APPENDIX 4D

NRW REDUCTION MANAGEMENT SYSTEM

APPENDIX 4D-1

METER REPAIR WORKSHOP

APPENDIX 4D-1

METER REPAIR WORKSHOP

1 Organization of Central Meter Workshop

The Meter Repair Section at the Central Workshop, or the Central Meter Workshop is located approximately 2 kilometers from the Head Office. In addition to the meter workshop, the Central Workshop has vehicle workshop, pump repair shop, electrical motor repair shop, fabrication shop, machine shop, and electronic shop.

The Central Workshop is also adjacent to the Main Store. The Central Workshop and the Main Store are respectively about 4 acres and 6 acres in area. The one-story building of the Central Meter Workshop is approximately 260 m^2 in area, including its store space, Besides the Central Meter Workshop, NWSDB has three local meter workshops in Matara, Negombo, and Kandy.

As shown in Figures 1 and 2, organizationally the Central Meter Workshop is controlled under the Chief Engineer Logistics, who in turn directly reports to the Deputy General Manager, Logistics. At the Central Workshop, there are roughly 130 staffs. The Central Meter Workshop has 10 staffs plus 1 acting staff. The 10 staffs comprise 1 Engineering Assistant, 8 repairmen, and 1 laborer. The 1 acting staff is the Storekeeper at the Central Workshop. One of the 8 repairmen is in charge of test bench. Another one is in charge of bulk meter repair. And another is assisting storekeeping work. Those 3 repairmen are not charged with repair of domestic meters, thus the other 5 repairmen are currently engaged in repair work of domestic meters.

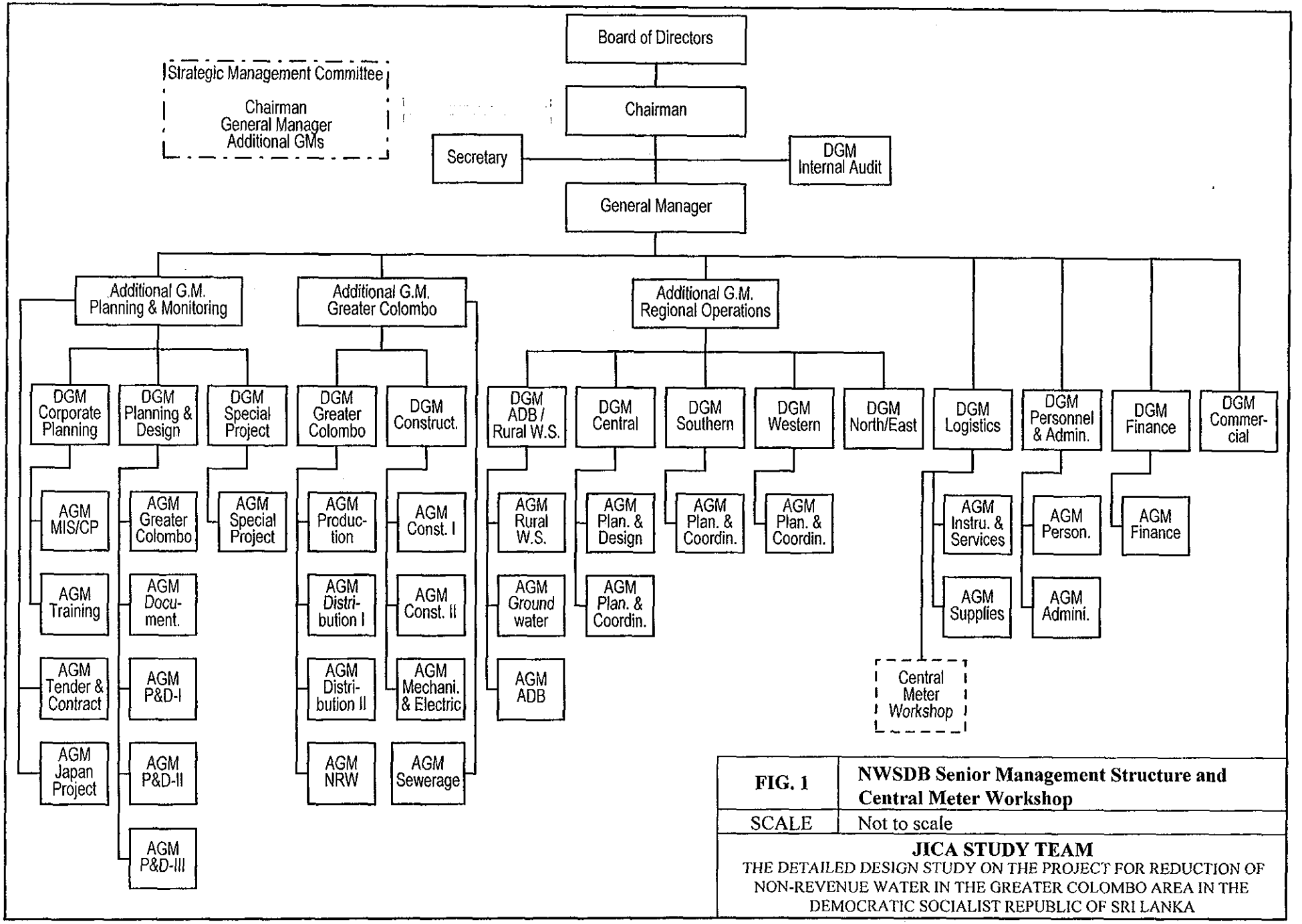

FIG. 1	NWSDB Senior Management Structure and Central Meter Workshop
SCALE	Not to scale

