2.2.4 Ngamoeyeik Transmission Pipeline

One pipeline conveying raw water of Ngamoeyeik Reservoir to Hlawga Reservoir will be constructed. The following is the specifications;

Design Flow	: 409,050 m^3/day (90 MGD)
Diameter	: 1,800 mm and 1,100 mm
Length	: 30,750 m (Dia. 1,800 mm), 13,280 m (Dia. 1,100 mm)
Pipe Material	: Ductile Iron Pipe

Figure 2.9 shows the plan of Ngamoeyeik Transmission Pipeline.

2.3 WATER TREATMENT PLANT

In the Master Plan, two Water Treatment Plants, namely Hlaing WTP and Hlawga WTP, were proposed. Construction of Hlaing WTP is included in Phase-1 works.
Hlaing WTP will be partially constructed in Phase-1 stage and its capacity equivalents to 50% of the design capacity. Therefore, plant capacity will be;

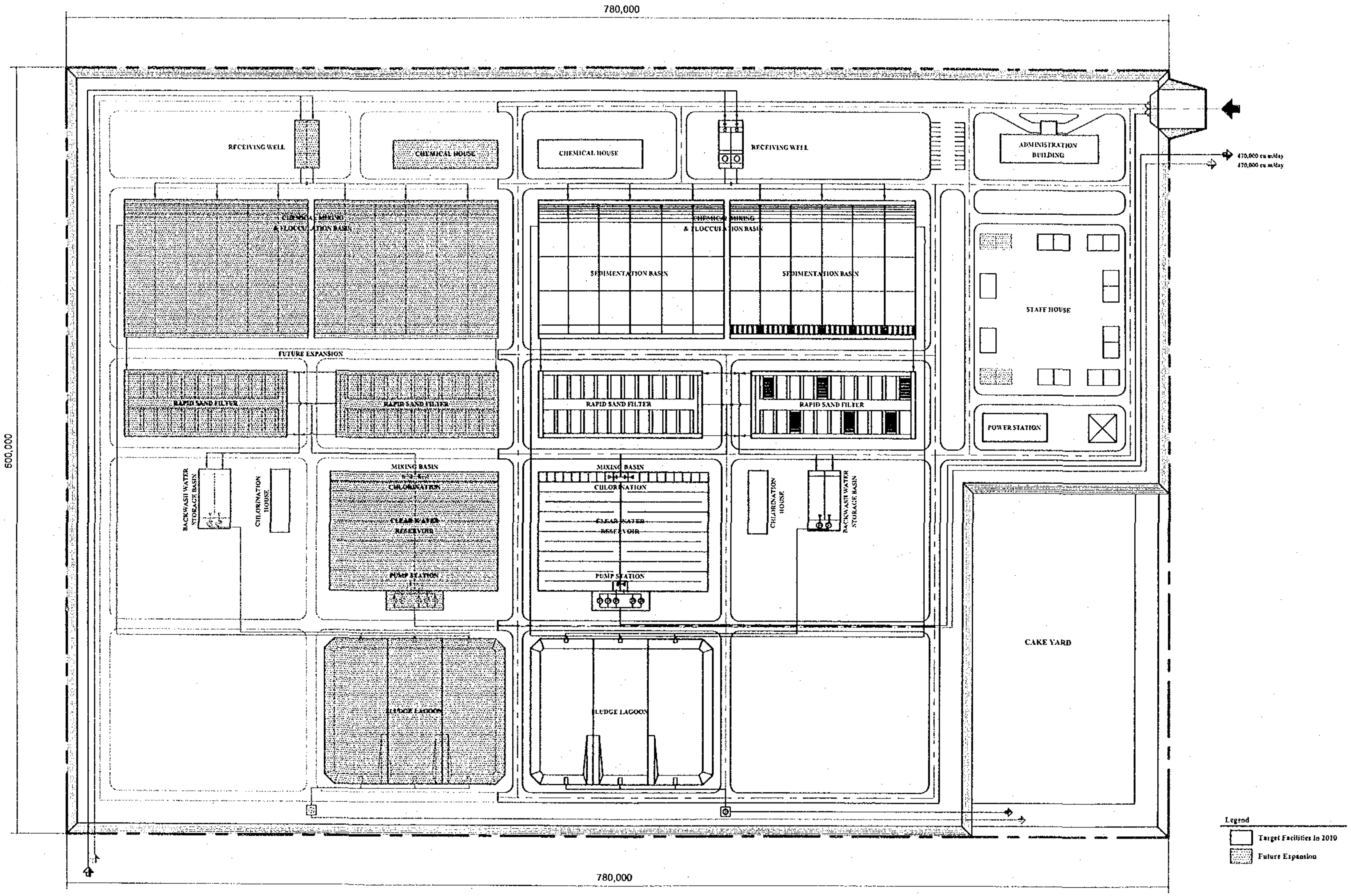
$$940,000\ m^3/day \times 0.5 = 470,000\ m^3/day$$

The following is the outline of major facilities.

2.3.1 Location and Layout of Major Facilities

Interview to the villagers in Gwedanshe, the proposed WTP construction site, was conducted to confirm the effect of saline water intrusion and flooding. According to the results, Gwedanshe is free from saline intrusion even during dry season but Gwedanshe has been flooded several times. The latest flooding was occurred in 1999, and the flooding depth was around 0.3 m. Since the ground level in proposed site is around 5.5 m above mean sea level, flooding water level is +5.8 m. Therefore, land mounding is necessary to cope with flooding if WTP is planned beside the Hlaing River bank in Gwedanshe.

There is the existing embankment about 6 km to the east. The top level of embankment is around +6.00 m high enough to prevent the flood flow. Since the embankment is located near to major road called Yangon-Phyi Road, it is convenient for transportation of the construction material and equipment. Thus, water treatment facilities were planned within this embankment. The location of the proposed site was shown in Figure 2.3 and Figure 2.10 indicates the layout of facilities. Flow process diagram of treatment plant is illustrated in Figure 2.11.

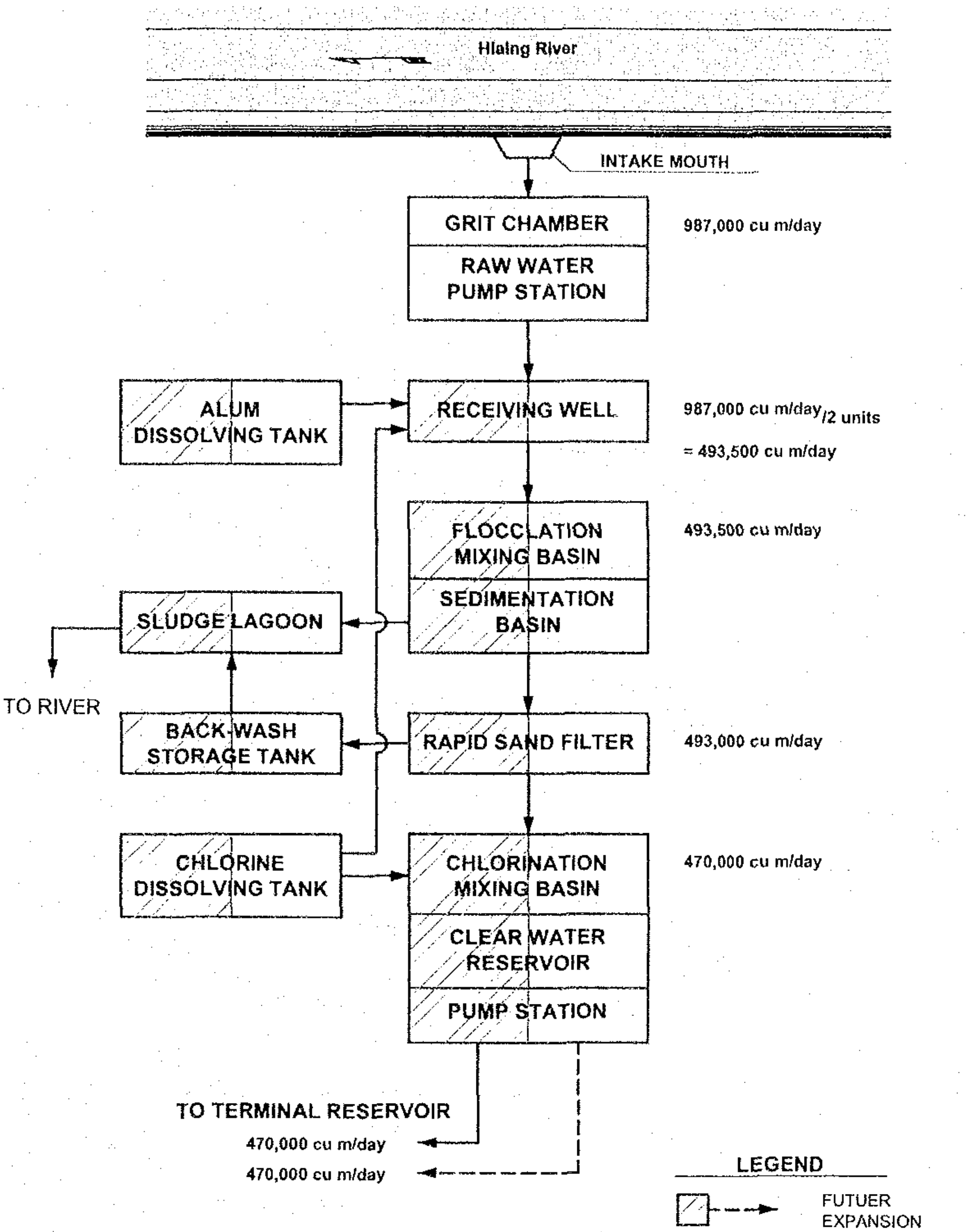


W.T.P FACILITIES

THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR

Layout of Hlaing Water Treatment Plant

FIG 2.10



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 2.11
	Treatment Flow Chart of Hlaing Water Treatment Plant	

2.3.2 Design Detail of Major Facilities

(1) Grit Chamber

Grit chamber is located just downstream of the intake gate. Treated water is sent to the treatment plant located about 7 km to the east.

Dimension	: L 42.0 m x W 14.0 m x D 3.0 m (LWL) x 4 channels
Retention Time	: 10 - 20 min
Surface Load	: 200 - 500 mm/min
Pumps	: 115 m^3/min x 30 m x 750 kW x 4 units (1 unit stand by)
Transmission pipe	: Dia. 2,500 mm x 7,000 m (Steel Pipe)

(2) Receiving Well

River water treated by grit chamber is poured into receiving well. Pre-chlorination is conducted in this tank as countermeasure for Nitrogen – Ammonia, which was detected in Hlaing river water by average concentration around 1.0 mg/L. Chlorine dosage rate is 2 mg/L. Alum is also injected in this well and mixed by gravity. Alum dosage rate is 50 mg/L.

