2 EXISTING CONDITIONS OF WATER SUPPLY

2.1 Existing Water Supply System

2.1.1 Overview

Residents of Mandalay City are getting water through distribution pipes from water supply system, communal taps, private wells and canals including moat water. The water supply system and communal taps are managed by the Water and Sanitation Department (herein after referred to as "WSD"), a department of the Mandalay City Development Committee (herein after referred to as "MCDC"). See Figure 5.7.2.1.

The main facilities supplying water to Mandalay City were constructed from 1983 until 1992 under *Mandalay Water Supply Project* co-financed by ADB, OPEC fund and Myanmar Economic Bank (herein after referred to as "the ADB Project"). MCDC has been improving and expanding the water supply system subsequent to the ADB Project. At the present, the water is distributed to approximately 50% or 0.4 million of the population, and covers 60% or 65 km^2 of the City area.

The water source for the existing water supply system is groundwater, and the quantity of groundwater drawn is approximately 104,500 m^3/d according to a brochure published by MCDC (herein after referred to as "the Brochure") in July 2000. Groundwater is drawn by tube well pumping stations (herein after referred to as "tube well"). The most of water drawn is conveyed to a reservoir at No.1 Booster Pumping Station (herein after referred to as "BPS1"), for distribution to the consumers by pumps of BPS1 through a network of pipes.

Service area of this water supply system does not cover the eastern area from 60^{th} street and southern area as shown in Fig.2.1.1. These areas are designated as "East New Town" and "South New Development Area", respectively for convenience in this report.

Residents of these areas (East New Town Area and South New Development Area) have to rely on 24 spot water supply systems (herein after referred to as "MCDC well") constructed by MCDC and the similar 30 spot water supply systems (herein after referred to as "KOICA well") constructed by KOICA (Korea International Cooperation Agency), or the private wells as well.

There are approximately 14,000 private wells in Mandalay City. Many of the private wells situating within the service area of the water supply system, are still in operation.

Before the completion of the ADB Project, the moat water supply system and 13-production well system had been operated as the public water supply system. Although 13-production well system has not been used since completion of the ADB project, the moat water has been still used for fire fighting and partly for domestic use of mainly residents living in the area west of the Palace, but not counted as a public water supply system.

According to a report (Water Supply and Sanitation Sector review, UNDP), 12 million imperial gallons (herein after referred to as "gals") per day of water replenishes the Palace moat and comes from Sedawgyi dam, situated 46 km north east of the Palace.

2.1.2 Water Supply Facilities

The existing water supply system consists of tube wells, two booster pumping stations (herein after referred to as "BPS"), distribution reservoirs, and distribution pipelines as shown in Fig. 2.1.1.

(1) Tube wells

There are altogether 28 tube wells for the water supply system in Mandalay City as of July, 2002. Out of 28 tube wells, 25 tube wells are located along the east bank of the Ayeyarwaddy River. Among 25 tube wells, one well (No.25) is not functional since pump has not been installed yet. Water drawn from 24 tube wells is transmitted to Booster pumping station No.1 (BPS1). Two tube wells (No.26&No.27) are situated within the site of BPS1 and BPS2, respectively. One tube well (No.28) is situated at west of Mandalay Hill approximate 1.2 km far from Mandalay Hill Reservoir. Groundwater drawn from No.28 tube well is transmitted to Mandalay Hill Reservoir, having a high water level (HWL) of 106 m. Then water is distributed to the consumers by gravity flow.

Out of 28 tube wells, 19 tube wells were constructed between 1989 and1991 as the ADB Project at first. Subsequently nine tube wells were constructed between 1996 and 2002 by MCDC budget.

The specifications of the tube wells are described as follows.
- Diameter of the upper part casing is 400 mm and the lower part casing is 300 mm.
- Depth of each well ranges from 110 m to160 m.
- Diameter of pump is either 289 mm or 200 mm.

Features of tube wells are shown in Table 2.1.1.

At least a single staff of WSD is assigned to operate and maintain each tube well round the clock. These tube wells are managed well and properly operated.