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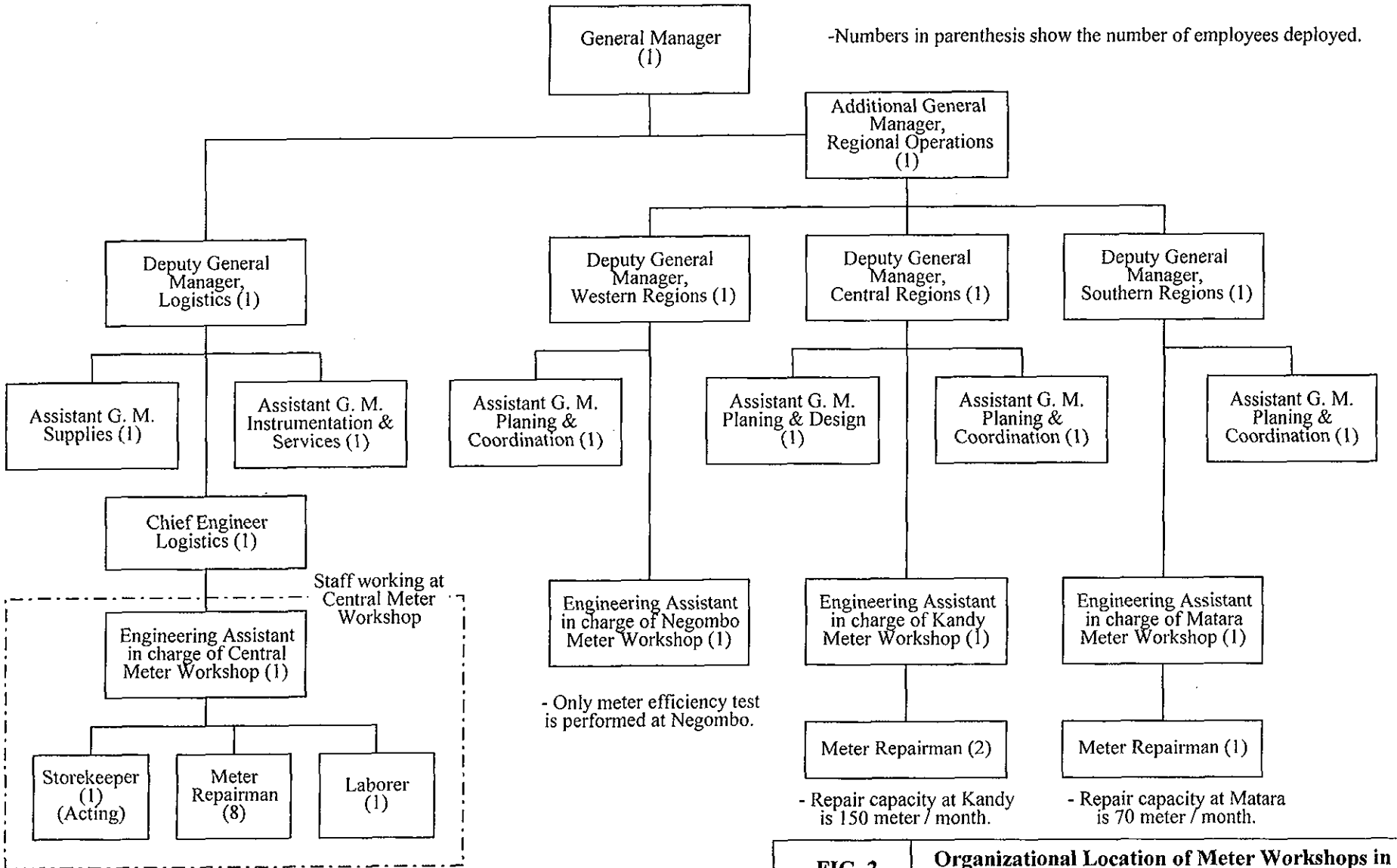

FIG. 2	**Organizational Location of Meter Workshops in NWSDB**
SCALE	Not to scale

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2 Meter Repair Process

The overall meter repair process at the Central Meter Workshop is depicted in Figure 3. Tasks at each process are explained subsequently.

Process ① Defective meters in Greater Colombo are recovered. NWSDB locates defective meters based on meter reading records and reporting from customers.

Process ② Defective meters in Regions of Matara, Hambantota, Ratnapura, Kurunegara, Kandy, and Bandarawera are collected and sent into local meter workshops in Matara, Negombo, and Kandy.

Process ③ At local meter workshops, those sent-in meters are segregated into repairable meters and unrepairable meters. The criteria of segregation are whether the meters collected are unrepairable type at local meter workshops and whether local meter workshops are overcapacity to repair the meters.

Process ④ Local meter workshops repair repairable meters.

Process ⑤ Those recovered meters in Greater Colombo are sent in to the Central Meter Workshop. Those meters, which cannot be repaired at local workshops, are sent in too.

Process ⑥ Meters sent in are counted, segregated on the basis of meter type, and stored at store place of the Central Meter Workshop.

Process ⑦ Stored meters are issued for process at the Central Meter Workshop, considering stock volume, repair capacity, etc.

Process ⑧ If the issued meters are unrepairable types, they are dismantled and segregated into brass parts and plastic parts.

Process ⑨ Brass parts are salable to outside recycle traders. They are stored and accumulated until they reach salable volume.