Retention Time	: 1 - 5 min
Dimension	: L 10.0 m x W 6.0 m x D 6.0 m x 1 unit

(3) Flocculation Basin

Hydraulic flocculation basin consists of reinforced concrete vertical baffle walls (up and down flow) and gradually increasing channel width forward for generating lower flow velocity to accelerate the growth of flocks. Average velocity shall be kept within a range of 15 to 30 cm/sec.

Retention Time	: 20 – 40 min
Dimension	: (Step 1) W 1.3 m x L 22.0 m x D 3.3 m x 2 channels/unit
	: (Step 2) W 1.8 m x L 22.0 m x D 3.3 m x 2 channels/unit
	: (Step 3) W 2.4 m x L 22.0 m x D 3.3 m x 2 channels/unit
Number of units	: 12 units

(4) Horizontal Flow Sedimentation Basin

Satisfactory flocculation and sedimentation were observed during the jar test on river water sample taken from Hlaing River. Also from the viewpoint of energy saving, Horizontal Flow Sedimentation Basin is recommendable.

In this basin, two baffle walls at the inlet and the outlet sides and overflow trough with length of 4.4 m at the outlet side are provided.

(Sedimentation Basin)

Retention Time	: 2.5 - 4.0 hours
Surface Load	: 15 – 30 mm/min
Horizontal Velocity	: less than 0.4 m/sec
Dimension	: W 22.0 m x L 80.0 m x D 3.8 m x 12 units

(Overflow Trough)
Overflow Load : 350 m3/m/day
Dimension : L 4.4 m x 14 units/basin

(5) Rapid Sand Filter

The filter is the constant rate, rising level with self-backwashing type. During backwashing, surface washing is also conducted simultaneously to remove the sediments in filters.

Filtration rate : 120 – 150 m/day
Surface Washing : 0.20 m3/m2/min, duration = 6 min
Backwashing : 0.70 m3/m2/min, duration = 8 min
Dimension : W 5.8 m x L 14.8 m x 44 units (4 units stand by)

(6) Chlorination Channel

Liquid chlorine was adopted as chlorination agent. Capacity of dosage equipment is 4 mg/L at maximum and average dosage rate is set by 1.5 mg/L.

Contact Time : more than 2 min
Dimension : W 6.0 m x L 36.0 m x D 3.0 m x 2 units

(7) Clear Water Reservoir

Filtered and disinfected water is led to the clear water reservoir. Clear water is sent to Terminal Reservoir built in south west of the Hlawga reservoir by pump.

Retention Time : more than 1 hour
Dimension : W 42.0 m x L 84.0 m x D 3.0 m x 2 units

(8) Backwash Wastewater Storage Tank

This storage tank receives wastewater from rapid sand filters. Total volume of wastewater including backwashing and surface washing water is 584 m^3/filter. Sinc two filters will be washed simultaneously, required tank volume is 584 x 2 filters = 1,167 m^3. Supernatant is discharged to Hlaing River through canal and sludge on the bottom is pumped to sludge lagoon.

Retention Time : 1 hour
Dimension : W 12.0 m x L 36.0 m x D 3.0 m x 2 units (1 unit stand by)

(9) Sludge Lagoon

Sludge lagoon receives sludge from sedimentation tank and backwash wastewater storage tank. Supernatant is sent back to Hlaing River and sludge is dried during dry season.

Dimension : W 46.0 m x L 180.0 m x D 3.0 m x 3 units

(10) Other Facilities

Administration building includes the following rooms;

Office, Meeting Room, Manager's Room, Water quality analysis laboratory
Store Room, Electric Room

Staff houses are allotted next to administration building. Chemical house will be prepared to provide alum, and Chlorination house to supply liquid chlorine.

2.4 CLEAR WATER TRANSMISSION FACILITIES

2.4.1 Hlaing WTP to Terminal Reservoir

In Phase-1, one line of clear water transmission pipeline will be installed to convey clear water treated in Hlaing WTP to Terminal Reservoir, which will be constructed within the site of proposed Hlawga WTP. Treated water will be conveyed by transmission pumps to be installed just downstream of Clear Water Reservoir of Hlaing WTP. The specification of transmission pumps and pipeline are shown below and Figure 2.12 shows the profile of this transmission pipeline.

Transmission Pump : 85 m^3/min x 55 m x 1,150 kW x 5 units (1 unit stand by)
Transmission Pipeline : Dia. 2,000 mm x 33.3 km

2.4.2 Terminal Reservoir System

Terminal Reservoir will receive treated water from Hlaing WTP, Gyobyu reservoir water and Hlawga reservoir water together with pumped Phugyi and Ngamoeyeik reservoir water. Several service reservoirs will be constructed during Phase-1 stage and they will receive clear water from Terminal Reservoir through transmission pipeline. Figure 2.13 shows the schematic drawing of Terminal Reservoir System, and plan of proposed Hlawga WTP including Terminal Reservoir is drawn in Figure 2.14. The specifications of transmission pumps and pipelines are shown in Table 2.5;

Table 2.5 Specifications of Terminal Reservoir Pumping Station

Pumped to	Transmission Pump	Transmission Pipeline
Kokine Service Reservoir	80 m^3/min x 79 m x 1.150 km x 5 units (1 unit stand by)	Connection to the existing pipeline; To Gyobyu Pipeline : Dia. 1,400 mm x 4.2 km To Hlawga No.1 Pipeline : Dia. 1,650 mm x 1.0 km To Hlawga No.2 Pipeline : Dia. 1,100 mm x 1.3 km
CB Hlawga Service Reservoir	80 m^3/min x 38 m x 0.64 km x 6 units (1 unit stand by)	Dia. 2,200 mm x 3.9 km
CB West Service Reservoir	80 m^3/min x 38 m x 0.64 km x 8 units (1 unit stand by)	Dia. 2,700 mm x 7.5 km

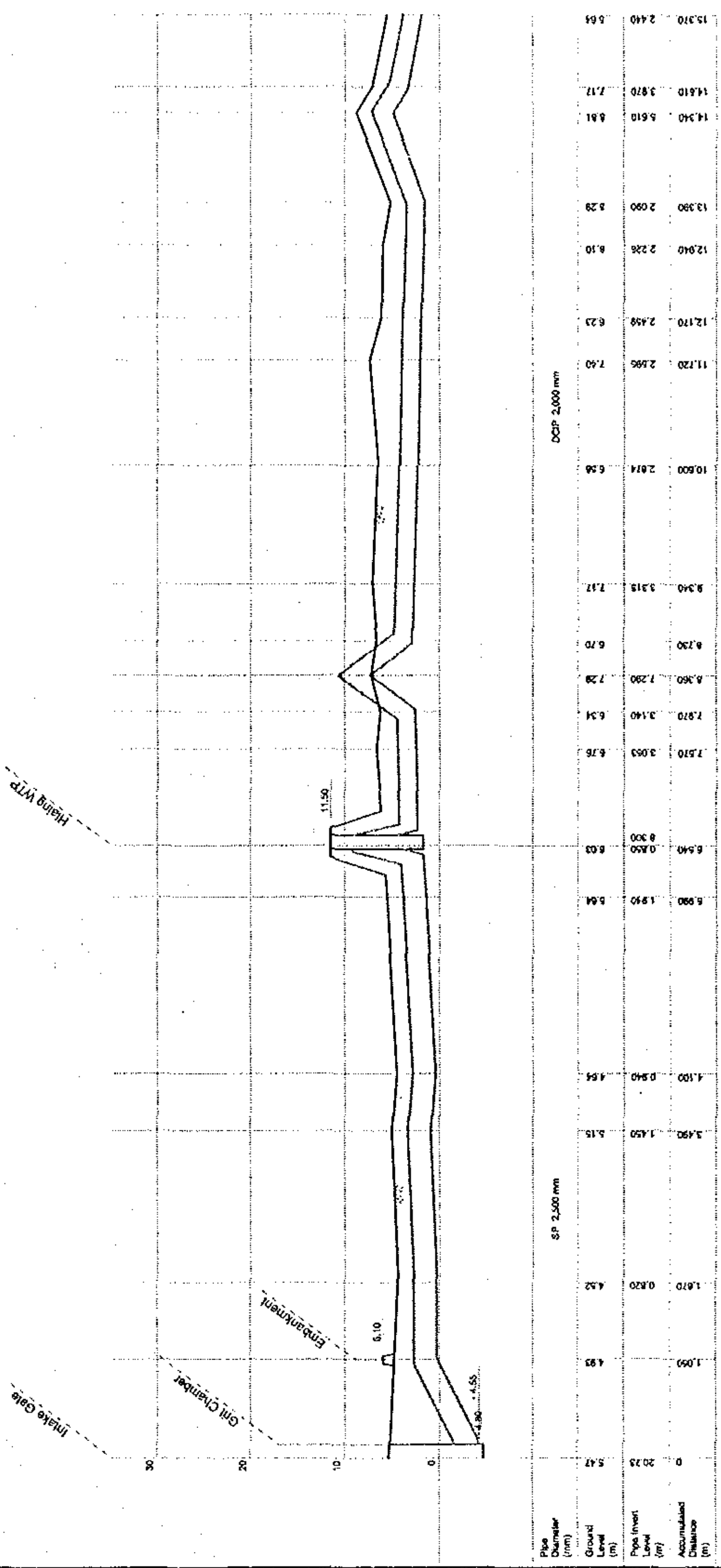


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FIG 2.12

Hlaing WTP Clear Water Transmission Pipeline (1/3)

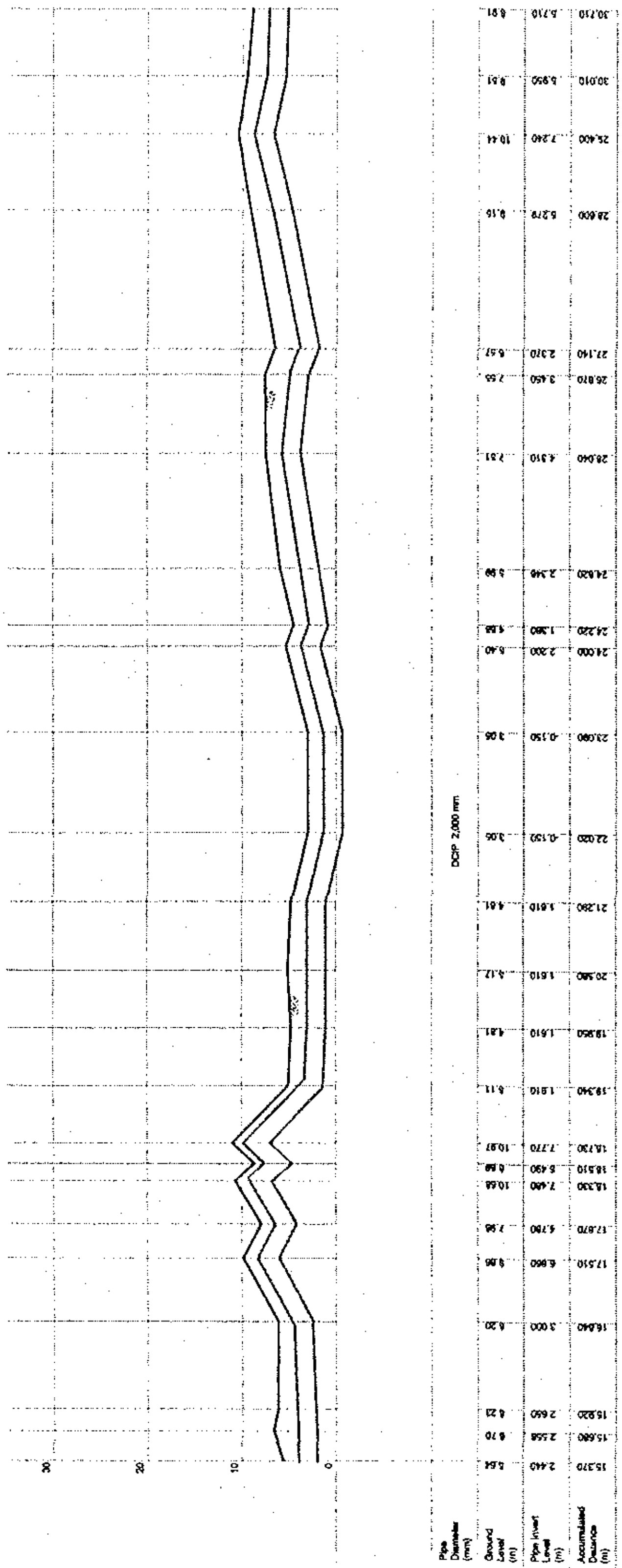

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FIG 2.12

Hlaing WTP Clear Water Transmission Pipeline (2/3)