(2) Chlorination facility

A house with chlorination facility was constructed under the ADB Project near the intersection of 35th street and 89th street for disinfecting the groundwater. Liquefied chlorination gas had been injected into groundwater of transmission pipe from tube wells to BPS1 before a chlorination gas leakage happened in1994. Although WSD tried to repair the chlorination facility for around two years, it had failed to recover the function of chlorination system due to a lack of funds. Since December 1996, the system has been not functional up to now.

(3) Booster Pumping Stations

The water from 25 tube wells is transmitted to the ground RC reservoir (capacity 5.0 million gallons or 23,000 m^3) at Block No.550 (34th, 35th, 85th, and 86th street), which is in the same compound of a booster pumping station (BPS1). From BPS1, stored water is distributed to consumers by pumps. There are four (4) pumps in BPS1. Three pumps are electrical motor driven, double suction volute pumps of the same specifications, each having a diameter of 350mm and capacity of 990 l/s. The remaining pump with diameter of 350 mm and capacity of 1080 l/s is driven by an 880HP engine and kept for stand by. The specifications of pumps in BPS1 are shown in Table 2.1.2. BPS1 is properly operated and managed well.

There is another BPS and a ground RC reservoir (capacity 0.5 million gallons or 2,300 m^3) in the distribution network, and it is designated as No.2 Booster Pumping Station (BPS2). The main inflow water comes from the reservoir at BPS1 through distribution pipe network. Some water drawn from No.27 tube well situated within the compound of BPS2, is also conveyed to the reservoir directly. BPS2 is functioning for increasing water pressure of network situated at east area of BPS2.

BPS2 has three (3) pumps, which are electrically driven. Among three pumps, two (2) pumps are imported from Singapore and have same specifications, and one (1) is local pump. The capacity of two imported pumps is 7.5m^3/min, while the local pump has a

capacity of 2.6 m^3/min. The specifications of pumps in BPS2 are shown in Table 2.1.3.

BPS2 is properly operated and managed well. However the local pump appeared to be deteriorating and as well leaking.

(4) Distribution Reservoirs

1) Mandalay Hill Reservoir

Mandalay Hill Reservoir is situated in halfway up on Mandalay Hill and was built in 1991 by the ADB project. The reservoir is a concrete structure having a capacity of 12,500m^3 This reservoir was designed to store distributed water from BPS1 during night, however the reservoir had not been utilized till the time of starting operation of No.28 tube well, because water could not reach the required elevation due to insufficient pressure. At present the reservoir distributes stored water only transmitted from No.28 tube well.

Compressive strength of the concrete wall based on Schmit hammer test is enough. However a little water leakage from wall of the reservoir is observed.

2) Elevated Reservoirs

There are two (2) elevated tanks namely elevated reservoir No.1 and elevated reservoir No.2 in the distribution network. They were completed in 1991 by the ADB Project. Each reservoir is a steel structure with a capacity of 500m^3. High water level of elevated reservoir No.1 and elevated reservoir No.2 is 104 m and 93 m, respectively. A ground reservoir with capacity of 50,000gals(227m^3) is also situated within the same site. It has been designed to lift the water from the ground reservoir to the elevated reservoir by a pump. However, this system is not functional because the water cannot reach the ground reservoir due to insufficient pressure.

Locations of both reservoirs are shown in Fig. 2.1.1.

(5) Pipeline

1) Transmission Pipeline

Transmission pipeline is defined as pipes running between tube wells and BPS1. The pipe material of the pipeline is ductile iron. The total length and diameter of the pipeline is 6,774 m, and the diameter ranges from 400 mm to 900 mm, respectively. Length by diameter of pipes is shown below.

Diameter (mm)	Length (m)
400	682
600	1,727
800	3,040
900	1,325
Total	6,774

Source: WSD

Most of the pipes are laid under the ground, whereas some stream crossings are exposed. On visual investigation at the crossing over, a little leakage from the air valve and rust spots on the pipe surface were observed. However, these are minor and assumed negligible.

2) Distribution Pipeline

Distribution pipeline is defined as water distribution pipes having a diameter of 200 mm to 800 mm. The pipe material of the distribution is also ductile iron. Total length of distribution pipeline is 87,535 m. Length by diameter of pipe is shown below.

Diameter (mm)	Length (m)
200	39,200
250	11,200
300	13,500
400	9,345
600	9,160
800	5,130
Total	87,535

Source: WSD

As the distribution pipes are laid under the roads, normally conducting visual investigation is difficult. However underground distribution pipes can be observed when flow measurement test was conducted on the distribution pipes in this Study. The pipes were wrapped in polyethylene sleeve, and they appeared to be in good condition.