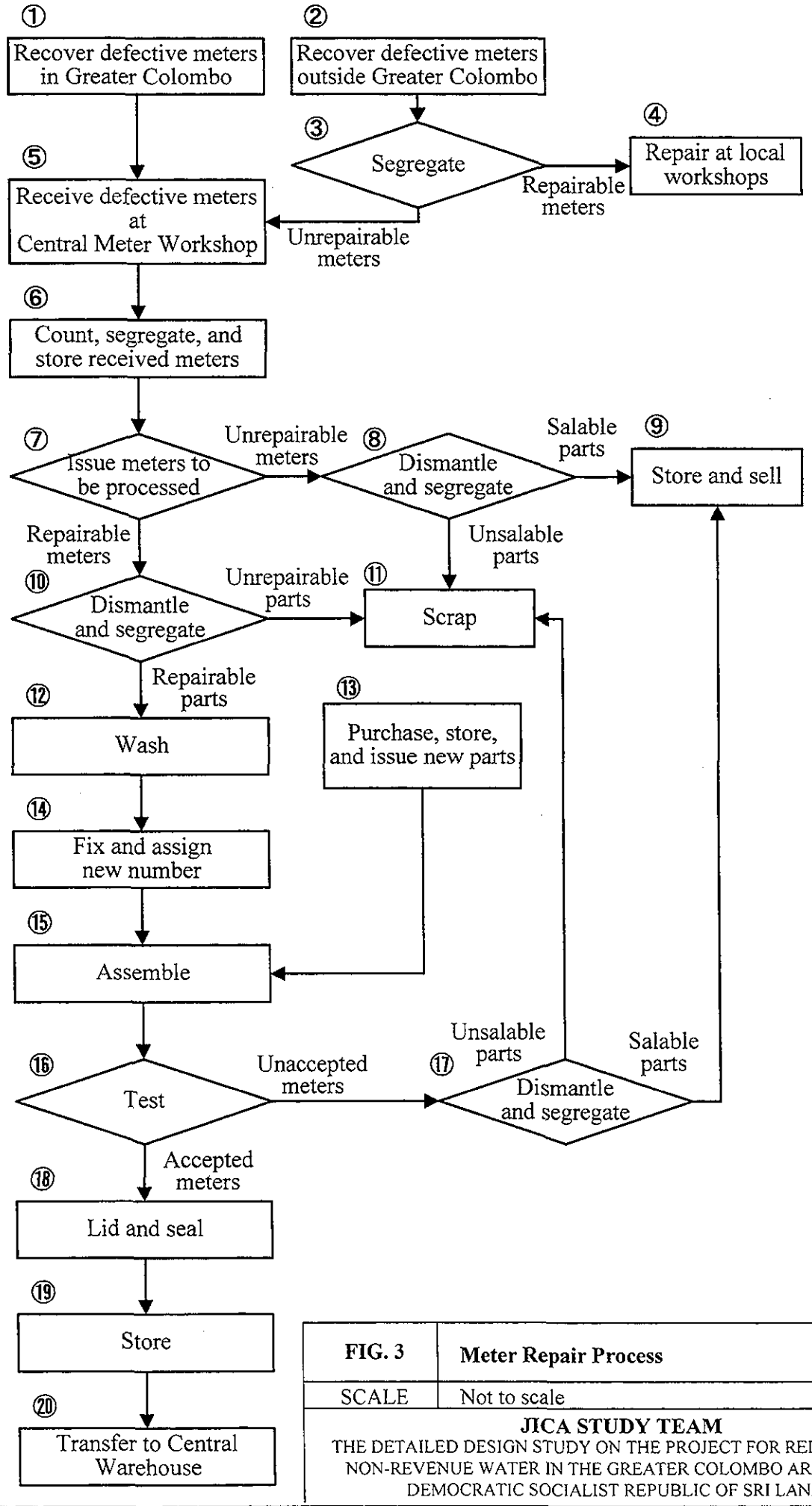

FIG. 3	**Meter Repair Process**
SCALE	Not to scale

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Process ⑩ If the issued meters are repairable types, they are dismantled and segregated into repairable parts like housing, and unrepairable parts like counter.

Process ⑪ The unrepairable and unsalable parts are scrapped and some of them are incinerated at the Central Meter Workshop.

Process ⑫ The repairable parts are washed at the washing basin using diluted solution of hydrochloric acid.

Process ⑬ Some new parts are purchased from manufactures and stored at the Central Meter Workshop. Those spare parts are ordered, considering reorder level, order volume, and timing of new meter purchase. Stored parts are issued when it become necessary.

Process ⑭ Washed parts are repaired properly. A new number is assigned to each recycled housing. Newly assigned numbers indicate the year of repair and if they are new meters or repaired meters. The old manufacture number is filed off. The new number is chiseled onto meter housing. Those filing and chiseling processes altogether take about 8 minutes. This numbering is performed at this stage because once parts are assembled into a meter, chiseling becomes technically difficult.

Process ⑮ Repaired parts are assembled into a meter.

Process ⑯ Assembled meters are tested. Generally there exist 3 types of flow tests, namely, Q minimum flow test, Q transitional flow test, and Q nominal flow test. (Table 1) Zero adjustment of counter is not performed anymore because counters are fully replaced at present. All repaired meters at the Central Meter Workshop undergo only the nominal flow test. Randomly selected new meters and tender meters undergo all the three tests. The tests for domestic meters (= 15 to 40 mm size) are performed at test stations. Smaller bulk meters (= 50 to 80 mm size) are tested on the floor by using calibration tank of other test station. Bigger bulk meters (=100 mm and over) cannot be tested.

Table 1 Type of Meter Test

Test type	Minimum flow	Transitional flow	Nominal flow
Flow rate standard	15 liter / hour	22.5 liter / hour	1.5 m^3 / hour
Tolerance	±5%	±2%	±2%
Testing cycle time	3 hours	2 hours	20 minutes
For repaired meters	Untested	Untested	Tested
For new model meter	Tested	Tested	Tested

Process ⑰ If assembled meters do not pass the test, they are dismantled and segregated into salable parts and unsalable parts. Estimatedly 5 percent of assembled meters fail in the test.

Process ⑱ If meters pass the test, they are sealed. The sealing is done on floor. If the meter lid is missing, a spare lid is attached at this stage. Estimatedly 95 percent of meters assembled pass the test.

Process ⑲ Sealed meters are stored at store place of the Central Meter Workshop.

Process ⑳ Stored meters are transferred to the Main Store when asked.

3 Performance of Central Meter Workshop

The number of defective meters received in 1999 and 2000 is classified in Table 2. The number of repaired meters is also shown in the same table. Table 3 shows current inventory stored at the Central Meter Workshop. Based on those information, the input and output situation at the Central Meter Workshop is depicted in Figure 4. Table 4 summarizes the capacity utilization of repair and test works.

