.30%
(2) Equal annual repayment amount of capital for foreign loan (US$1,000)): 43,064

As indicated in the above, a subsidy to the Project from General Account of YCDC or from the central Government of Myanmar (or some domestic financing sources) will be needed at the early stage of execution of construction works and at the time to be needed large scale of construction cost to invest. However, when the water charge is collected smoothly, YCDC can caver such deficit in any case.

9.5 ACCOUNTING OPERATION

Following table (Table 9.12) shows a result of projection of Profit and Loss of YCDC until the 2020. In this case, it is assumed that total outstanding collections are to be most pessimistic case as 10 % consisting of (1) outstanding charge: 2.60 %, (2) free connection rate: 3.45 %, (3) non-billing rate: 1.80 % and (4) the rate of communal water tapping: 2.59 % in average.

Table 9.12 Projection of Profit and Losses

(US$1,000)

	(Note)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
A. Revenue due to water charge collection		1,321	1,648	2,056	2,564	11,246	23,818	24,797	25,777	26,761	62,564
B. Outstanding collection						1,175	2,489	2,591	2,694	2,796	6,538
Outstanding charge	2.60%					292	619	645	670	696	1,627
Free connection rate	3.45%					388	822	856	889	923	2,158
Non-billing rate	1.80%					202	429	446	464	482	1,126
Communal water tapping	2.60%					292	619	645	670	696	1,627
C. Governmental and/or YCDC cross subsidy		0	0	0	0	0	0	0	0	0	0
D. Subtotal (A -B + C)		1,321	1,648	2,056	2,564	10,070	21,329	22,206	23,083	23,964	56,026
E. OM cost for YCDC own operation		179	210	246	289	0	0	0	0	0	0
F. OM cost for the Project					207	207	694	723	1,869	1,078	8,888
G. Replacement cost		0	0	0	0	651	1,335	3,855	5,752	9,465	12,205
H. Depreciation		0	0	0	0	1,008	2,065	5,962	8,898	14,528	18,878
I. Subtotal (E+F+G+H)		179	210	246	496	1,866	4,095	10,540	16,519	25,071	39,970
J. Profit before Tax (D - I)		1,142	1,438	1,810	2,068	8,204	17,234	11,666	6,564	-1,107	16,056
K. Income tax		0	0	0	0	0	0	0	0	0	0
Net Profit (J - K)		1,142	1,438	1,810	2,068	8,204	17,234	11,666	6,564	-1,107	16,056

(US$1,000)

	(Note)	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
A. Revenue due to water charge collection		64,380	66,195	68,009	69,824	90,046	93,634	97,231	100,819	104,415	142,789
B Outstanding collection		6,728	6,917	7,107	7,297	9,410	9,785	10,161	10,536	10,911	14,921
Outstanding charge	2.60%	1,674	1,721	1,768	1,815	2,341	2,434	2,528	2,621	2,715	3,713
Free connection rate	3.45%	2,221	2,284	2,346	2,409	3,107	3,230	3,354	3,478	3,602	4,926
Non-billing rate	1.80%	1,159	1,192	1,224	1,257	1,621	1,685	1,750	1,815	1,879	2,570
Communal water tapping	2.60%	1,674	1,721	1,768	1,815	2,341	2,434	2,528	2,621	2,715	3,713
C. Governmental and/or YCDC cross subsidy		0	0	0	0	0	0	0	0	0	0
D. Subtotal (A -B + C)		57,652	59,277	60,902	62,527	80,636	83,849	87,071	90,283	93,504	127,867
E. OM cost for YCDC own operation		0	0	0	0	0	0	0	0	0	0
F. OM cost for the Project		9,233	9,964	8,906	9,894	9,318	9,999	8,923	9,911	16,225	30,916
G. Replacement cost		15,756	16,805	17,787	18,427	18,667	19,198	19,743	21,676	24,483	28,182
H. Depreciation		24,371	25,993	27,512	28,502	28,873	29,694	30,538	33,528	37,869	43,591
I. Subtotal (E+F+G+H)		49,360	52,763	54,204	56,823	56,857	58,891	59,204	65,116	78,577	102,689
J. Profit before Tax (D - I)		8,292	6,515	6,698	5,704	23,779	24,958	27,867	25,167	14,926	25,178
K. Income tax		0	0	0	0	0	0	0	0	0	0
Net Profit (J - K)		8,292	6,515	6,698	5,704	23,779	24,958	27,867	25,167	14,926	25,178

(Note)

Communal water tapping is used by lowest income levels with share rate of 3.7 % of total households connected with YCDC Water Supply System. However, total domestic users shared at 70 % of total water volume to be supplied. So, it is assumed that the rate of communal water tapping users is to be 2.6 % of the water volume to be supplied (= 3.7 % * 70 %).