3) Internal Network Pipeline

Internal network pipeline is defined as distribution pipes having a diameter of 100 mm and

150 mm. The length of former pipe is 136 km, and that of later is 65km, totaling 201 km in length. Ductile iron pipes are used for the internal network pipeline.

(5) KOICA Wells

There are 30 KOICA wells in Mandalay. These wells are distributed in eastern part of three Townships namely Ma Ha Aung Myay, Chan Mya Thar Zi and Pyi Gyi Tha Gun. Each KOICA well has an airlift pump with a capacity of 0.09 m^3/min, a concrete tank with a capacity of 5,000 gals (23m^3), and several communal taps. 100 mm-diameter casing with a length range of 36 m to 122 m is installed in KOICA wells. KOICA wells were constructed between 1996 and 1997. Served population per well ranges from 75 to 450, and approximately 6,000 in total. The water is distributed free of charge.

Features of KOICA wells are shown in Table 2.1.4.

(6) MCDC Wells

There are 24 MCDC wells in Pyi Gyi Ta Gun Township. Each MCDC well has an airlift pump with a capacity of 0.09 m^3/min, a concrete tank with capacity of 5,000 gals, and several communal taps. 100 mm-diameter casing with a length range of 24.5m to 36.5 m is installed in the tube wells. These tube wells were constructed between 1994 and1995 by MCDC budget. Served population per well ranges from 225 to 450, and total served population is approximately 8,400. The water is also distributed free of charge.

Features of tube wells are shown in Table 2.1.5.

(7) Water Meter and Fire Hydrant

1) Water Meter

Number of water meters by diameter as of November 2002 is summarized below.

Diameter of water meter	Number	Remarks
15 mm	62,076	
20 mm	560	
25 mm	454	
30 mm	60	
65 mm	4	
Total	63,154	

Source: WSD

2) Fire Fighting and Fire Hydrant

Fire fighting service is managed by the Fire Service Department of Ministry of Social Welfare, Relief and Resettlement. Therefore fire fighting is out of MCDC duties. However installation and maintenance of fire hydrants is managed by WSD. There are 115 pillar type fire hydrants with diameter of 150 mm and 594 underground type fire hydrants with diameter of 100 mm in the network of pipelines.

The jurisdiction area of Mandalay Office of Fire Service Department covers 7 townships including 5 townships of Mandalay city. There are 5 firefighting stations and 54 firefighting cars managed by the Mandalay Office and about 40 stations managed by communities and private organizations. Typical fire engine has a container with a capacity of 1,000 gals (4.5 m^3) and a pump with a capacity of 350 gals/min (1.59 m^3/min) and a pressure of 70 psi (4.92 kg/cm^2).

Number of fire cases was 44 in 1999 and 36 in 2000 in 7 townships. From an interview with a government official of the Mandalay office of the Fire Service Department, following comments are obtained.

- Number of fire hydrants is sufficient in downtown districts, but insufficient in other districts.

- Fire hydrant cannot be used directly because both flow and pressure are not enough, so before distinguish fire, filling water to a container is necessary.

- Pillar type fire hydrant is preferable to underground type fire hydrants because of less water leakage

2.1.3 Water Production and Consumption

(1) Production Quantity

Daily water production was 104,500 m^3/d in 2000. This quantity was confirmed through a flow measurement survey conducted in 2001 (refer to the Progress Report). After that No.28 tube well having pump with a capacity of 75 l/s has been operating since June 2002. As this tube well is operated 15 hours, its production quantity is estimated at approximate 5,000 m^3/d (75l/s x 3600 s/hr x 15 hrs/d). Therefore total production quantity is supposed to be around 109,000 m^3/d in 2002.

(2) Distribution Quantity

Daily distribution quantity is supposed to be 96,000 m^3/d considering overflow from the BPS1 and consumption of water at tube well pumping stations, BPS1, and BPS2.

(3) Water Consumption by the Bill Collection

MCDC charges the consumer for every three months. Table 2.1.6.shows quarterly billed amount by water meter reading.