Table 2 Number of Meters Processed at Central Meter Workshop

Meter type *1	Origin	Year 1999				Year 2000 Jan. -June			
		Received			Repaired	Received			Repaired
		from G.C.	from out-side G.C.	Total		from G.C.	from out-side G.C.	Total	
SHINSHAN 40 mm *2	China	2	0	2	0	0	0	0	0
KENT HELIX 150 mm	UK	1	0	1	1	1	1	2	2
KENT HELIX 100 mm	UK	4	0	4	4	1	0	1	1
KENT HELIX 80 mm	UK	6	6	12	12	6	3	9	9
KENT HELIX 65 mm	UK	1	0	1	1	0	0	0	0
KENT HELIX 50 mm	UK	26	21	47	47	18	5	23	23
KENT HELIX 40 mm	UK	0	1	1	1	0	0	0	0
MEINECKE 300 mm	Germany	0	0	0	0	0	1	1	1
MEINECKE 150 mm	Germany	1	1	2	2	0	0	0	0
MEINECKE 100 mm	Germany	2	2	4	2	0	4	4	3
MEINECKE 80 mm	Germany	7	6	13	13	2	1	3	3
SCHLUMBERGER 15mm *2	Indonesia	47	0	47	0	0	0	0	0
AICHI 150 mm *3	Japan	0	0	0	0	1	1	2	0
AICHI 15 mm *3	Japan	596	925	1,521	0	287	167	454	0
KENT PSM 40 mm *2	UK	3	4	7	0	11	1	12	0
KENT PSM 30 mm *2	UK	22	3	25	0	9	5	14	0
KENT PSM 25 mm *2	UK	584	20	604	0	107	24	131	0
KENT PSM 20 mm *2	UK	974	247	1,221	0	541	74	615	0
KENT PSM 15 mm *4	UK	3,632	6,739	10,371	9,654	2,476	2,588	5,064	2,300
KENT ESJ 40 mm *3	UK	18	6	24	0	26	5	31	0
KENT ESJ 30 mm *3	UK	3	2	5	0	1	0	1	0
KENT ESJ 25 mm *3	UK	337	23	360	0	462	11	473	0
KENT ESJ 20 mm *3	UK	1,403	170	1,573	0	708	47	755	0
KENT ESJ 15 mm *3	UK	1,224	601	1,825	0	433	80	513	0
G & C 20mm *3	UK	228	29	257	0	60	1	61	0
G & C 15mm *3	UK	271	81	352	0	51	3	54	0
NIGBO 15 mm *5	China	0	0	0	0	0	0	0	0
LIYANLI 20 mm *5	China	0	0	0	0	0	0	0	0
LIYANLI 15mm *5	China	0	0	0	0	0	0	0	0
DONGHAI 15 mm *6	China	0	0	0	0	0	0	0	0
Total		9,392	8,887	18,279	9,737	5,201	3,022	8,223	2,342

*1) 15 - 40 mm sized meters are domestic meters. 50 mm and over are bulk meters.
*2) Not repairable because spare parts are expensive. Better to buy new inexpensive meters.
*3) Not repairable because it is turbine type meter, which NWSDB has decided not to use any more.
*4) Includes PSM-L type and PSM-C type. PSM-L is, unlike PSM-C type, unrepairable because its counter is small-sized and the spare parts are not available.
*5) Introduced in 1999.
*6) To be introduced in 2000.

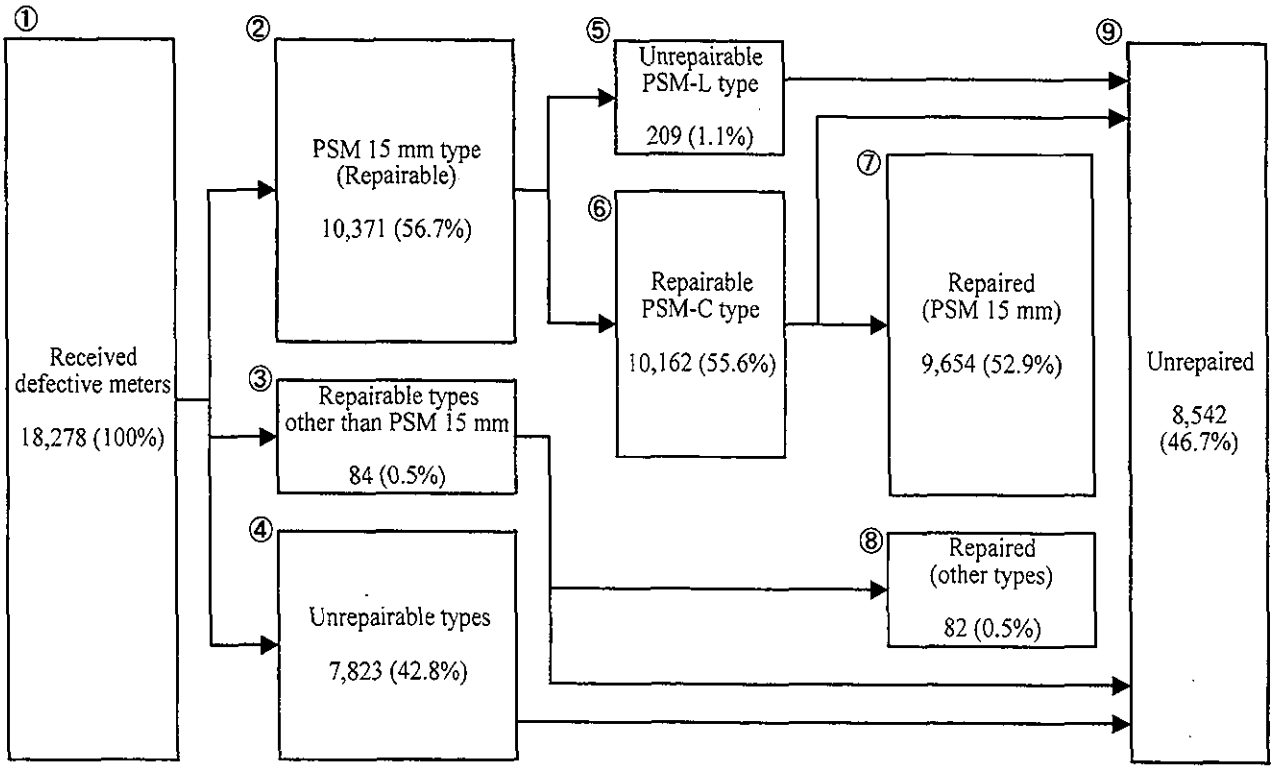
Table 3 Inventory at Central Meter Workshop

(As of July 4, 2000)

Item	Piece(s)
Meters to be repaired	
KENT PSM 15 mm	823
KENT PSM 20 mm	3,859
KENT PSM 25 mm	931
KENT PSM 30 mm	119
KENT PSM 40 mm	83
KENT HELIX 50 mm	12
KENT HELIX 80 mm	5
KENT HELIX 100 mm	6
MEINECKE 100 mm	5
Repaired meters	
KENT PSM 15 mm	836
KENT HELIX 200 mm	1
KENT HELIX 100 mm	1
KENT HELIX 80 mm	2
KENT HELIX 50 mm	7
MEINECKE 100 mm	5
Parts for KENT PSM 15 mm	
Backflow restrictor (non return valve)	4,198
PSM counter	8,666
Gasket	142,680
Hinge pin	25,692
Lid	7,035
Body-O-ring	2,100
Working chamber	1,000
Counter-O-ring	20,474