As indicated in the above table, there is only once to register a deficit in the fiscal year 2009/10 during the period to the year 2020 even in case of most pessimistic case from the viewpoint of one-year-budget.

Based on the above projection of profit and loss of YCDC, a projection of fund flow of YCDC is made. This table indicates a situation of balance sheet in each year over the future. Following tables show its results:

Table 9.13 Future Balance Sheet Situation

(US$1,000)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
A. Source of Fund (B+G+I)	1,142	1,438	1,810	35,653	44,475	149,191	115,472	203,154	158,410	218,034
B. Internal fund generation (C+D)	1,142	1,438	1,810	2,068	9,212	19,299	17,628	15,461	13,422	34,934
C. Depreciation					1,008	2,065	5,962	8,898	14,528	18,878
D. Net profit	1,142	1,438	1,810	2,068	8,204	17,234	11,666	6,564	-1,107	16,056
G. Credit of International Financing Institution to the Project				31,247	32,399	117,046	90,097	158,583	123,557	158,448
I. Counterpart contribution by YCDC (Local currency portion)				2,338	2,865	12,846	7,747	29,110	21,432	24,653
J. Application of fund (K+L+M)	1,142	1,438	1,810	35,653	44,475	149,191	115,472	203,154	158,410	218,034
K. Investment for the Project			0	33,585	35,264	129,892	97,844	187,693	144,989	183,101
L. Debt retirement				0	406	827	2,349	3,520	5,582	7,188
Repayment of principal for Phase-1				0	0	0	0	0	0	0
Interest payment of loan amount for Phase-1				0	406	827	2,349	3,520	5,582	7,188
M. Working capital	1,142	1,438	1,810	2,068	8,805	18,472	15,279	11,941	7,840	27,746
Available cash	1,431	2,869	4,678	6,747	15,552	34,024	49,304	61,245	69,084	96,830

(US$1,000)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A. Source of Fund (B+G+I)	86,736	83,131	67,212	46,565	80,045	82,770	158,083	203,393	243,529	80,889
B. Internal fund generation (C+D)	32,663	32,508	34,210	34,206	52,652	54,653	58,405	58,695	52,795	68,769
C. Depreciation	24,371	25,993	27,512	28,502	28,873	29,694	30,538	33,528	37,869	43,591
D. Net profit	8,292	6,515	6,698	5,704	23,779	24,958	27,867	25,167	14,926	25,178
G. Credit of International Financing Institution to the Project	45,600	42,063	29,586	10,011	22,200	22,080	85,025	120,324	163,568	9,849
I. Counterpart contribution by YCDC (Local currency portion)	8,473	8,559	3,416	2,348	5,193	6,037	14,653	24,374	27,165	2,271
J. Application of fund (K+L+M)	86,736	83,131	67,212	46,565	80,045	82,770	158,083	203,393	243,529	80,889
K. Investment for the Project	54,073	50,622	33,002	12,359	27,393	28,117	99,678	144,697	190,733	12,120
L. Debt retirement	9,248	9,841	41,762	42,147	42,277	42,565	42,852	43,958	45,522	47,648
Repayment of principal for Phase-1	0	0	31,374	31,782	32,195	32,614	33,038	33,467	33,903	34,343
Interest payment of loan amount for Phase-1	9,248	9,841	10,388	10,364	10,081	9,951	9,814	10,490	11,619	13,305
M. Working capital	23,415	22,667	-7,552	-7,941	10,375	12,088	15,553	14,738	7,274	21,121
Available cash	120,245	142,912	135,361	127,420	137,795	149,883	165,435	180,173	187,446	208,567

As indicated in the above table, a deficit of net profit in 2009/10 may be covered by the accumulated available cash (disposable cash balance at the end of each year). Also, in the year 2013 and 2014, working capitals will be booked in credit side as indicated in the above table. They are caused by high investment cost in 2008, and just starting time of repayment in 2013 and 2014. However, these are also balanced out by the accumulated available cash. Accordingly, YCDC can keep sound accounting until the year 2020 and thereafter.

CHAPTER 10 INITIAL ENVIRONMENTAL EXAMINATION

10.1 ENVIRONMENTAL PROTECTION

10.1.1 Institutions and Jurisdictions

(1) Environmental Agencies

1) Ministry of Environment

Presently, there is no responsible agency for environmental protection administration. The National Environmental Policy of Myanmar was adopted, and the National Commission for Environmental Affairs is finally drafting the National Framework Environmental Law and the Environmental Impact Assessment (EIA) Law with the aim to integrate environment and development effectively.

2) National Commission for Environmental Affairs (NCEA)

The NCEA has been established under direct authority of the Minister of Foreign Affairs in order to carry out, follow-up and evaluate the national level of environmental policy and decision making for sustainable development in accordance with Myanmar AGENDA 21.