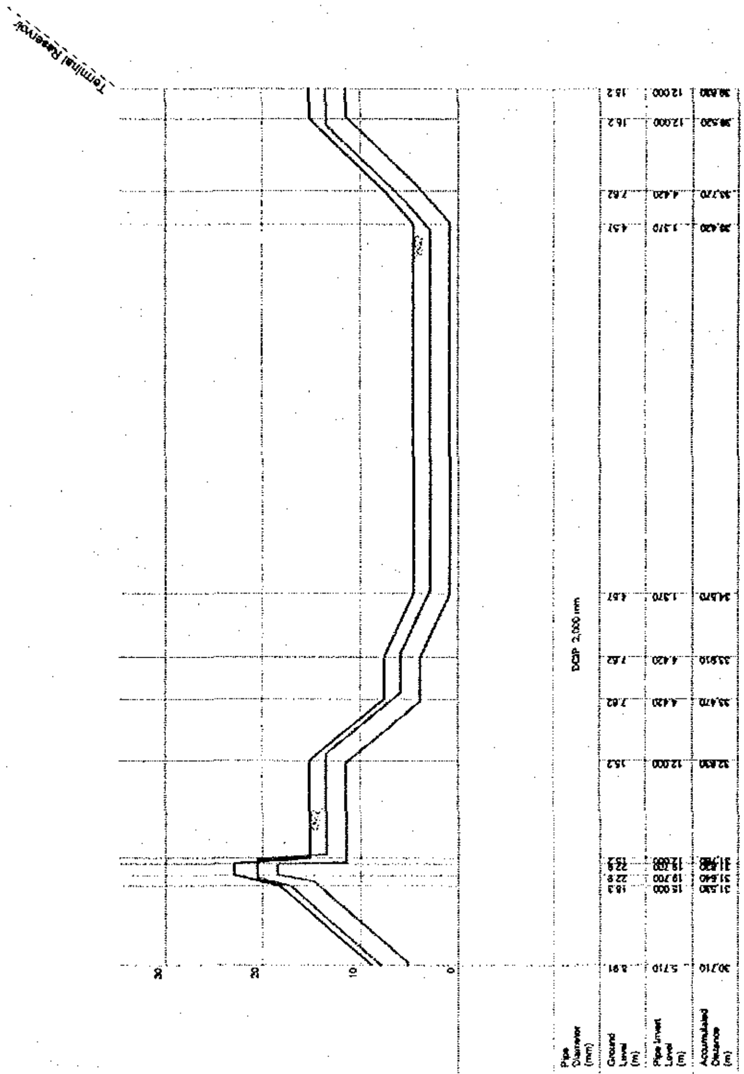

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FIG 2.12

Hlaing WTP Clear Water Transmission Pipeline (3/3)

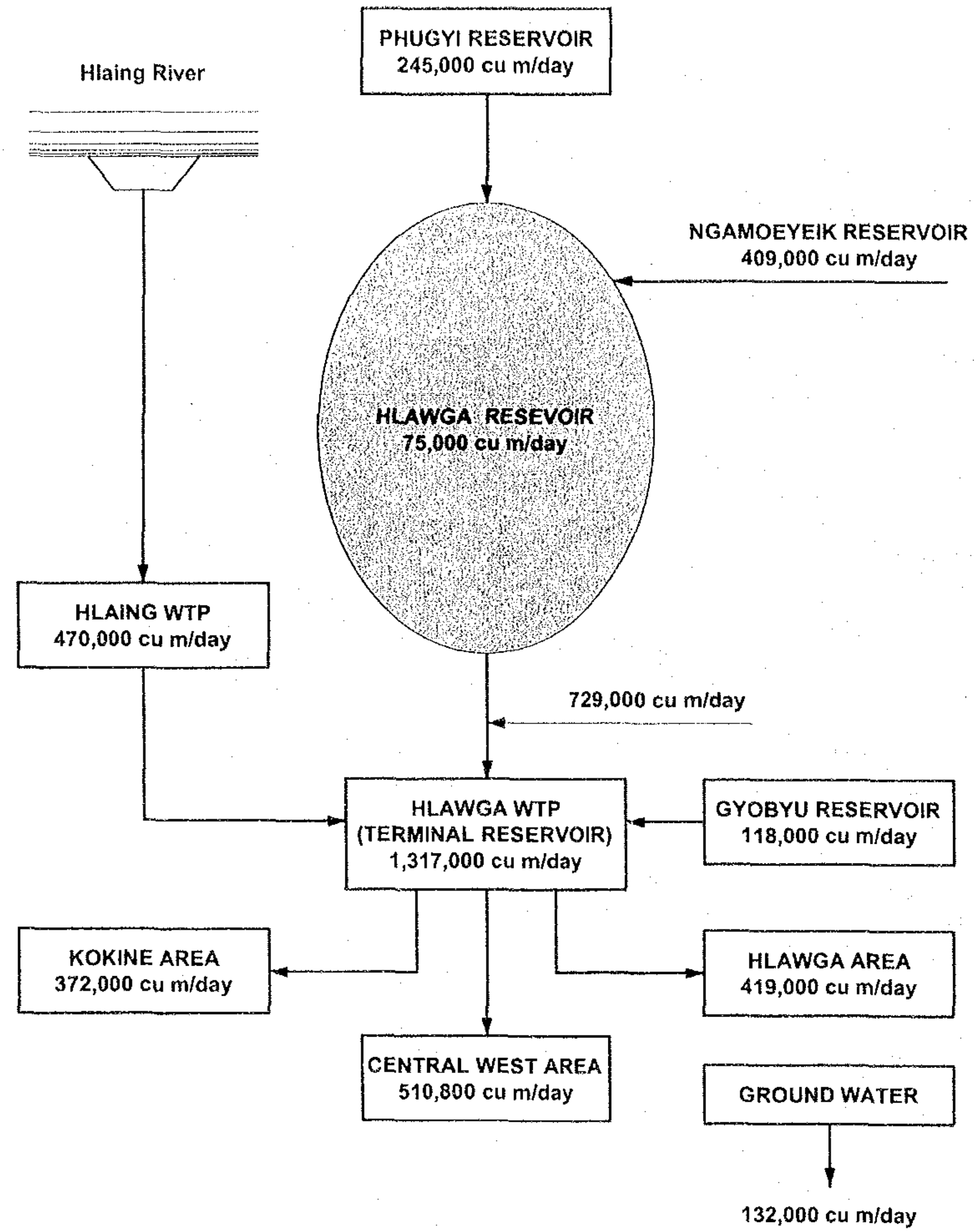

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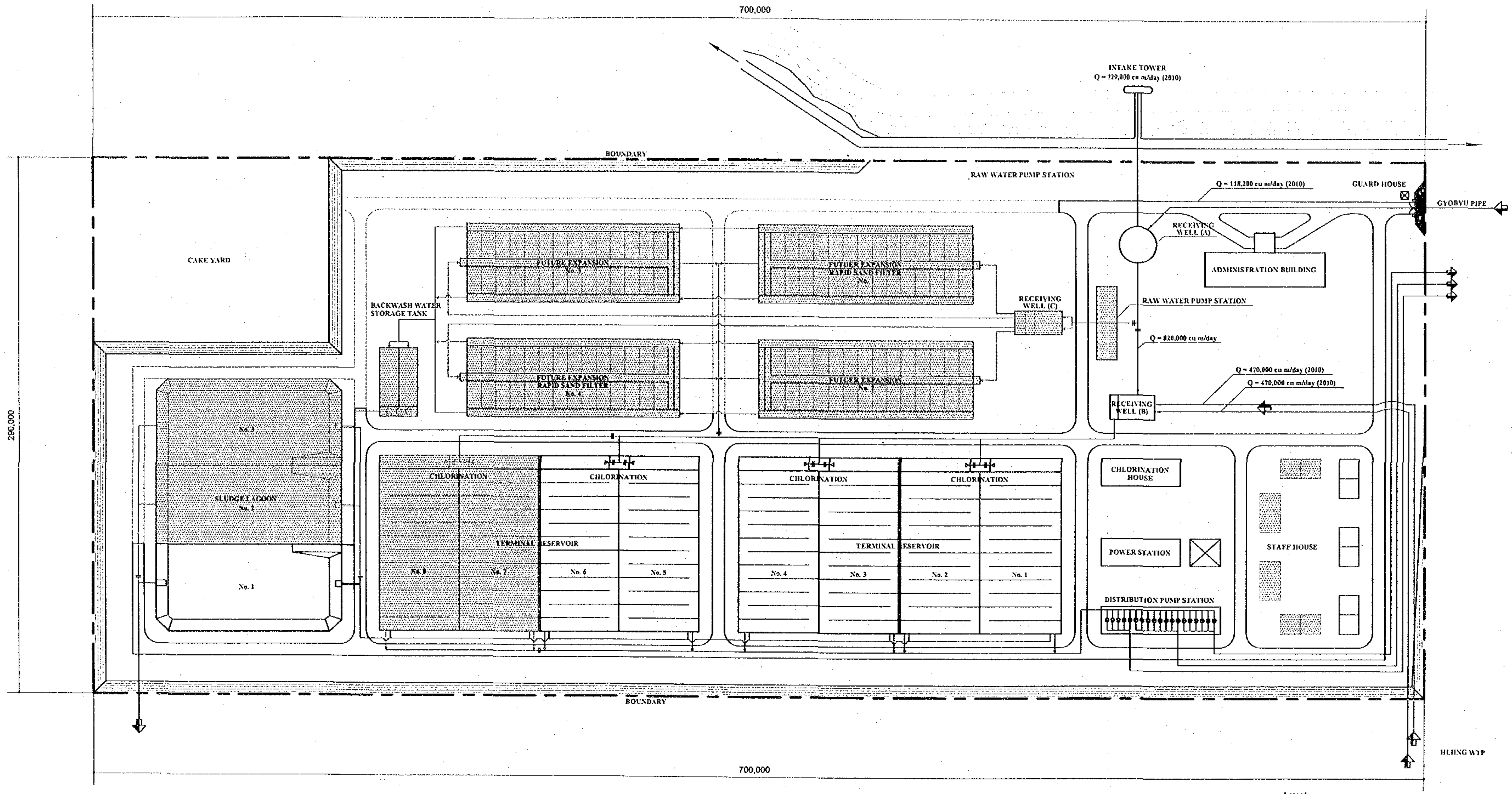
FIG 2.13