Item	Piece(s)
Parts for bulk meters	
Adapter ring assembly	6
Body bolt washer	293
Back bearing cap assembly 1	2
Back bearing cap assembly 2	50
Blank cover plate	11
Hexagon bold	5
Back vane support	1
Measuring element with counter	13
Measuring element with counter	4
Counter locking clip	68
Spring dowel pin A	50
Spring dowel pin B	97
Drive clip	538
Element screw washer	39
First pinion	47
Lid	16
Lid (lockable)	61
O-ring 1	142
O-ring 2	40
O-ring 3	3
O-ring 4	6
Regulator assembly 1	5
Regulator assembly 2	6
Regulator assembly 3	3
Rotor support assembly	17
Sealing ring 1	39
Sealing ring 2	97
Spring retain ring	9
Bearing cap screw	161
Top cover	10
Worn wheel	48
Worn shaft 1	16
Worn shaft 2	1
Worn shaft 3	10
Measuring element	31

1999



Jan. - June 2000

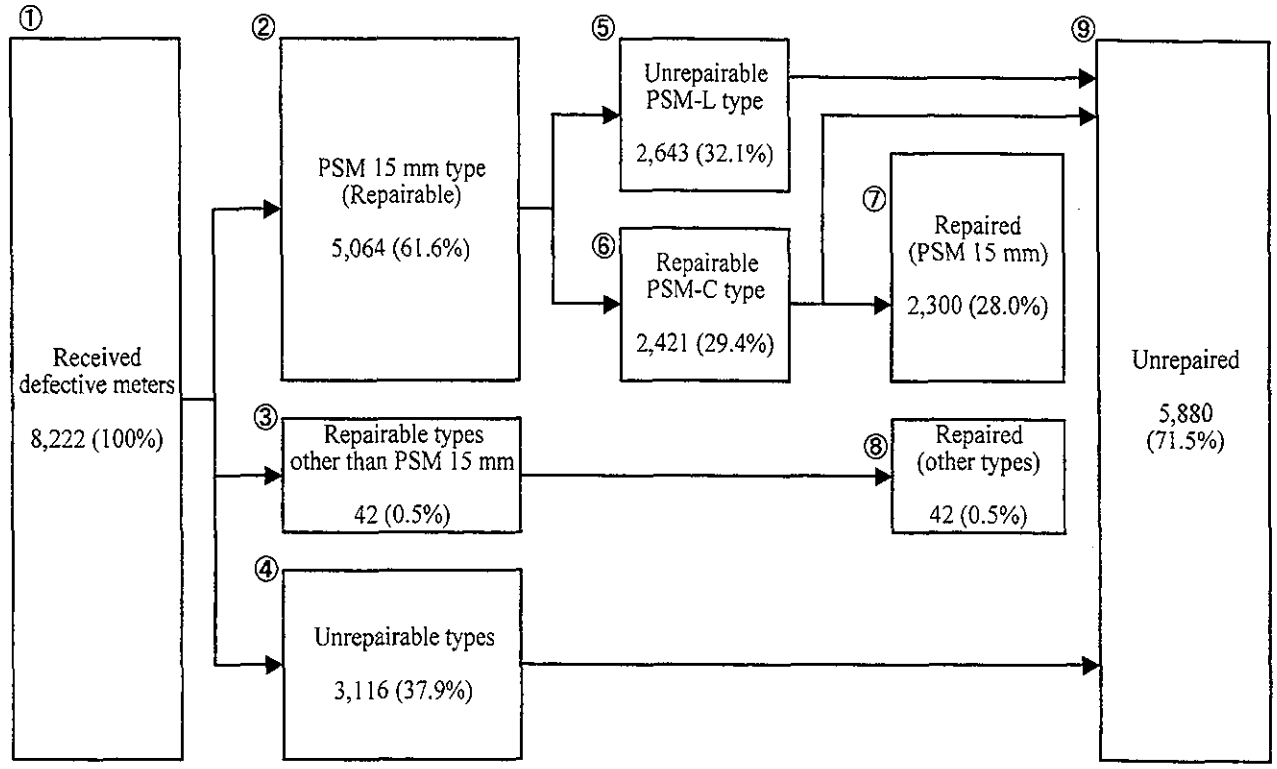


FIG. 4	**Input and Output of Meter Repair Process**
SCALE	Not to scale

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Table 4 Capacity Utilization of Central Meter Workshop

Capacity factor / Task	Current capacity	Current operation (Jan. – June 2000)	Capacity utilization
Domestic meter repair (15-40 mm)	1,200 meters / month *	383 meters / month	32%
Bulk meter repair (50-80 mm)	20 meters / month	7 meters / month	35%
Repaired domestic meter test	5,760 meters / month	383 meters / month	7%
Repaired bulk meter test	20 meters / month	7 meters / month	35%

* The current repair capacity of domestic meters at the Central Meter Workshop is computed as follows:

- 1 repairman can repair 12 meters per day, thus the daily repair capacity is 60 meters (= 5 x 12).
- Usually repairmen work 20 days per month, therefore, the monthly repair capacity is 1,200 meters (=5 x 12 x 20).

It is noted that the number of repaired meters considerably decreased from 9,737 in the year 1999 to 2,342 in the first 6 months of the year 2000. The main contributor to this decrease is that in the year 2000, more 15 mm KENT PSM-L type meters were sent in. That type of meter, unlike 15 mm KENT PSM-C type, cannot be repaired because the spare parts are not available at reasonable price. This decrease in the number of repaired meters leads to the low capacity utilization. Regarding the domestic meter repair, which is the dominant work at the Central Meter Workshop, the capacity utilization is currently as low as 32 percent.

The number of received domestic meters is almost equivalent to the number of replaced meters. In Greater Colombo, each area sets the meter replacement target, which is called the "meter rectification program". In order to achieve the target, likely defective meters are picked out. Those customers who may have a defective meter are visited and their meters are checked whether they are really defective. If they turn out to be defective, they are replaced new meters or rectified on the spot. Those suspect meters are located primarily through information from meter readers (estimatedly 65 percent), secondarily reporting from customers (estimatedly 25 percent), and thirdly billing data of dubious customers who have, for example, zero or unusually low consumption (estimatedly 10 percent).