(2) Other Agencies Strongly Involved in Environment Management

1) Ministry of Health

The Office of Environmental Hygiene and Protection against Diseases Vectors are major managing agencies for dealing with the urban environmental issues of Yangon.

2) Ministry of Forestry

Community Forestry Instructions, stated by the Ministry of Forestry calls for decentralization and development in forest management with the primary purposes of both satisfying the basic needs of local communities and protecting the forests against undue causes.

3) Ministry of Industry (1)

The Ministry of Industry (1) prescribed the Standing Order No.3/95 for factories and enterprises in order to adopt uniform preparatory measures beforehand for the prevention of pollution and destruction of the entire natural environment enveloping the water, land and atmosphere by which are being discharged by the factories.

(3) Outline of Jurisdictions and Competence

1) Industrial Environment

In the field of industrial environment, the Ministry of Industry (1) has a duty to control polluting establishments.

2) Living Urban Environment

In the field of quality of the living urban environment, the main agencies responsible are the Ministry of Health for hygiene and sanitation and the Ministry of Forest for living amenities.

3) Natural Resources

Natural resources relevant in Yangon are mainly fresh water and fishery. The protection of ambient surface water quality will involve the Ministry of Environment for nature protection purpose and the Ministry of Health for hygiene for sanitation purpose.

4) Natural Habitats and Species

The Ministry of Forestry makes conservation of natural habitats and species through management of natural resources.

5) Information System

There is no regular collection of environmental data in Yangon, excepting health data and drinking water quality data. The National Framework Environmental Law has required for the preparation of annual statement of environmental quality.

10.1.2 Legislative and Regulatory Framework

(1) Living Environment

The National Framework Environmental Law would stipulate that discharge and disposal of liquid and solid waste by individuals or industries are forbidden. The law explicitly provides that waste deposits in public places as well as throwing away domestic waste and other waste like gravel and stones in public places, streets, rivers, or ponds are forbidden.

(2) Natural Environment

1) Biodiversity

Myanmar scores as one of the richest biological reservoirs in Asia. Wide varieties of flora and fauna exist in the country. 285 families of flora, consisting of about 7,000 species have been recorded. Myanmar also has a rich diversity of wild fauna. About 300 mammal species have been recorded.

2) Forest Resources

Myanmar is well endowed with rich natural forests. Forests cover about 340,000 km^2 constituting over 50 percent of the total area of the country. The Government is currently making efforts to prevent deforestation in. The Forest Policy was adopted to ensure sustainable development of forest resources while conserving wildlife and wild plants, and enhancing the ways of living of indigenous people.

(3) Landscape and Cultural Patrimony

The preservation of cultural patrimony is managed under the Protection and Preservation of Cultural Heritage Region Law. The law provides the rules that the Minister in charge of

culture must establish the national inventory of goods, monuments and sites of cultural value.

(4) Natural and Technological Risks

The management of natural and technological risks, especially the risks related to flooding, landslide, drought and fires, is the duty of the State Peace & Development Council.

(5) Public Participation

The involvement of the public is one of the most crucial aspects of the EIA process. The provision for public participation is contained in the National Framework Environmental Law.

10.1.3 Environmental Policies

(1) Local Environment Policy

The YCDC has launched a program of environmental protection around 1990's, with the objectives of protecting ecosystems and living conditions of people. However, actions have been limited to specific aspects like preservation of green belt, rehabilitation of soils and awareness heightening, etc.

(2) National Environment Policy

The NCEA drafted the National Environmental Policy, which was adopted. The Policy forms the basis for developing environmental strategies, environmental programmes and plans. The NCEA also initiated the drafting of the Myanmar Agenda 21 based on the Agenda 21 laid down by the United Nations Environment and Development Conference in 1992 for achieving sustainable development.

10.1.4 Environmental Conventions and Criteria

(1) International Conventions

The government of Union of Myanmar has signed or ratified several international conventions pertaining to environmental protection. The follow-up of conventions initiated by the Rio Conference is the duty of the NCEA, which has been designated as the focal point, in charge of coordinating technical commissions composed of concerned ministers.

(2) Environmental Standards

There are no ambient quality standards for environment in Myanmar. Emission standards for water and air pollutions are those only generated from industrial activities, established by Ministerial Standing Order No.3/95 of Ministry of Industry (1).

10.2 EXAMINATION OF ENVIRONMENTAL EFFECTS

10.2.1 Scope of Environmental Evaluation

(1) EIA Requirement

The national framework environmental law and the decree establishing an EIA both require an EIA for activities, projects and programs of development. These requirements are discussed below in order to better define the expected scopes and pertinence of an EIA for the Master Plan. The EIA legal requirement as established in Myanmar concerns activities, projects and programmes all together. The EIA procedure requires that positive and negative impacts are both considered and specified mentioned in the study.