Table 2.1.6 Quarterly Billed Amounts (Unit: Ks1000)

Period	Year 2001	Year 2002
January to March	42,650	45,292
April to June	49,280	47,157
July to September	50,490	No data
October to December	52,080	No Data
Total	194,500	

Source: MCDC

Although MCDC has data on revenue amount in currency by water supply service, but does not have data on revenue water quantity in volume. Therefore, revenue water quantity is estimated using unit rate for water tariff and above the table.

The unit rate of Ks 10/m^3 is applied until water usage of 30 m^3 per month, and Ks 15/m^3 is

applied water usage of more than 30 m^3 per month. According to a domestic water usage survey conducted in March 2002, Ks 15/m^3 was applied to only 4% of the total amount. Considering that target people for the survey excluded commercial consumers, Ks 15-portion could be higher than 4 %. Therefore assuming that Ks 15/m^3-portion is 10%, 51,500m^3/d of average billed amount in 2001 is estimated. Besides, the billed amount for 3 luxury hotels (Novotel, Sedona, Swan) is not included in Table 2.1.6. These hotels used approximately 200 m^3/d of MCDC water in total during July to September in 2002. Therefore billed quantity maybe reach around 52,000 m^3/d (51,500+200).

Finally, production quantity, distribution quantity and billed quantity are summarized below.

Production quantity	109,000 m^3/d
Distribution quantity	96,000 m^3/d
Billed quantity	52,000 m^3/d

Table 2.1.1 Features of Tube Well Pumping Stations

No.	Fund	Location	Configuration of Well		Features of Pump							Amount Supplied of Water in Daily Averag			No. of Worker	Operation Started
			Diameter of Casing (mm)	Length of Casing (m)	Type	Capacity (ltr/sec)	Total Head (m)	Diameter (mm)	Power Source	Power	Position of Lowest Impeller	through a year (m3/day)	in dry season (m3/day)	in rainy season (m3/day)		(month-year)
1	ADB	Ayeyarwaddy River	400/300	159	Vertical Turbine	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	4,270	3,978	4,547	one (1) through 24 hrs	Oct-91
2	-ditto-	-ditto-	-ditto-	123	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	May-90
3	-ditto-	-ditto-	-ditto-	144	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
4	-ditto-	-ditto-	-ditto-	143	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
5	-ditto-	-ditto-	-ditto-	126	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
6	-ditto-	-ditto-	-ditto-	150	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
7	-ditto-	-ditto-	-ditto-	146	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
8	-ditto-	-ditto-	-ditto-	140	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
9	-ditto-	-ditto-	-ditto-	133	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
10	-ditto-	-ditto-	-ditto-	135	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-91
11	-ditto-	-ditto-	-ditto-	153	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Dec-91
12	-ditto-	-ditto-	-ditto-	157	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	May-90
13	-ditto-	-ditto-	-ditto-	142	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	May-90
14	-ditto-	-ditto-	-ditto-	136	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	May-90
15	-ditto-	-ditto-	-ditto-	130	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-89
16	-ditto-	-ditto-	-ditto-	114	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Apr-89
17	-ditto-	-ditto-	-ditto-	162	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-89
18	-ditto-	-ditto-	-ditto-	108	-ditto-	75	47	289	Electricity & Engine	90kw,177Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Nov-89
19	-ditto-	-ditto-	-ditto-	121	-ditto-	75	47	289	Electricity & Engine	90kw,??Hp	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	May-90
20	MCDC	-ditto-	-ditto-	108	-ditto-	75	47	289	Electricity	90kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Oct-96
21	-ditto-	-ditto-	-ditto-	124	Submersible	75	47	200	Electricity	75kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Feb-99
22	-ditto-	-ditto-	-ditto-	120	-ditto-	75	47	200	Electricity	75kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Oct-99
23	-ditto-	-ditto-	-ditto-	138	-ditto-	75	47	200	Electricity	75kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Mar-99
24	-ditto-	-ditto-	-ditto-	140	-ditto-	75	47	200	Electricity	75kw	GL-38m	-ditto-	-ditto-	-ditto-	-ditto-	Feb-01
25	-ditto-	-ditto-	-ditto-	150	-	-	-	-	-	-	-	-	-	-	-ditto-	-
26	-ditto-	BPS-2	-ditto-	154	Submersible	75	47	200	Electricity	75kw	GL-42m	2,800	2,800	2,800	2 for day time, 2 for night time incl. BPS	Aug-00
27	-ditto-	BPS-1	-ditto-	130	-ditto-	75	47	200	Electricity	75kw	GL-42m	4,320	4,320	4,320	for night time incl. BPS	Mar-01