Table 5 shows the meter rectification plans and the results in Greater Colombo. It is noticeable that the number of meters replaced in the first half of the year 2000 has accumulated at a higher pace than in the year 1999 in Towns South and Colombo City. While in Towns East and Towns North, the pace in comparison with the previous year, is much lower in the year 2000. And in overall Greater Colombo, the pace is almost same as that of 1999. However, this overall meter rectification target in Greater Colombo itself may not be sufficient. As of May 2000, the number of households and other connections is 260,185 in Greater Colombo. In the absence of meter installation data, assuming that meters are installed at 90 percent of those connections,

there are approximately 234,000 installed meters. Furthermore, humbly assuming that all those meters are under normal circumstances where meters can properly function for 10 years, still 23,400 meters have to be replaced every year.

Table 5 Meter Rectification Program in Greater Colombo

	Towns East		Towns South		Towns North		Colombo City		Total G. C.	
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual
Year 1999 Total	6,394	3,350	4,338	2,670	1,629	1,500	2,835	3,262	15,196	10,782
Jan. 2000	333	196	316	394	78	113	800	674	1,527	1,377
Feb. 2000	333	150	316	448	72	136	600	584	1,321	1,318
Mar. 2000	334	160	316	473	75	88	500	628	1,225	1,349
Apr. 2000	400	160	316	220	75	0	400	456	1,191	836
May 2000	400	150	316	295	75	4	400	379	1,191	828
Jun. 2000	400	171	316	535	75	51	300	238	1,091	995
Jan. - June 2000	2,200	987	1,896	2,365	450	392	3,000	2,959	7,546	6,703
Jul. 2000	500		316		75		580		1,471	0
Aug. 2000	500		316		75		680		1,571	0
Sep. 2000	500		316		75		500		1,391	0
Oct. 2000	766		316		75		350		1,507	0
Nov. 2000	766		316		75		400		1,557	0
Dec. 2000	768		316		75		300		1,459	0
Year 2000 Total	6,000	987	3,792	2,365	900	392	5,810	2,959	16,502	6,703

Table 6 shows the costs incurred at the Central Meter Workshop in 1999. It should be noted that the Labor cost amounted to Rs. 191,039, accounting for only 3 percent of total cost. This is because that labor cost during idle hours is not included here. Instead it is charged as overhead cost.

Table 6 Cost at Central Meter Workshop

Material cost	Rs. 4,551,149
Labor cost	191,039
Other cost	14,190
Overhead cost	1,600,758
Total cost	Rs. 6,357,136

The direct labor cost estimated on the basis of accumulation of average personnel costs is shown in Table 7. The data of those average personnel costs in NWSDB is shown in Table 8.

Table 7 Staff and Direct Labor Cost at Central Meter workshop

Job title	Job rank	①No of staff	②Personnel costs based on average of same job rank (Rs / person / month)	①×②×12 Direct labor cost (Rs / year)
Engineering assistant	7	1	16,091	193,092
Store keeper (acting)	10	1	13,369	160,428
Meter repairman	13	8	12,873	1,235,808
Laborer	15	1	10,793	129,516
Total		11		1,718,844

Table 8 Average Personnel Costs of NWSDB

Job Category	Job rank	No. of staff	Basic salary (Rs./mth)	Overtime & allowance (Rs./mth)	Pension & medical contribution (Rs./mth)	Monthly portioned bonus (Rs./mth)	Total (Rs./mth)
Top Management	1	1	25,000	4,000	3,750	833	33,583
Senior Management	2	14	23,174	3,948	3,476	833	31,431
Sennior Management	3	28	21,539	4,853	3,231	833	30,456
Executive	4	90	20,077	4,228	3,012	833	28,150
Executive	5	92	18,208	1,200	2,731	833	22,972
Executive	6	85	13,931	1,587	2,090	833	18,441
Executive	7	135	12,203	1,227	1,828	833	16,091
Supervisory, Clerical and Allied	8	127	10,912	3,359	1,637	833	16,741
Supervisory, Clerical and Allied	9	529	10,433	2,798	1,565	833	15,629
Supervisory, Clerical and Allied	10	272	9,149	2,015	1,372	833	13,369
Supervisory, Clerical and Allied	11	552	8,569	1,691	1,284	833	12,377
Skilled	12	1,025	8,303	2,558	1,245	833	12,940
Skilled	13	1,675	7,456	3,465	1,118	833	12,873
Unskilled	14	614	7,210	2,946	1,081	833	12,071
Unskilled	15	2,129	6,699	2,257	1,003	833	10,793
Total / Average		7,368	8,290	2,635	1,243	833	13,001

* Based on June 2000 information

The average cost of repaired meter, or total cost divided by the total number of repaired meters, can be compared with prices of new meters (Table 9).

Table 9 Comparison among Repair Cost, New Meter Price, and Spare Part Price

①Average cost per repaired meter in 1999	Rs. 653
②Average material cost per repaired meter in 1999	Rs. 467
③Minimum direct labor cost to repair one meter *	Rs. 54
④Price of a new Chinese 15 mm type meter	Rs. 750
⑤Price of a new KENT PSM 15 mm C type meter	Rs. 1,500
⑥Price of a spare part of KENT PSM 15 mm C type (Counter)	Rs. 450
⑦Price of a spare part of KENT PSM (Working chamber)	Rs. 500
⑧Price of a spare part of Chinese meter (Counter)	Rs. 200
⑨Price of a spare part of Chinese meter (Working chamber)	Rs. 250

* 1 repairman can repair maximum of 240 meters per month. The average personnel cost of one repairman is estimatedly Rs.12,873 per month. Thus, assuming that the repairman works at his full capacity, the direct labor cost per meter becomes Rs.54 (=12,873÷240).

To sum up those cost data, the following indications are obtained although the costs and prices vary depending on market situation:

- Buying a new KENT domestic meter costs Rs. 1,500.
- Buying a new Chinese domestic meter costs Rs. 750.
- Repair of a defective meter averagely costs Rs. 653.
- Repair of a Chinese meter, if the working chamber and the counter are replaced, costs Rs. 450.