Terminal Reservoir System (2010)



Legend
Target Facilities in 2010
Future Expansion

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FIG 2.14

Layout of Hlawga Water Treatment Plant

Upon completion of these P/S and transmission pipelines, the existing Yegu P/S will be abolished. Dimensions of proposed Intake Tower, Receiving Wells are as follows;

Intake Tower : W5.0 m x L 15.0 m x H 18.8 m
(Intake valve : Dia. 1,900 mm x 3 units, intake level +13.0 m and +19.0 m at valve center)
(Raw water main: 2,000 x 2,000 mm box culvert x 2 units, L = 68 m)
Receiving Well (A): Dia. 36.0 m x D 11.0 m
Receiving Well (B): W 14.2 m x L 30.4 m x D 6.6 m

Total volume of Terminal Reservoir 80,000 m^3 is divided into eight units with 10,000 m^3 each. Six units will be implemented during Phase-1 work. Dimension of Terminal Reservoir is shown below and retention time was set more than 1 hour.

Dimension : W 42.0 m x L 84.0 m x D 3.0 m x 6 units

2.4.3 Service Reservoirs

The following clear water transmission pipelines will be installed to convey received treated water to another service reservoir located in downstream;

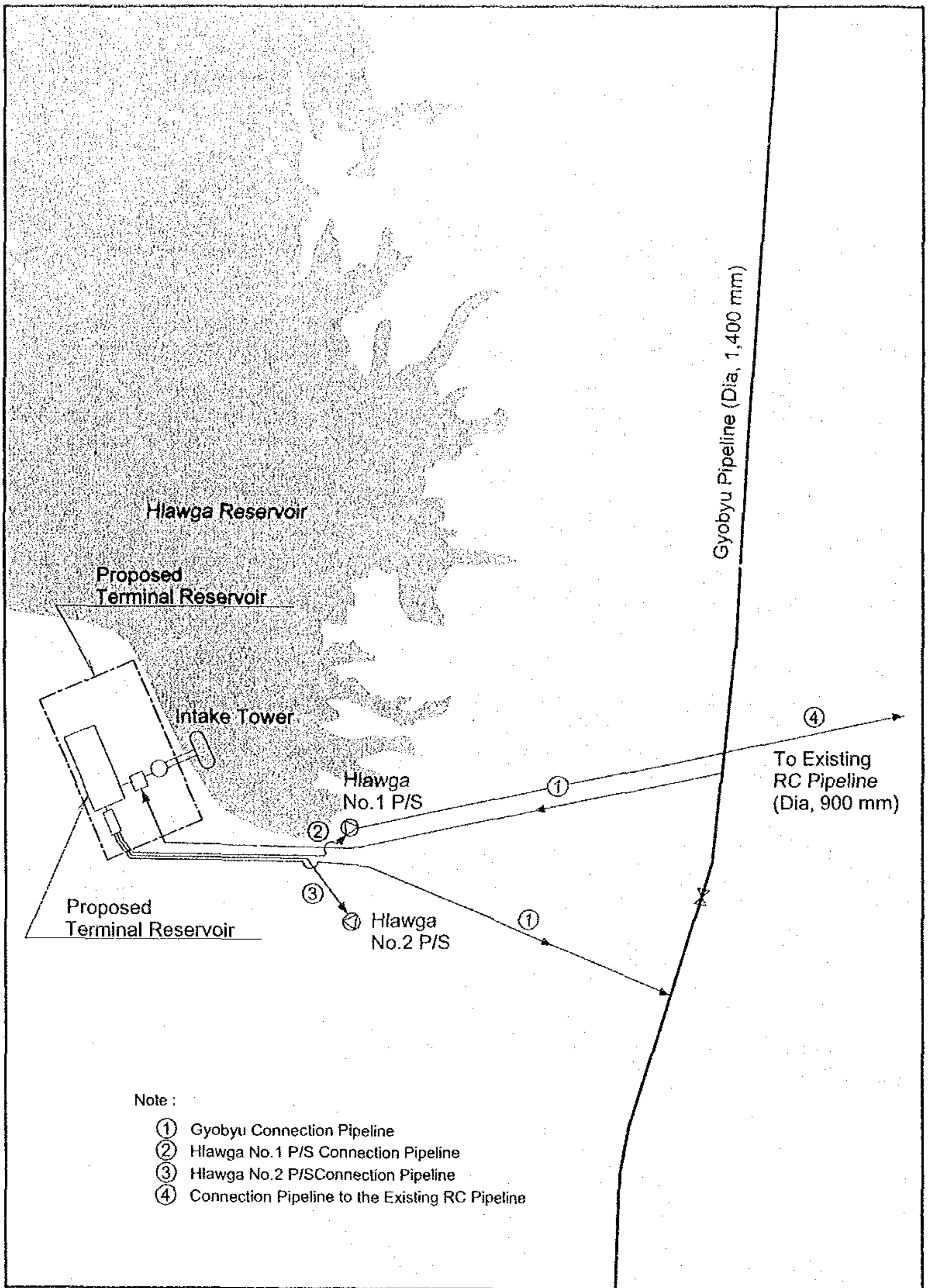
From	To	Transmission Pipeline
CB West Service Reservoir	CB DT East Service Reservoir	Dia. 1,800 mm x 12.2 km
CB DT East Service Reservoir	EB South Service Reservoir	Dia. 1,200 mm x 7.6 km

2.4.4 Other Connection Pipeline

Connection pipeline to the RC pipeline, which is now under construction, is also planned to serve water to CB North (Zone 5), EB North (Zone 8) and EB Central (Zone 7). Pipeline will be connected to Hlawga No.1 P/S.

Connection Pipeline : Dia. 1,200 mm x 2.0 km

Figure 2.15 shows the location of connection pipelines including that to Gyobyu pipeline and so on.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 2.15
	Connection Pipelines	

2.5 SERVICE RESERVOIRS

2.5.1 Central Block

(1) Zone 1 (Downtown Area)

In Zone 1, the existing Kokine and Shwedagon Service Reservoir will be utilized. Treated water will be supplied from Terminal Reservoir by pumps through existing pipelines, but one pipeline will be connected to Eastern T/S belonging to other service zone. Since it was proposed that said treated water sent through the existing pipelines serve in Zone 1 exclusively, this pipeline connected to other zone shall be closed by valve and additional pipeline to send water to Kokine Service Reservoir shall be installed.

Additional Pipeline to Kokine Service Reservoir : Dia. 1,400 mm x 1.35 km

(2) Zone 2 (CB Downtown East Service Reservoir)

CB Downtown East Service Reservoir will receive treated water sent from CB West Service Reservoir and water will be distributed by pump. Necessary total reservoir volume was estimated as 100,000 m^3, but based on water demand in 2010, only 50% of the facility will be constructed in Phase-1.

Reservoir	Dimension: W 46.5 m x L 93.5 m x D 6.0 m x 2 tanks Capacity: 50,000 m^3
Distribution Pump	158 m^3/min x 27 m x 900 kW x 3 units (1 unit stand by)

(3) Zone 3 (CB West Service Reservoir)

CB West Service Reservoir will be supplied with treated water pumped from Terminal Reservoir and then water will be sent to CB Downtown Service Reservoir and to EB South Service Reservoir. Zone 3 will be served by this reservoir through gravity flow. Same as CB Downtown Service Reservoir, only 50% of the facility will be constructed in Phase-1.

Reservoir	Dimension: W 46.5 m x L 93.5 m x D 6.0 m x 2 tanks Capacity: 50,000 m^3
Distribution Pump	None (Gravity supply)

(4) Zone 4 (CB Hlawga Service Reservoir)

CB Hlawga Service Reservoir will receive treated water pumped from Terminal Reservoir and then water will be sent to CB North, EB North and EB Central Service Reservoir. However, these three service reservoirs will be implemented in Phase-2. CB Hlawga Service Reservoir will serve Zone 4 by gravity flow. Same as CB Downtown Service Reservoir, only 50% of the facility will be constructed in Phase-1.

Reservoir	Dimension: W 46.5 m x L 93.5 m x D 6.0 m x 2 tanks Capacity: 50,000 m^3
Distribution Pump	None (Gravity supply)

(5) Zone 5 (CB North Service Reservoir)

CB North Service Reservoir will be supplied with treated water sent from CB Hlawga Service Reservoir. Zone 5 will be served by this reservoir through gravity flow. The construction of this service reservoir is included in Phase-2 but Zone will be served through RC pipelines being under construction when connection pipeline from Hlawga No.1 P/S will be implemented.

Reservoir	None (Phase-2)
Distribution Pump	None (Phase-2, Gravity supply)

2.5.2 East Block

(1) Zone 6 (EB South Service Reservoir)

EB South Service Reservoir will be supplied with treated water sent from CB West Service Reservoir. Zone 6 will be served by this reservoir by distribution pumps. Necessary total reservoir volume was estimated as 50,000 m^3, but based on water demand in 2010, only 50% of the facility will be constructed in Phase-1.

Reservoir	Dimension: W 46.5 m x L 93.5 m x D 6.0 m Capacity: 25,000 m^3
Distribution Pump	70 m^3/min x 24 m x 350 kW x 3 units (1 unit stand by)

(2) Zone 7 (EB Central Service Reservoir)

EB Central Service Reservoir receives treated water sent from CB Hlawga Service Reservoir. Zone 7 will be served by this reservoir by pumps. Although, the construction of this service reservoir is included in Phase-2, Hlawga reservoir water will be conveyed through RC pipeline now under construction.

Reservoir	None (Phase-2)
Distribution Pump	None (Phase-2)

(3) Zone 8 (EB North Service Reservoir)

EB North Service Reservoir will be supplied with treated water sent from Terminal Reservoir. Zone 8 will be served by this reservoir by distribution pumps. The construction of this service reservoir is included in Phase-2 but just as same as Zone 7, the Zone will be served by Hlawga reservoir water upon the completion of Hlawga No.1 P/S connection pipeline to RC pipeline now under construction.