Table 2.1.2 Features of Pumps at BPS1

Item	Description	Remarks
Distribution Pump Electrically Driven		
Number of Pump	3 set	
Type	Double Suction Volute Pump	Kubota
Diameter	350mm	
Motor	11KV, 3Phase, 410kw (550HP)	Shinko
Capacity in one oparation	0.99m3/sec	Head 27m
Capacity in two oparation	1.52m3/sec	Head 35m
Capacity in three oparation	2.085m3/sec	Head 38m
Distribution Pump Diesel Engine Driven		
Number of Pump	1set	Stand-by
Type	Double Suction Volute Pump	Kubota
Capacity	1.08m3/sec	Head 48m
Diameter	350mm	
Diesel Engine	880HP	Yanmar

Table 2.1.3 Features of Pumps at BPS2

Item	Specifications	Remarks
Number of Pump	2set	NGE (Singapore)
Type	Horizontal Volute Pump	
Diameter	200mm	
Motor	110kw,3Phase	
Total Head	50m	
Capacity	7.5m3/min	
Number of Pump	1set	Local made
Type	Volute Pump	
Diameter	150mm	
Motor	55 Kw	
Total Head	---	
Capacity	2.6 m3/min	

Table 2.1.4 Features of KOICA Wells

CODE	Location (Town Ship)	Configuration of Well		Configuration of Air Lift Pump					Approximate No. of Served Population (persons)	Operation Started (month, year)
		Diameter of Casing (mm)	Length of Casing (m)	Water Discharge (ltr/sec)	Diameter of Water Production Pipe (mm)	Power Source	Power of Engine (Hp)	Diameter of Air Pipe (mm)		
1	Chan Mya Thar Zi	100	36	1.5	50	Compressor with Engine	10	20	270	Feb-97
2	Chan Mya Thar Zi	-ditto-	43	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	270	Feb-97
3	Chan Mya Thar Zi	-ditto-	43	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Apr-97
4	Pyi Gyi Tha Gun	-ditto-	36	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Jan-97
5	Pyi Gyi Tha Gun	-ditto-	36	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Feb-97
6	Pyi Gyi Tha Gun	-ditto-	36	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	150	Feb-97
7	Chan Mya Thar Zi	-ditto-	38	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	125	Mar-97
8	Pyi Gyi Tha Gun	-ditto-	37	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	75	Jan-97
9	Pyi Gyi Tha Gun	-ditto-	122	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	250	Nov-96
10	Ma Ha Aung Myay	-ditto-	39	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	450	Mar-97
11	Chan Myar Thar Zi	-ditto-	91	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	100	Jun-97
12	Chan Myar Thar Zi	-ditto-	91	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Jun-97
13	Chan Myar Thar Zi	-ditto-	107	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	250	Jun-97
14	Ma Ha Aung Myay	-ditto-	39	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	225	Jun-97
15	Chan Mya Thar Zi	-ditto-	39	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Jun-97
16	Chan Mya Thar Zi	-ditto-	39	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Jun-97
17	Pyi Gyi Tha Gun	-ditto-	38	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	250	Jun-97
18	Pyi Gyi Tha Gun	-ditto-	43	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	250	Jun-97
19	Ma Ha Aung Myay	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	275	Jul-97
20	Chan Mya Thar Zi	-ditto-	46	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Jun-97
21	Chan Mya Thar Zi	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	250	Aug-97
22	Pyi Gyi Tha Gun	-ditto-	43	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Aug-97
23	Pyi Gyi Tha Gun	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Aug-97
24	Pyi Gyi Tha Gun	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Aug-97
25	Pyi Gyi Tha Gun	-ditto-	39	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	300	Aug-97
26	Pyi Gyi Tha Gun	-ditto-	42	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	300	Aug-97
27	Chan Mya Thar Zi	-ditto-	42	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	300	Aug-97
28	Ma Ha Aung Myay	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Sep-97
29	Chan Mya Thar Zi	-ditto-	56	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	180	Sep-97
30	Chan Mya Thar Zi	-ditto-	40	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	360	Sep-97
									6,070	