(2) Purpose of IEE

The Initial Environmental Examination (IEE) is useful to find out the possible negative impacts of the Master Plan project on the social and natural environment. The IEE is a procedure which is recommended by JICA's guidelines and which follows checklists established for the water supply sector. The purpose of IEE is to clarify the needs and targets for further environmental assessment within the scope of EIA.

The IEE process includes the evaluation of the initial state of environment conditions. The result of the IEE is an evaluation of the main expected orientations and issues to be focused on in the forward EIA study. The IEE is performed below through the review of the project components and potential impact sources, and the screening and ranking of possible negative effects.

10.2.2 Project Components and Sources of Environmental Impacts

Implementation of the Master Plan is based on the installation of indispensable water supply facilities, which will meet the future water demand and improve the sanitation conditions of Yangon City. Construction and operation of these units are however potential sources of undesirable impacts, which need consideration in order to avoid negative feedback effects on social or natural environment. The detailed project components of Master Plan have been proposed other chapters.

10.2.3 Screening of Potential Effects

The analysis of the present conditions of environment in Yangon and its outskirts that there is no critical issues both in terms of urban and natural environment. The sanitary conditions of Yangon have important impacts on the health aspect of resident, their quality of life and quality of the natural environment. The initial screening of the possible impacts both construction and operation & maintenance phases have been done by the checklist fulfilled.

The results showed that the conditions of operation and maintenance of facilities are the main factors of environmental sustainability of the projects and determine the nature and importance

of the potential effects. Institutional capacity to manage and follow up environmental measures is also an important factor of good integration of environment in the project and Master Plan.

10.2.4 Terms of Reference of EIA

(1) Purpose of the EIA Study

The Master Plan will permit to achieve better public health performances and to upgrade the quality of the living environment. The full achievement of such objectives is, however, related to the favourable selection of sites for water supply facilities, their technical design and their suitable operation and maintenance.

The purpose of the EIA study is to make sure that sanitation improvement will not result into transferring pollution and nuisances from the urban area to the natural area.

The output of the EIA study will be the evaluation of the expected impacts of the Pre-Feasibility Study and the definition of an environmental management plan intended to define a frame for taking into account environment and sustainability factors in the project.

(2) Study Areas and Projects

The EIA will be done within the scope of the Pre-Feasibility Study and cover the study area of the Master Plan.

(3) Scope and Objectives of the EIA

It is assumed that the scope of this EIA is basically determined by the global figure of the Master Plan more than the individual project packages induced by the Master Plan, which will be subject to alternative choices.

The evaluation of the positive and negative impacts of the projects within the scope of the Pre-Feasibility Study constitutes the core of the study. It will be based on a good knowledge of the present conditions in the project areas and the impact sources of planned facilities.

(4) Major Potential Sources of Impacts and Main Issues of Study

The major potential sources of impacts of the projects have been identified for summarised below:

- Conditions of installation and maintenance of facilities in the on-site treatment area
- Construction works
- Land acquisition
- Others (pollution and nuisances)

(5) Field Surveys

The environmental assessment will be based on a set of investigations and field surveys, which will be conducted by the local consultant in coordination with JICA study team and YCDC, and based on TOR. The TOR is prepared by the JICA study team in coordination with YCDC for finalisation.

1) Ecological Survey

The ecological survey of the Hlaing River will provide data for a better evaluation of the effects of raw water intake and wastewater discharge and for future follow-up of environmental improvement with implementation of the Master Plan. The survey should focus on the aquatic habitats existing at the location of the planned raw water intake and wastewater discharging outlets.

2) Social Surveys

The social questions raised by the project sites issue are:

- To which extent does the implementation of facilities impair the livelihood resource base of local communities and their living environment?
- To which extent do these facilities after operation and during construction works induce nuisances to the neighbourhood residents?
- Does the project directly or indirectly fit with the social objectives of current policies (poverty, employment, public health)
- Are the project sites free of valuable natural and cultural assets or environmentally valuable assets?

The social surveys of facilities implantation areas will provide all the necessary data for a better understanding of possible effects on the human communities. The surveys will cover several key tasks that need to be identified after observation of sites on case-by-case basis.

(6) Analytic studies

Investigations will be based on the analysis of existing data and on field observation, as well as from discussion with experts as possible. These investigations deal with 2 categories of objectives:

- Evaluating the possible importance of expected impacts for specific issues, according to the projects design and management conditions.
- Evaluating the mitigations / measures to be undertaken as regards to all the identified impacts of the project on the environment.

(7) Reporting

The full EIA report will include all the chapters required by the draft on Environmental Impact Study Law in Myanmar, based on the environment related chapters included in the Final Report of the JICA study.