Reservoir	None (Phase-2)
Distribution Pump	None (Phase-2)

2.5.3 West Block

(1) Zone 9 (WB South Service Reservoir)

EB South Service Reservoir will be supplied with groundwater sent from existing and newly drilled tube wells. Zone 9 will be served by this reservoir by pumps. However, the construction of this service reservoir is included in Phase-2.

Reservoir	None (Phase-2)
Distribution Pump	None (Phase-2)

(2) Zone 10 (WB Central Service Reservoir)

EB Central Service Reservoir will receive groundwater sent from newly developed tube wells. Zone 10 will be served by this reservoir by distribution pumps. However, the construction of this service reservoir is included in Phase-2.

Reservoir	None (Phase-2)
Distribution Pump	None (Phase-2)

(3) Zone 11 (WB North Service Reservoir)

EB North Service Reservoir will be supplied with groundwater sent from newly drilled tube wells. Further, treated water will be supplied from Terminal Reservoir in 2019. Zone 11 will be served by this reservoir by distribution pumps.

Reservoir	Dimension: W 35.5 m x L 71.5 m x D 6.0 m x 2 tanks Capacity: 30,000 m^3
Distribution Pump	94 m^3/min x 27 m x 550 kW x 2 units (1 unit stand by)

Figure 2.16 shows the schematic drawing of whole water supply system allocation.

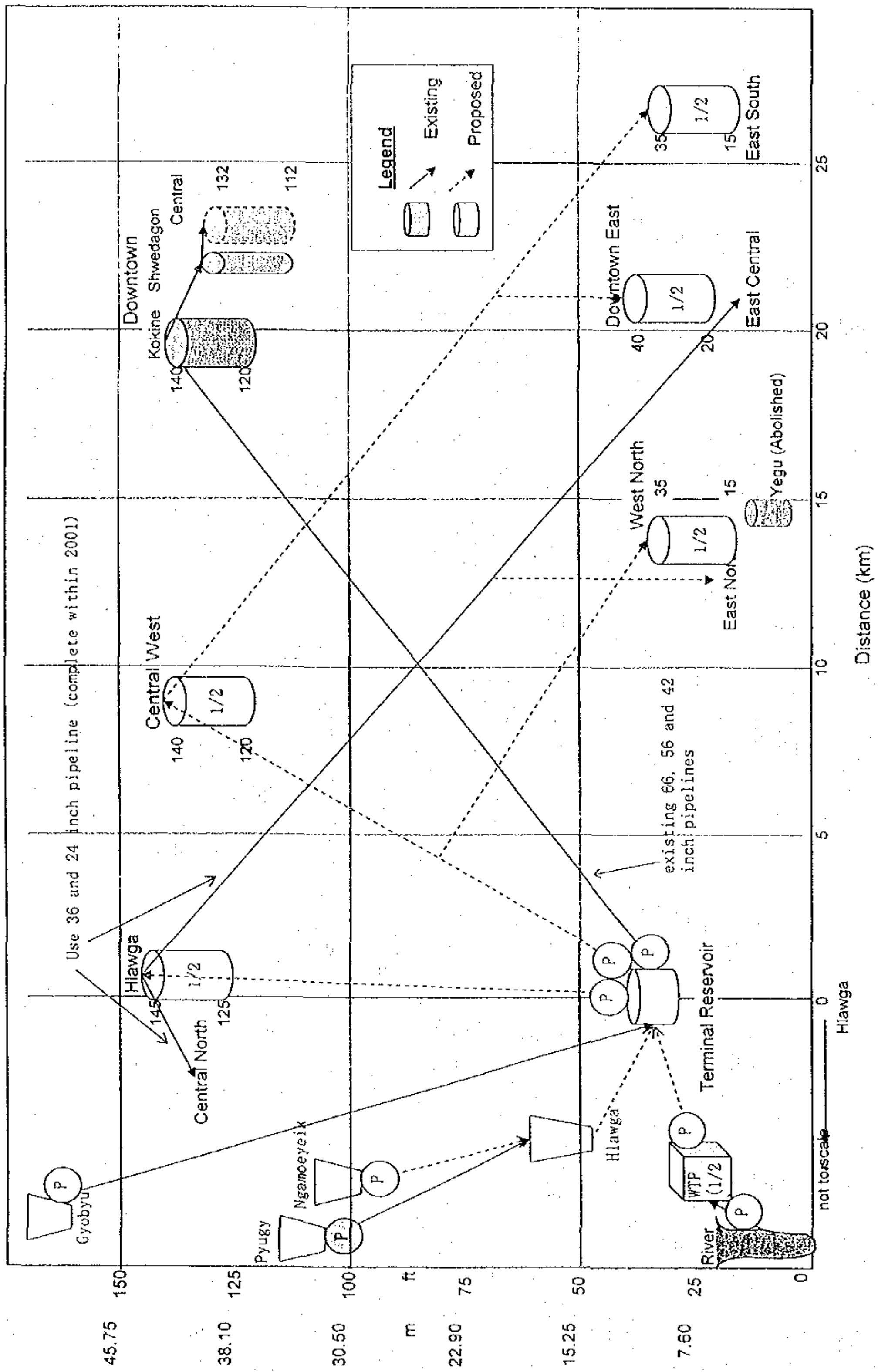


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FIG 2.16

Schematic Drawing of Service Reservoir Allocation

2.6 DISTRIBUTION FACILITIES

2.6.1 Rehabilitation of Aged Pipelines

Since the first distribution pipeline construction in Yangon City was launched on 1879, most of them have already been heavily deteriorated and been causing large volume of water leakage. Along with systematic water source development, such water leakage must be eliminated as soon as possible. In this connection, aged pipelines mainly installed in downtown areas will be replaced.

The target T/S was screened by age of their existing pipelines. T/Ss having pipeline with average age over 50 years were selected as scope of this work. Aged pipelines in the following 14 T/Ss will be replaced;

Average Pipe Age	Name of T/S
Over 80 Years	Ahlone, Botataung, Kyauktada, Kyeemyindaing, Lanmadaw, Latha, Pabedan, Pazundaung, Tamwe (9 T/Ss)
50 to 80 Years	Sanchaung, Mingalartaungyunt, Dagon, Bahan Yankin (5 T/Ss)

Table 2.4 shows the length of pipelines to be replaced classified by T/S and diameter. Pipe replacement was planned in five years and higher implementation priority was given to T/S with older pipelines.

2.6.2 Primary Mains

Distribution pipelines were classified into two categories by pipe diameter as follows;

Primary Mains : Dia. 300 mm to 1,500 mm
Secondary Mains : Dia. 75 mm to 250 mm

Based on the pipeline network analysis, necessary diameter and length of proposed new primary mains were determined and tabulated in Table 2.5 by distribution zone.

2.6.3 Secondary Distribution Pipes

Same as primary mains, necessary diameter and length of proposed new secondary mains were determined and tabulated in Table 2.6 by distribution zone.

Table 2.6 Replacement Plan of Aged Pipeline

Township	Zone no	YCDC piped water coverage %	Average age yrs	Replace. priority	Replace. with strengthen	Expansion	Pipe length m	Pipe to be replaced (m) < 60 yrs	Pipe to be replaced (m) 50<>60 yrs
1 Ahlone	1	26	84	1st	Yes	Yes	19,532	19,532	
2 Bahan	1	91	49	2nd	Yes		60,009		60,909
3 Botataung	1	68	65	1st			31,228	31,228	
4 Dagon	1	97	65	2nd	Yes		25,687		25,687
5 Dagon Myothit East	8	0				Yes	0		
6 Dagon Myothit North	8	0				Yes	0		
7 Dagon Myothit Seikkan	7	0				Yes	0		
8 Dagon Myothit South	7	0				Yes	0		
9 Dala	9	13	10			Yes	23,814		
10 Dawbon	6	2	10			Yes	214		
11 Hlaing	3	10	10			Yes	32,470		
12 Hlaingthaya	11	0				Yes	0		
13 Insein	3	11	17			Yes	4,194		
14 Kamayut	1	47	27			Yes	17,962		
15 Kyauktada	1	100	65	1st			20,214	20,214	
16 Kyeemyindaing	1	20	64	1st			23,467	23,487	
	10								
17 Lanmadaw	1	96	60	1st			16,156	16,158	
18 Latha	1	100	65	1st			12,135	12,136	
19 Mayangone	3	8	13			Yes	39,612		
20 Mingalardon	3	19	21			Yes	4,208		
	4								
	5								
21 Mingalartaungnyunt	1	99	61	2nd	Yes		23,643		23,643
22 North Okkalapa	3	66	27			Yes	33,115		
	4								
23 Pabedan	1	100	80	1st			16,150	16,150	
24 Pazundaung	1	100	84	1st			21,863	21,863	
25 Sanchaung	1	40	77	2nd	Yes	Yes	31,697		31,697
26 Seikan Port	1	20	10			Yes	2,663		
27 Seikkyi Kanaungto	10	0				Yes	0		
28 Shwepyitha	4	0				Yes	0		
29 South Okkalapa	2	68	34			Yes	53,525		
30 Tamwe	1	92	81	1st			30,218	30,218	
31 Thaketa	8	15	34			Yes	46,679		
32 Thingangyun	2	7	30			Yes	26,962		
33 Yankin	1	59	65	2nd	Yes	Yes	14,303		14,303
	2								
Total/average		32	50				634,840	193,000	156,000

5 years work — 1st priority work plan (m) (2004 to 2008)

Township	2004	2005	2006	2007	2008	2009	2010	total
1 Ahlone	3,900	3,900	3,900	3,900	3,900			19,500
2 Bahan	0	0	0	0	0			0
3 Botataung	6,200	6,200	6,200	6,200	6,200			31,000
4 Dagon	0	0	0	0	0			0
5 Dagon Myothit East	0	0	0	0	0			0
6 Dagon Myothit North	0	0	0	0	0			0
7 Dagon Myothit Seikkan	0	0	0	0	0			0
8 Dagon Myothit South	0	0	0	0	0			0
9 Dala	0	0	0	0	0			0
10 Dawbon	0	0	0	0	0			0
11 Hlaing	0	0	0	0	0			0
12 Hlaingthaya	0	0	0	0	0			0
13 Insein	0	0	0	0	0			0
14 Kamayut	0	0	0	0	0			0
15 Kyauktada	4,000	4,000	4,000	4,000	4,000			20,000
16 Kyeemyindaing	4,700	4,700	4,700	4,700	4,700			23,500
(zone 10)	0	0	0	0	0			0
17 Lanmadaw	3,600	3,600	3,600	3,600	3,600			18,000
18 Latha	2,400	2,400	2,400	2,400	2,400			12,000
19 Mayangone	0	0	0	0	0			0
20 Mingalardon	0	0	0	0	0			0
(zone 4)	0	0	0	0	0			0
(zone 5)	0	0	0	0	0			0
21 Mingalartaungnyunt	0	0	0	0	0			0
22 North Okkalapa	0	0	0	0	0			0
(zone 4)	0	0	0	0	0			0
23 Pabedan	3,200	3,200	3,200	3,200	3,200			16,000
24 Pazundaung	4,300	4,300	4,300	4,300	4,300			21,500
25 Sanchaung	0	0	0	0	0			0
26 Seikan Port	0	0	0	0	0			0
27 Seikkyi Kanaungto	0	0	0	0	0			0
28 Shwepyitha	0	0	0	0	0			0
29 South Okkalapa	0	0	0	0	0			0
30 Tamwe	6,000	6,000	6,000	6,000	6,000			30,000
31 Thaketa	0	0	0	0	0			0
32 Thingangyun	0	0	0	0	0			0
33 Yankin	0	0	0	0	0			0
(zone 2)								
Total/average	38,300	38,300	38,300	38,300	38,300			191,500