Table 2.1.5 Features of MCDC Wells (self-financed)

CODE	Location (Town Ship)	Configuration of Well		Configuration of Air Lift Pump						Approximate No. of Served Population (persons)	Operation Started (month,year)
		Diameter of Casing (mm)	Length of Casing (m)	Water Discharge (ltr/sec)	Diameter of Water Production Pipe (mm)	Power Source	Power of Engine (Hp)	Diameter of Air Pipe (mm)	Blow Point of Air (GL - m)		
7986	Pyi Gyin Ta Gun	100	30.0	1.5	50	Compressor with Engine	8～10	20	27.4	350	May-94
7987	-ditto-	-ditto-	30.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	27.4	355	Jun-94
7990	-ditto-	-ditto-	33.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	28.9	310	Jul-94
7991	-ditto-	-ditto-	33.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	28.9	360	Jul-94
1	-ditto-	-ditto-	36.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	33.5	400	Nov-94
2	-ditto-	-ditto-	33.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	30.0	290	Nov-94
3	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	275	Feb-95
4	-ditto-	-ditto-	27.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	24.5	420	Nov-94
5	-ditto-	-ditto-	35.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	32.0	440	Nov-94
6	-ditto-	-ditto-	30.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	27.4	420	Nov-94
7	-ditto-	-ditto-	30.0	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	27.4	412	Dec-94
8	-ditto-	-ditto-	27.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	24.5	310	Nov-94
9	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	300	Mar-95
10	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	250	Feb-95
11	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	435	Feb-95
12	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	450	Feb-95
13	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	300	Mar-95
14	-ditto-	-ditto-	22.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	19.5	225	Feb-95
15	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	380	Mar-95
16	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	445	Feb-95
17	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	390	Apr-95
18	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	305	Apr-95
19	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	280	May-95
20	-ditto-	-ditto-	24.5	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-	21.5	285	Jun-95
									Total	8,387	