Judging from the above, although simplified, the following conclusions can be derived:

- Keep repairing KENT meters as long as repairable KENT meters are recovered and necessary parts are available.
- Buy Chinese meters if repairable KENT meters are depleted.
- However, since the purchase price of a new Chinese meter is already approximate to the repair price of a KENT meter, Chinese meters may be purchased at any time.
- Repair Chinese meters when they start getting defective.

Table 10 shows a simulation to find out the appropriate capacity of the Central Meter Repair Workshop and the utilization rate from the year 2001 through 2005. The numbers of defective meters, repairable meters and purchasable meters are also clarified. The assumptions and targets used in the simulation are based on the best obtainable data such as findings of NRW Management Block Study, NWSDB Corporate Plan 1999 – 2005, and various latest commercial data.

Table 10 Analysis of Meter Workshop Capacity Utilization

(unit : number)

	Year	2000	2001	2002	2003	2004	2005
1	Connections at end of year						
2	Greater Colombo	280,000	307,000	334,000	361,000	388,000	415,000
3	Other Regions	280,000	310,000	340,000	370,000	400,000	430,000
4	Total	560,000	617,000	674,000	731,000	788,000	845,000
5	New connections during year						
6	Greater Colombo	26,951	27,000	27,000	27,000	27,000	27,000
7	Other Regions	29,880	30,000	30,000	30,000	30,000	30,000
8	Total	56,831	57,000	57,000	57,000	57,000	57,000
9	Meters to be installed for new connections						
10	Greater Colombo 99% of new connections	26,681	26,730	26,730	26,730	26,730	26,730
11	Other Regions 99% of new connections	29,581	29,700	29,700	29,700	29,700	29,700
12	Total	56,263	56,430	56,430	56,430	56,430	56,430
13	Meters to be installed for existing connections						
14	Greater Colombo	9,410	9,500	9,500	9,500	9,500	9,500
15	Replacement of defective meters	8,469	8,550	8,550	8,550	8,550	8,550
16	Installation of new meters to no meter connections	941	950	950	950	950	950
17	Other Regions	11,300	11,500	11,500	11,500	11,500	11,500
18	Replacement of defective meters	10,170	10,350	10,350	10,350	10,350	10,350
19	Installation of new meters to no meter connections	1,130	1,150	1,150	1,150	1,150	1,150
20	Total	20,710	21,000	21,000	21,000	21,000	21,000
21	Replacement of defective meters	18,639	18,900	18,900	18,900	18,900	18,900
22	Installation of new meters to no meter connections	2,071	2,100	2,100	2,100	2,100	2,100
23	Meters installed at end of year						
24	Greater Colombo	274,400	302,080	329,760	357,440	385,120	412,800
25	Other Regions	274,400	305,250	336,100	366,950	397,800	428,650
26	Total	548,800	607,330	665,860	724,390	782,920	841,450
27	Meter penetration rate						
28	Greater Colombo	98%	98%	99%	99%	99%	99%
29	Other Regions	98%	98%	99%	99%	99%	100%
30	Defective meters to be newly generated						
31	Greater Colombo 8.3% of (row10+row39)		19,528	20,204	20,825	21,394	21,916
32	Other Regions 8.3% of (row11+row40)		19,799	20,716	21,557	22,329	23,036
33	Total		39,327	40,921	42,382	43,723	44,952
34	Defective meters at end of year						
35	Greater Colombo	65,856	85,384	105,588	126,413	147,807	169,722
36	Other Regions	65,856	85,655	106,372	127,929	150,258	173,294
37	Total	131,712	171,039	211,960	254,342	298,065	343,016
38	Functional meters at end of year						
39	Greater Colombo	208,544	216,696	224,172	231,027	237,313	243,078
40	Other Regions	208,544	219,595	229,728	239,021	247,542	255,356
41	Total	417,088	436,291	453,900	470,048	484,855	498,434
42	Meter defect rate						
43	Greater Colombo	24%	28%	32%	35%	38%	41%
44	Other Regions	24%	28%	32%	35%	38%	40%
45	Plan 1 (Current output level of 5,000 meters/year to be maintained)						
46	Defective meters to be repaired		4,914	4,914	4,914	4,914	4,914
47	Defective meters to be repaired (% of recovered meters)		26%	26%	26%	26%	26%
48	New meters to be procured		72,516	72,516	72,516	72,516	72,516
49	Capacity utilization based on year 2000 capacity (14,400 meters p.a.)		34%	34%	34%	34%	34%
50	Plan 2 (Current capacity to be fully utilized)						
51	Defective meters to be repaired		14,364	14,364	14,364	14,364	14,364
52	Defective meters to be repaired (% of recovered meters)		76%	76%	76%	76%	76%
53	New meters to be procured		63,066	63,066	63,066	63,066	63,066
54	Capacity utilization based on year 2000 capacity		100%	100%	100%	100%	100%
55	Plan 3 (Current capacity to be increased and fully utilized)						
56	Defective meters to be repaired		18,900	18,900	18,900	18,900	18,900
57	Defective meters to be repaired (% of recovered meters)		100%	100%	100%	100%	100%
58	New meters to be procured		58,530	58,530	58,530	58,530	58,530
59	Capacity utilization based on year 2000 capacity		131%	131%	131%	131%	131%

Note:

2,3) As of August 2000, there are 264,155 metered connections, 2,817 unmetered connections and 2,160 no-metered connections in G.C., totaling to 269,132 connections. In other regions, there are 267,379 metered connections and 789 unmetered connections, totaling to 268,168 connections.

6,7) The total connections were 444,812 and 505,026 respectively at end 1998 and at end 1999. As of July 2000, the connections totals 535,711. Figure of 2000 is targeted in Action Plan 2000. Figures of 2001 through 2005 are estimated by the Team.

10,11) Assumedly 1% of new connections do not have a meter due to various reasons.

15,18) Defective meters are found and recovered mainly as a result of execution of meter installment programs. Those "defective meter" connections that will get a new meter under meter installment programs are estimated to be 90 percent of total meter installation for existing connections.

16,19) Some connections have no meter because there was a time when NWSDB could not provide meters. Those "no-metered" connections that will get a new meter under meter installment programs are estimated to be 10 percent of total meter installation for existing connections.

27) Meter penetration rate is computed as [1 - (unmetered connections + no meter connections) / total connections] x 100.