5 years work — 2nd priority work plan (m) (2006 to 2010)

Township	2004	2005	2006	2007	2008	2009	2010	total
1 Ahlone			0	0	0	0	0	0
2 Bahan			12,200	12,200	12,200	12,200	12,200	61,000
3 Botataung			0	0	0	0	0	0
4 Dagon			5,100	5,100	5,100	5,100	5,100	25,500
5 Dagon Myothit East			0	0	0	0	0	0
6 Dagon Myothit North			0	0	0	0	0	0
7 Dagon Myothit Seikkan			0	0	0	0	0	0
8 Dagon Myothit South			0	0	0	0	0	0
9 Dala			0	0	0	0	0	0
10 Dawbon			0	0	0	0	0	0
11 Hlaing			0	0	0	0	0	0
12 Hlaingthaya			0	0	0	0	0	0
13 Insein			0	0	0	0	0	0
14 Kamayut			0	0	0	0	0	0
15 Kyauktada			0	0	0	0	0	0
16 Kyeemyindaing			0	0	0	0	0	0
(zone 10)			0	0	0	0	0	0
17 Lanmadaw			0	0	0	0	0	0
18 Latha			0	0	0	0	0	0
19 Mayangone			0	0	0	0	0	0
20 Mingalardon			0	0	0	0	0	0
(zone 4)			0	0	0	0	0	0
(zone 5)			0	0	0	0	0	0
21 Mingalartaungnyunt			4,700	4,700	4,700	4,700	4,700	23,500
22 North Okkalapa			0	0	0	0	0	0
(zone 4)			0	0	0	0	0	0
23 Pabedan			0	0	0	0	0	0
24 Pazundaung			0	0	0	0	0	0
25 Sanchaung			6,300	6,300	6,300	6,300	6,300	31,500
26 Seikan Port			0	0	0	0	0	0
27 Seikkyi Kanaungto			0	0	0	0	0	0
28 Shwepyitha			0	0	0	0	0	0
29 South Okkalapa			0	0	0	0	0	0
30 Tamwe			0	0	0	0	0	0
31 Thaketa			0	0	0	0	0	0
32 Thingangyun			0	0	0	0	0	0
33 Yankin			2,000	2,900	2,900	2,900	2,900	14,500
(zone 2)								
Total/average			31,200	31,200	31,200	31,200	31,200	156,000

Total replacement plan

Township	2004	2005	2006	2007	2008	2009	2010	total
1 Ahlone	3,900	3,900	3,900	3,900	3,900	0	0	19,500
2 Bahan	0	0	12,200	12,200	12,200	12,200	12,200	61,000
3 Botataung	6,200	6,200	6,200	6,200	6,200	0	0	31,000
4 Dagon	0	0	5,100	5,100	5,100	5,100	5,100	25,500
5 Dagon Myothit East	0	0	0	0	0	0	0	0
6 Dagon Myothit North	0	0	0	0	0	0	0	0
7 Dagon Myothit Seikkan	0	0	0	0	0	0	0	0
8 Dagon Myothit South	0	0	0	0	0	0	0	0
9 Dala	0	0	0	0	0	0	0	0
10 Dawbon	0	0	0	0	0	0	0	0
11 Hlaing	0	0	0	0	0	0	0	0
12 Hlaingthaya	0	0	0	0	0	0	0	0
13 Insein	0	0	0	0	0	0	0	0
14 Kamayut	0	0	0	0	0	0	0	0
15 Kyauktada	4,000	4,000	4,000	4,000	4,000	0	0	20,000
16 Kyeemyindaing	4,700	4,700	4,700	4,700	4,700	0	0	23,500
(zone 10)								0
17 Lanmadaw	3,600	3,600	3,600	3,600	3,600	0	0	18,000
18 Latha	2,400	2,400	2,400	2,400	2,400	0	0	12,000
19 Mayangone	0	0	0	0	0	0	0	0
20 Mingalardon	0	0	0	0	0	0	0	0
(zone 4)								0
(zone 5)								0
21 Mingalartaungnyunt	0	0	4,700	4,700	4,700	4,700	4,700	23,500
22 North Okkalapa	0	0	0	0	0	0	0	0
(zone 4)								0
23 Pabedan	3,200	3,200	3,200	3,200	3,200	0	0	16,000
24 Pazundaung	4,300	4,300	4,300	4,300	4,300	0	0	21,500
25 Sanchaung	0	0	6,300	6,300	6,300	6,300	6,300	31,500
26 Seikan Port	0	0	0	0	0	0	0	0
27 Seikkyi Kanaungto	0	0	0	0	0	0	0	0
28 Shwepyitha	0	0	0	0	0	0	0	0
29 South Okkalapa	0	0	0	0	0	0	0	0
30 Tamwe	6,000	6,000	6,000	6,000	6,000	0	0	30,000
31 Thaketa	0	0	0	0	0	0	0	0
32 Thingangyun	0	0	0	0	0	0	0	0
33 Yankin	0	0	2,900	2,900	2,900	2,900	2,900	14,500
(zone 2)								
Total/average	38,300	38,300	69,500	69,500	69,500	31,200	31,200	347,500

Township	Zone	75 mm	100 mm	125 mm	150 mm	200 mm	225 mm	250 mm	300 mm	350 mm	400 mm	450 mm	Total
1 Ahlone	1	0	2,300	0	15,400	0	0	0	500	0	0	1,400	19,600
2 Bahan	1	5,200	11,000	0	32,300	1,400	0	2,800	8,100	0	0	0	60,800
3 Botataung	1	0	900	0	17,700	400	0	400	11,300	0	0	600	31,300
4 Dagon	1	1,700	5,300	0	10,200	0	0	5,800	2,600	300	0	0	25,700
5 Dagon Myothit East	8												
6 Dagon Myothit North	8												
7 Dagon Myothit Seikkan	7												
8 Dagon Myothit South	7												
9 Dala	9												
10 Dawbon	6												
11 Hlaing	3												
12 Hlaingthaya	11												
13 Insein	3												
14 Kamayut	1												
15 Kyauktada	1	2,800	0	0	11,700	300	0	700	4,900	0	0	0	20,200
16 Kyeemyindaing	1	0	6,100	0	15,900	0	0	1,400	0	0	0	0	23,400
	10						0						
17 Lanmadaw	1	1,200	1,000	0	8,400	0	0	4,700	2,900	0	0	0	18,200
18 Latha	1	1,000	0	0	6,700	0	0	1,900	2,600	0	0	0	12,200
19 Mayangone	3												
20 Mingalardon	3												
	4												
	5												
21 Mingalartaungnyunt	1	0	1,900	0	12,900	0	0	700	7,100	0	0	900	23,500
22 North Okkalapa	3												
	4												
23 Pabedan	1	0	0	0	9,000	0	0	1,000	6,100	0	0	0	16,100
24 Pazundaung	1	200	2,100	0	14,100	0	0	900	3,600	0	0	800	21,700
25 Sanchaung	1	0	5,200	0	21,700	0	0	4,400	0	0	400	0	31,700
26 Seikan Port	1												
27 Seikkyi Kanaungto	10												
28 Shwepyitha	4												
29 South Okkalapa	2												
30 Tamwe	1	1,000	7,600	0	18,600	0	0	2,000	0	0	0	1,000	30,200
31 Thaketa	8												
32 Thingangyun	2												
33 Yankin	1	1,400	7,400	0	2,500	300	0	1,000	1,700	0	0	0	14,300
	2												
Total/average		14,300	50,800	0	197,100	2,400	0	27,500	51,400	300	400	4,700	348,900

(Pipe replacement length by diameter (m))

Table 2.7 New Primary Mains Installation Work by Zone

Distribution Zone Name	No.	Total length (m)	Primary mains new installation plan dy diameter (mm) 300	350	400	500	600	700	800	900	1,000	1,100	1,200	1,350	1,400	1,500
Downtown	1	22,550	0	0	0	5,000	3,370	3,340	4,950	70	1,880	0	0	3,290	650	0
Downtown East	2	11,070	0	0	1,220	2,280	2,910	470	2,570	280	320	0	390	630	0	0
Central West	3	16,760	0	1,090	4,440	1,730	770	2,300	2,440	0	1,970	0	1,310	710	0	0
Hlawga	4	11,040	0	0	470	4,360	580	0	590	770	1,540	830	710	530	580	80
Central North	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East South	6	4,440	0	0	590	580	890	270	0	1,080	590	340	0	100	0	0
East Central	7	6,560	4,280	0	860	310	200	140	320	0	450	0	0	0	0	0
East North	8	6,450	2,030	0	1,570	430	1,820	0	0	600	0	0	0	0	0	0
West South	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West North	11	8,800	0	0	1,660	3,230	0	2,280	580	960	0	90	0	0	0	0
		87,670	6,310	1,090	10,810	17,920	10,540	8,800	11,450	3,760	6,750	1,260	2,410	5,260	1,230	80

Table 2.8 New Secondary Mains Installation Work by Zone

Distribution Zone		Pipe replacement length by diameter (m)					
Name	No.	75 mm	100 mm	150 mm	200 mm	250 mm	Total
Downtown	1	2,100	4,200	20,400	1,500	1,800	30,000
Downtown East	2	4,700	9,500	45,900	3,400	4,100	67,600
Central West	3	4,900	9,800	47,400	3,500	4,100	69,700
Hlawga	4	3,400	6,800	33,200	2,500	2,900	48,800
Central North	5	200	400	1,800	100	100	2,600
East South	6	2,100	4,100	20,200	1,500	1,800	29,700
East Central	7	800	1,500	7,300	500	700	10,800
East North	8	1,000	2,000	9,600	700	800	14,100
West South	9	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0
West North	11	1,300	2,600	12,500	900	1,100	18,400
		20,500	40,900	198,300	14,600	17,400	291,700

CHAPTER 3

UFW REDUCTION PLAN

CHAPTER 3 UNACCOUNTED FOR WATER REDUCTION PLAN

3.1 INTRODUCTION

This report has been prepared as the follow up stage to the Master Plan for Yangon. In the Master Plan, the principles of UFW Control were explained along with the general policy and strategy for application in Yangon, in the period to 2020.