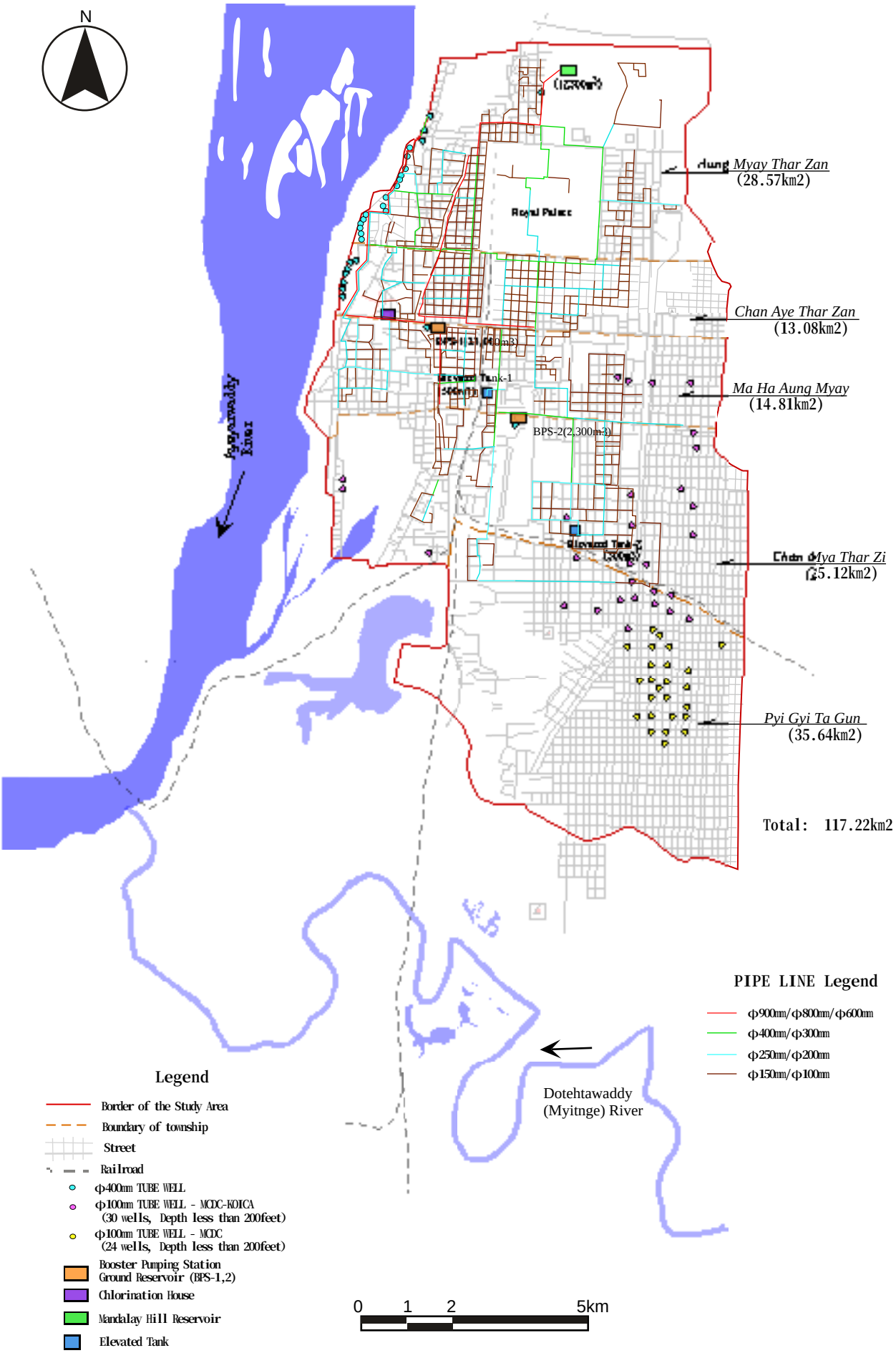

Fig.2.1.1 Existing Water Supply System

2.2 Water Service Level

2.2.1 Service Area and Service population

(1) Service Area

Service area served by existing water supply system is approximate 65 km^2 covering 60% of Mandalay City area.

(2) Service population

Service population is approximately 50% of the total population in year 2000. However service ratio by township varies widely as follows:

Table 2.2.1 Service Population in Each Township

Name of Township	Population as of July 2000 (A)	Service population of Water Supply (B)	(B)/(A)*100 (%)
Aung Myay Tharzan	215,774	98,000	45.4
Chan Aye Tarzan	205,385	120,000	58.4
Ma Ha Aung Myay	187,798	105,000	55.9
Chan Myar Tharzi	144,543	70,000	48.4
Pyi Gyi Tha Gun	48,207	7,000	14.5
Total	801,707	400,000	49.9

Note : (B) was estimated based on No of water meters proportionally and is not the actual number.

Source: JICA Study

Service population has been increasing as far as considering the number of water meters. Actually 58,587 water meters were counted in July 2000, and 63,154 water meters in November 2002. Assuming that 6.5 persons per one (1) water meter is the service population in average, total population served is estimated at approximately 410,500.

2.2.2 Water Distribution Condition

(1) Water Distribution

Daily distribution quantity is estimated at 96,000m^3 in average. The water demand per capita including commercial, industrial, institutional use, and unaccounted-for water is estimated about 230 liter (96,000 m^3/410,500) in average.

The tube wells are in operation round the clock, however BPS1 and BPS2 are operated only17.5 hours per day from 5:30 to 23:00. During laid-off of BPS, tube well pumping stations along the Ayeyarwaddy River distribute to consumers directly. Moreover water could not reach some areas due to insufficient pressure, owing to elevation or being distant from the two BPS's. Especially water pressure is severely low in the areas, West of Mandalay hill, East of the Palace, between 62nd and 65th street respectively.

Therefore one of the biggest problems in the existing water supply system is insufficient pressure for distribution of water effectively.

(2) Water Tariff

MCDC applies two-step charges for house connections. Up to 30 m^3/month of water usage, fixed rate of Ks 10 per m^3 is applied. For more than 30 m^3/month of water usage, fixed rate of Ks 15 per m^3 is applied.

While the billed amount of the year 2001 was Ks194.5 million, collected amount during the year 2001 was Ks145.3 million. Therefore, the levy ratio of water charges in 2001 was approximately 75 %.