In this document, the Pre-Feasibility Study is presented, where the Plan of Action for the first period of the overall strategy is considered in greater detail. The specific actions and tasks required to achieve the objectives are defined and estimates made of the requirements.

It is generally assumed at this stage that the principles and techniques of UFW control are already known and understood. These have been described in the Master Plan report and this document should be referred to, as required, for background and explanation.

However, to set the context of the Pre-Feasibility Study plan of action in respect of UFW Control, a summary review is given in this report of:

- Existing Situation in Yangon
- Master Plan Strategy & Objectives

The Master Plan provided a strategy to be followed up to 2020. The pre-feasibility study takes the period up to 2010, Phase 1 for the more detailed planning. Within this, there are two sub phases,

a) Stage 1 up to 2005
b) Stage 2 2005 to 2010.

The report is divided into three parts of increasing levels of detail. The overall plan of action and associated tasks is set out briefly, along with the timetable for implementation and the relative phasing of the various components.

The second part gives a description of the work to be undertaken and the resources that will be required. Finally, the third part is presented in annex, providing supporting information, typical examples or models used elsewhere.

3.1.1 Constituents of Water Balance for UFW Calculation

Just to serve as a reminder and checklist for the categories to be investigated, the components of UFW are reviewed here.

UFW is defined as the difference between net production and net consumption.

UFW = Net Production - Net Consumption (known or assessed)

Anything else is 'unaccounted for water, but this is not just leakage it will also include water that has been used for some purpose, but which is not known about or is not included in the calculation for some reason.

The following list is a summary of the places where water may be used. If they are not all included in the calculation then that is unaccounted for use and not leakage.

The other place that water use can be 'lost' is in metering error, which can be minimised, but never completely reduced to zero.

Production
- Water into supply surface water
- Water into supply groundwater abstraction
- Water treatment plant use and losses

Transmission & Storage
- Transmission main losses
- Bulk transfer out of supply area
- Bulk transfer into supply area
- Service reservoir leakage
- Cleaning & emptying of reservoirs

Distribution
- Network Losses on
  - Mains
  - Services
- Extension/rehabilitation flushing/swabbing etc.
- Routine maintenance and repairs
- Refilling/Re-pressurising of network when supply is restored (intermittent supply)

Consumption
- Metered Use
  - Domestic
  - Industrial
  - Commercial
  - Government
  - Military
  - Others
- Un-metered Use

Same categories as for metered

Unmeasured Legitimate use, possibly including
- Fire service
- Port supply
- Public amenity/Municipal
- Government & Military
- YCDC internal and operational use – taken from the network after production meters

Illegal connections

Un-metered user wastage & leakage NOT allowed for in water balance calculation such as
- Continuously running taps
- Overflowing tanks
- Plumbing leaks and bad repairs

3.2 REVIEW OF EXISTING SITUATION

The present state of the YCDC water supply network is that it is in very poor condition, with:
- High levels of leakage on the network
- High levels of non-physical losses from unaccounted for consumption
- Ageing pipework profile
- Unregulated service lines in poor condition and with high leakage levels

This situation is made worse by the fact that demand is greater than supply and so there is not enough water and the system does not cover the whole population of the city:
- Service Coverage: 37%

3.2.1 Network

The present situation has lasted for a long time with the same problems and factors being cited by Metcalf & Eddy in 1980. It is in fact worse now, because there has been no sufficient level of investment to maintain or improve the network.

The system now has a marked lack of secondary mains (outside the old downtown area), resulting in long service lines, and recent installation practice and quality control has not been according to norms for good working practice.

Repairs are not of good, long-lasting quality due to lack of proper tools and equipment and repair materials.

3.2.2 Data

Making any realistic, quantitative assessment of the scale of the problems is not currently possible. This is because relevant basic data for the network operations & maintenance is neither:
- recorded
- collated
- analysed

The starting point of UFW assessment (as well as general network management) is measurement of the flows and volumes of water put into the system.

There are effectively not even any flow meters at all in the YCDC water supply network. SO even the most basic information is not available with any degree of accuracy.

Typical data required includes:
- Burst & repair history
- Pipe profile in terms of age, diameter, material, joint type etc
- Metered consumption

- Assessed consumption
- Other consumption data such as free supplies, public use, YCDC operational use
- Production flow data
- Zone flow data at least to and from service reservoirs

3.2.3 Organisation & Staffing

The present organisation of YCDC does not include for:

- UFW control
- New works planning and control
- Regulation & control of licensed plumbers working on service lines
- Strategy for achieving universal customer metering OR alternative measures to assess and monitor unmetered use
- Data collection and processing for planning and management use

So at present the Water Supply department has none of the typical components or structures or mechanisms relevant to systematic network management, planning and UFW control.

3.2.4 Present UFW Estimate

The crude estimate for present UFW level is: 65 to 70 %
Based on:

Production	400 Mld		
Consumption	140 Mld gives	UFW	260 Mld or 65%

A significant part of this is reckoned to be water used for consumption but not properly included or allowed for in the consumption data. This problem is contributed to considerably by the "bad" operating practice of supplies and connections being taken directly from the transmission mains.

This would suggest that the actual leakage is not as bad as first appears. However, this is offset by the fact that leakage is suppressed at present by:

- Intermittent service in some areas
- Very low system pressures around the network generally

3.3 SUMMARY OF MASTER PLAN APPROACH FOR UFW CONTROL

3.3.1 Overview

As described above, there is no active UFW Control policy and practice currently operating within YCDC Water Supply Department. Therefore, the strategy developed in the Master Plan has to start right at the beginning. This means initiating action on all aspects of UFW control and putting in place the necessary systems.

The problems faced and tasks to be accomplished are on a large scale. Given the size of the task and the fact that all of these tasks are new to YCDC, the strategy is based on the following underlying principles:

- Start small in terms of area covered and staff involved to keep it manageable
- Deal with all facets of UFW control, albeit on a limited scale initially
- Expand progressively with increasing
    - Resources (e.g. trained staff)
    - Experience and competence
    - Area of acceptable water supply (24 hr duration and pressure >15m)

3.3.2 Staffing

In order to get started and to be effective; the strategy requires that a specialist unit be set up within YCDC, dedicated to UFW control. This team, the UFW control Unit (UCU), will be responsible for achieving the objectives on UFW reduction by implementing, co-ordinating and managing the necessary plans and measures.

Initially the UCU will be of limited size in order to be manageable and due to limitations on capacity. As it becomes more practised and competent and as the scope of work in terms of area and activity expands, the team will be enlarged and/or tasks delegated to other departments.

To succeed, the UCU needs to have sufficient resources and authority to achieve the objectives and so continued support from senior management is essential. With this support, this team will be the key to reducing UFW to the target levels and thus ensuring that the people of Yangon can be adequately supplied with drinking water by 2020.

3.3.3 UFW Control Unit (UCU) Tasks & Activities

The UCU team is the central tenet of the Master Plan Strategy to reduce UFW losses and so limit the scale of investment required to meet the need for increased water source supply to the city. The team will be responsible for the range of activities to be implemented to reduce both Physical Losses (PL) and Non-Physical Losses (NPL). These will include:

- Bulk Metering
- Network Sectorisation into discrete supply zones and district metered areas (DMA)

- Survey of trunk mains and service reservoir
- Registering unlisted connections and supplies

The scale of priority of these activities will vary with time and relative importance. TO create the right context for this work, there are some key tasks that must be effected as a preliminary stage, including primarily:

- Set up the UCU and train the team
- Complete survey of the network and customers/connections to bring up-to-date
- Begin systems of recording & collating range of data wanted for trend analysis
- Setting up pilot zones as a prelude to full sectorisation

3.3.4 Targets & Phasing

Presently, UFW is estimated at roughly 65%. The master plan has set targets to reduce the level to 30% by the end of the plan period, 2020. This is ambitious, but is essential to ensure adequate supply of water, even with the development of the available, additional sources of water.

One of the most important factors in setting these targets is the shortage of water now and for a long time to come and the difficulties in increasing the supply into the system. So, YCDC cannot afford to allow large volumes of water to be wasted and UFW reduction must be taken seriously.

To achieve this will certainly be very demanding, especially since there are no elements of UFW control currently being practised by YCDC. As a generalisation, UFW control work is largely a matter of continuing and repeating the same basic tasks to reduce and then maintain a reduced level of losses. The emphasis changes depending on the circumstances. It is not a once only function – if UFW control is stopped, losses will rise again.

Taking account of this, the Master Plan Strategy divides the plan into three phases:

- Phase 1 Initial set up and Implementation up to 2005
- Phase 2 Development of UFW Control 2005 – 2010
- Phase 3 Continuing review and modification of activities 2010 - 2020

Only Phase 1 can be considered in any detail. Thereafter, the same tasks will continue, but adapted after review to take account of the changing situation. The strategy includes a periodic review of plans and activities for this reason. This review should include an analysis of the proposed actions on a cost-benefit basis. It is important that UFW control should be cost effective and ensure that that the value of the savings is greater than the cost of achieving it.

3.3.5 Training & technical Assistance

Since there is no existing skill base related to UFW control within YCDC at the moment, the strategy includes for both training and technical assistance. This will be predominant in phase 1 and will be much reduced in phase 2 and involve only continuing training in phase 3; reflecting the increasing competence and self-sufficiency of YCDC over time.

3.3.6 New Works Programmes for Pipe Network

In the Master Plan, the effect on UFW by the network improvement programme was addressed.

(1) Leakage

The level of leakage and the rate at which it occurs is highly dependent on the quality of any new works programme. So leak detection and repair work is reduced in the future by ensuring that all new works is of good quality by means of :

- Design criteria & principles
- Specification standards of materials & manufacture
- Specification standards of installation and site works
- Quality of workmanship

This applies to all parts of the programme:

- Distribution and secondary mains
- Service line replacement & new installations
- Customer metering

(2) Monitoring & Control

The design principles of the network layout for new works programmes is also to incorporate the division of the system into discrete districts with district metering. In this way, means for monitoring and control is built in at the start.

3.3.7 Other Activities related to UFW Control

The Master plan strategy also refers to a number of issues that need to be addressed to ensure the correct context is created to enable the UFW control to be as effective as possible. These are:

(1) Byelaws & Regulations

A clear system of regulation needed to define responsibilities of customer & YCDC and standards to be met for connections and use of water. Enforcement & education are also issues

(2) Universal Customer metering

If Universal metering is policy then a strategy to achieve it is required, as well as effective measures for the interim period before it is achieved

(3) Tariff Structure

Review of tariff structure including real pricing of water, basic social needs, higher cost for higher use (given that coverage now is only 37%)

3.4 OUTLINE OF UFW CONTROL ACTION PLAN

The pre-feasibility study concentrates on the Phase 1 of the master plan (up to 2010) and details the preliminary requirements for implementation of the plan. In respect of UFW control, there are 4 main categories of activity to be addressed. These are:

- Urgent & Immediate action as a precursor to the main action
- 'Interim' period intervention on the existing network as it is
- 'New works' associated activity as long-term preventive action
- Policy related facets of water supply operations to ensure the necessary environment for successful implementation & maintenance of the UFW control measures

The constituents of these categories are outlined briefly below and presented in greater detail later in the report.

The overall aim is to begin the work of monitoring & controlling UFW and develop the capability in YCDC to reduce and control losses. This plan provides a set of guidelines of how this can be achieved, but it needs to be fully supported by the Senior Officers of YCDC. So, before starting to implement the proposed measures, it is essential that the problem of UFW is recognised and a firm decision taken that it must be dealt with.

3.4.1 Urgent Immediate Action

The main elements for immediate action are:

- Network & customer survey
- Set up a UFW Control team
- Large user monitoring
- Inspection & Leak detection (visible)
- Repair of leaks located
- Reviewing & Updating of network maps, customer database etc.

The network and customer survey is essential to bring all the network data and maps up-to-date, so that they are an accurate reflection of the real situation. This information is required for good results on:

- Network design & rehabilitation planning
- UFW control
- Network management & operations

The UFW control team will have responsibility for the planning & implementing of the necessary measures for investigation and monitoring work as well as co-ordination of related work with other departments. This will not be a part-time job and that is why a separate, dedicated team is required.

The remaining items on the list are the simplest and most effective measures to take as a beginning. However, they are also proposed on the basis of tasks which YCDC can do immediately with the existing organisational capacity.

YCDC has no leakage or UFW control operations at present, but once the decision is taken to do something about the problem these tasks can readily be done. This serves both to begin the long process of reducing losses and also serves as a signal of the commitment of YCDC to dealing with UFW seriously. This will encourage outside agencies to become involved.

3.4.2 'Interim' Period Direct Intervention on Existing Network

Phase 1 of the master plan will entail large-scale construction works programmes on the pipe network to improve the condition of the water supply system. These new works are scheduled to be intensive and rapid, because of the poor state and lack of service coverage of the existing network. Hence, large sections of the existing system will be rehabilitated or replaced within the Phase 1 period. This will have a considerable effect on both:

- Leakage losses from the network: new and repaired pipework
- UFW control monitoring: division of network into sectors with bulk metering

Thus, this new works programme has to be taken into consideration when formulating the plan of action for UFW control including factors such as:

- Incorporation of monitoring & control at design stage for new works
- Limited benefit from installing district meters, boundary valves etc. in an area due for imminent new works improvement
- *Concentrate efforts in areas of existing network where:*
- New works have lower priority
- "Good" service areas (24 hour duration and reasonable pressure)
- Unaffected by new works for whatever reason (e.g. production & service reservoir metering)

In effect, this means that UFW control action in respect of the pipe network will be divided into 2 parts:

- "New works" related generally longer-term, preventative
- "Interim" works on existing pipework

The principal elements of this Interim category include:

- Bulk Metering & Network sectorisation
- Active Leak Detection activities (ALC) in selected areas
- Pilot areas set up & control
- Measuring campaign associated with pilot areas
- Reducing the level of consumption & use that is not measured or allowed for

Leak detection scheduling will initially be based on a regular or routine programme of sounding rather than prioritisation of areas estimated to have high levels of leakage. This is to begin to get results before the system of zone and district metering (on which prioritisation is based) is implemented. As pilot areas become operational, more work can be done to prioritise leak detection efforts from the measuring campaign results;

3.4.3 Long-term Preventive Action

Any new works programme, but especially one on the scale foreseen in the master plan, relates to UFW control in 2 ways:

- Amount of losses and rate of increase
- Monitoring and control of the network

(1) Amount of losses and rate of increase

The amount of losses and the rate of increase (NRR) depend largely on:

- Quality of materials and manufacture for pipe, fittings, joints etc.
- Quality of installation method including backfill, compaction, testing etc
- Quality of workmanship

The excavation of site works is a large part of the cost of pipe laying, especially in dense, urban areas; not to mention the disruption and inconvenience caused of the economic life of the city.

It is a false economy to cut costs on first time installation, only to have to return and re-do work in the relatively near future. So the quality of all aspects of new works should be as high as possible to ensure a long, trouble-free life and minimise losses. The design criteria & principles and the specifications must reflect the importance of these factors.

(2) Monitoring and control of the network

The layout and design of the network can readily provide for monitoring and control, by incorporating the practices and principles in widespread use today for good network management.

These include:

- Loop design for security of supply
- Valving of the network to facilitate control and maintenance
- Division of the network into discrete districts by closing valves to form boundaries and supply water through a single inlet point
- Inclusion of measuring points at the inlet to each district.
- Rationalising connections to avoid crossing district boundaries

On an existing system, this is additional work required under the UFW monitoring programme. With new works it can be included at the design stage at low cost. This has been done for this study, but must continue to be included at the detailed design and specification stage.

Some basic criteria include:

- Each district should comprise about 1000 to 3000 properties or 30 km of mains
- All junctions and tees shall be valved
- The inlet point of each district shall be provided with a meter chamber and bypass, fully equipped.

3.4.4 Associated Activity & Indirect UFW Control Measures

In order for UFW control to be as effective as possible (or in the worst case to have any effect at all) certain associated activities have an important role to play. These come under consideration in different aspects of this pre-feasibility study, but their relevance to UFW control is summarised here.

These related issues come under of two general categories:

- Staffing & Organisation of YCDC
- Policy & regulation

(1) Staffing & Organisation of YCDC

The specific case of the UFW Control Unit (UCU) has been mentioned, but this team has to be effectively integrated into the overall organisation, along with adequate structures for:

- Repairs of leaks on Pipe Network and customer service pipes, since there is no reduction in losses until the leaks found have been properly repaired
- Stores system with stocks of the requisite repair materials
- Implementation of Universal Customer Metering including:
- Initial installation programme to achieve 100 % metering coverage
- Follow up replacement programme
- Procurement of new & replacement meters
- Repair & test workshops
- Records, maps, documentation systems such that
- Good data
- Kept up-to-date
- Accessible for Operations & Analysis

(2) Policy & Regulation

The principal elements of this category include:

- Metering
- Tariff Structure
- Byelaws & Regulations

Metering

Policy commitment will be required to implement universal metering for all customers along with preparation of an effective and realistic strategy to ensure that it is achieved according to a set of targets.

Tariff Structure

An effective, revised tariff structure will have an impact on leakage and wastage. It should at least ensure that people pay the true cost of the water they use.

Byelaws & Regulations

A review and updating of the existing byelaws and regulations is required to ensure among other things: effective standards for installation and materials used on connections as well as clarification of duties & responsibility between the customer & YCDC. This will also require long-term efforts to educate and inform the public.

3.4.5 Phase 1 Overall Plan & Timetable

It has been explained that action will be required on all aspects of UFW control, as well as some related activities. The general approach to implementing and phasing this policy has been outlined. In this section, the particular elements of this approach are summarised.

The plan is explained in greater detail in the following sections:

3.5 Details of each task, grouped into the 4 categories of
- Policy Issues for action
- Preliminary or Immediate Action
- Preventative Measures (Design and Installation of New Works)
- Practical O&M measures for UFW control and metering

3.6 Details of the resources and inputs required to effectively carry out the tasks
- Equipment
- Technical assistance and training

3.7 YCDC Staffing

3.8 Cost estimates for implementing the plan

(1) Timetable for First Phase of Master Plan to 2010

A draft outline of a timetable on a task by task basis for the first phase of implementation of the UFW Control Plan is shown in figure 3.4.1. This will be refined at the start-up of the project, with more detailed planning. The schedule for stage 2 will be developed and refined at the end of stage 1 based on the lessons learned, progress made, resources available and crucially the priorities determined during this initial period.

(2) Activity Checklist

To provide an overview of the range of activities and to provide a form of ready reference, a checklist of the tasks to be undertaken with summary description and related information has been compiled. This is shown in table 3.5.1 in the following section 3.5. Not all of these categories will be carried out by nor be the sole responsibility of the UCU.

(3) UFW Control Plan Long-term:

During the first periods, phase 1 and 2, a number of results will have ensued:

- Established, experienced staff in the UFW control team
- reliable teams for active leakage control and repair
- programme of activities directed to UFW reduction and loss control
- Installation of production and bulk metering equipment
- data recording and collection systems set up and operating
- data results giving historical data, trends, seasonal variations etc.
- a much clearer picture of the situation with respect to:
- UFW losses and the division between leakage and non-physical losses
- The status of programmes such as rehabilitation and expansion of the system

Phase 2, the remainder of the master plan period duration, will not represent a major change of approach or activity, but rather a continuation and adaptation of those being followed in the previous phase. As noted previously, UFW control is the repetition of tasks to achieve and maintain reduced levels of losses.

Five years is an appropriate period for long term projections of UFW control activities. It is proposed that during this extended long term period, this should be the interval for undertaking a detailed review of the situation and preparing a framework strategic plan for the coming period. This 5 year plan will then 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.

Figure 3.4.1 Planning Schedule

Group	Task		Repeat	Prepare	Phase 1							Phase 2	Remarks
			Cycle		Stage 1		Stage 2					Start	
				2003	2004	2005	2006	2007	2008	2009	2010	2011	
				1	2	3	4	5	6	7	8	9	
	Take UfW Seriously												
1) Policy													
	Standards & Byelaws												
	Tariff Structure												
2) Preliminary													
2a) PreCursor for Other Operations													
	Network & Customer Survey												
	Large User Monitoring												
2b) Part measures possible with existing capacity													
	Improve Network Data												
	Connections review												
	Pressure Measurement												
	Trunk Mains Survey		4 years										
	Visible Leak location												
	Leak Repairs												
	Service Reservoir Leakage Inspection		4 years										
3) Preventative													
	Planning & Design												
	Design Criteria & spec												
4) Practice (O&M)													
4a) UfW Reduction													
	UCU set up												
	UCU Operations												
	Leak Detection by Routine sounding												
	Leak Repairs												
	Measurement campaign												with aquaprobe meters
	Pilot areas setup												
	NPL monitoring & control												
4b) UfW Monitoring													
	Network Sectorisation												
	Bulk Metering 1												
	Bulk Metering 2												
	Tubewell metering												

Figure 3.4.1 Planning Schedule

Group	Task		Repeat	Prepare	Phase 1								Phase 2	Remarks
			Cycle		Stage 1		Stage 2						Start	
				2003	2004	2005	2006	2007	2008	2009	2010		2011	
				1	2	3	4	5	6	7	8		9	
	Rehabilitation Areas													
4c) Customer Metering														
	Domestic Metering		7 year											
	Non-Domestic Metering													
	Large Users Monitoring		5 year											
	Meter repair & test													
4d) Other O&M Activities														
	Control Room													
TECHNICAL ASSISTANCE PROGRAMME														
	Long term Technical Assistance													
	Short term specialists													

KEY:

Primary Activity OR First period of activity ▬▬▬

Continuation of activity once set up or after first period ▪▪▪▪▪▪▪▪