28,29) NRW Reduction Pilot Project in CB1is being carried out. According to the provisional result, the sample area characterized by concentration of domestic connections, had 413 registered connections (225 functional meters + 70 defective meters + 49 no-metered + 69 unknown status) and 467 unregistered connections. Those data result in meter penetration rate of 86%. As another information source, according to NWSDB statistics (see the above note 2,3), the meter penetration rates are 98.2% and 99.7% respectively in G.C. and other regions. In this simulation, the Study Team assumed that the meter penetration rate is 98% in both G.C. and other regions.

31,32) Service life of meter is assumed to be 12 years. This means that 8.3% of functional meters at end of the previous year and 8.3% of newly installed meters during the year become defective.

42) Meter defect rate is computed as (defective meters / installed meters) x 100

43,44) NRW Reduction Pilot Project in CB1is being carried out. According to the provisional result, the sample area characterized by concentration of domestic connections, had 413 registered connections (225 functional meters + 70 defective meters + 49 no-metered + 69 unknown status) and 467 unregistered connections. Assuming that those figures are applicable to other areas, 24% of installed meters are estimatedly defective.

49,54,59) Repair capacity for recovered meters is 14,400 pieces per year. Test capacity for new or recovered meters is 130,560 pieces per year. Repair & test capacity for recovered meters is therefore, 14,400.

According to the simulation, NWSDB will recover in the year 2001 for example, 8,550 defective meters in Greater Colombo. If other regions are included, the number totals to 18,900. Those defective meters recovered from existing customers have to be replaced by either new or repaired meters.

Plan 1 assumes the situation where the current output level of the Central Meter Repair Workshop is maintained. Under this plan, 26 percent of those defective meters will be replaced

by repaired meters and the remaining will be replaced by new meters. The capacity utilization will be 34 percent, thus there will be no need to increase the capacity.

Plan 2 assumes that the current capacity is not increased but fully utilized. Under this plan, 76 percent of defective meters will be replaced by repaired meters in 2001.

Plan 3 assumes that the capacity is increased and fully utilized. It should be noted that the capacity increase of the Central Meter Repair Workshop is constrained by various factors such as the capacity of technical gangs engaged in meter installment program, and the number of defective and repairable meters to be recovered in future. Both of those factors are unknown, therefore, the simulation assumes that the current levels are maintained. The result shows that the capacity increase by 31 percent is sufficient.

The Study Team supports the Plan 3 because that is most consistent with the conclusions of "Buy or repair" problem analyzed in the previous section. Under the plan, the repair capacity of the Central Meter Repair Workshop has to be beefed up by 31 percent. The test capacity needs no increase. The capacity increase of 31 percent is interpreted as additional deployment of 2 repairmen, and purchase of 1 repair bench and some additional repair tools such as files, chisels, press, screwdrivers, and spanners. Table 11 shows the actions to be taken and the costs incurred from 2001 to 2005.

Table 11 Actions and Costs to Increase The Capacity of Meter Repair Workshop

(Unit: Rs. Million)

Period / Action	2001	2002～2005	Total cost
Deploy 2 more repairmen *	0.3	1.3	1.6
Purchase a repair bench and tools	3.0	0.0	3.0
Total cost	3.3	1.3	4.6

*Average personnel cost of a repairman (rank 13) is Rs. 12,873 / month.

APPENDIX 4D-2

METER READING, BILLING AND COLLECTION SYSTEM

METER READING, BILLING AND COLLECTION SYSTEM

1 Meter Reading and Billing System

1.1 Customer Classification in CMC Area

Those who consume much and are accordingly billed much are separated from other less consuming users and called priority users. By another definition, the priority users are those who have water meters of 20 mm diameter or larger. The priority users are scattered in Greater Colombo area and the user's line up slightly varies from year to year due to change of their consumption volume. Table 1 shows the number of connections, consumptions, and billings as of August 2000 classified by area and user type. In terms of the number of connections, non priority users are overwhelmingly dominant. However, in terms of consumption and billing amount, the importance of priority users becomes noticeable. 53 percent of billing amount and 42 percent of consumption are attributable to priority users of 2 percent in CMC area. On the contrary, non priority users accounting for 98 percent of total billed connection, consume 58 percent of total volume and their billings account for 47 percent of the total billing in CMC area.

Table 1 Water Consumption and Billing in CMC Area

As of Aug. 2000

		No. of connections	(%)	Consumption (m3)	(%)	Billing * (Rs.)	(%)
Non	CB1	29,326	37%	657,570	18%	9,907,200	14%
Priority	CB2	22,408	28%	594,590	16%	9,172,200	13%
Users	CB3	27,147	34%	888,500	24%	15,094,600	21%
	Sub total	78,881	98%	2,140,660	58%	34,174,000	47%
Priority	CB1	491	1%	453,230	12%	14,220,490	20%
Users	CB2	423	1%	492,500	13%	14,661,020	20%
	CB3	495	1%	605,180	16%	9,854,970	14%
	Sub total	1,409	2%	1,550,910	42%	38,736,480	53%
Total CMC		80,290	100%	3,691,570	100%	72,910,480	100%

* Billing includes water charge and service charge.

Detailed data of both priority and non priority users in CB1 are shown in Table 2. In the non priority user category, domestic user accounts for 79 percent in terms of the number of connections and 71 percent in terms of consumption. The commercial user comes next, accounting for 17 percent and 19 percent respectively in the number of connections and in the consumption. But when it comes to the billing, the situation reverses. The commercial user accounts for 46 percent and the domestic user accounts for 38 percent.

Table 2 Water Consumption and Billing in CB1

As of August 2000

	Number of connections			Consumption			Billing *3		
		*1	*2	(m3)	*1	*2	(Rs.)	*1	*2
Non Priority Users									
Domestic users	23,070	79%	77%	482,009	71%	43%	3,788,666	38%	16%
Board quarters	1	0%	0%	20	0%	0%	63	0%	0%
Government schools	48	0%	0%	3,572	1%	0%	95,434	1%	0%
Government quarters	610	2%	2%	10,048	1%	1%	91,472	1%	0%
Stand posts	10	0%	0%	347	0%	0%	2,715	0%	0%
Tenement gardens	8	0%	0%	187	0%	0%	1,835	0%	0%
Government institutions	131	0%	0%	11,570	2%	1%	382,180	4%	2%
Police	12	0%	0%	1,551	0%	0%	50,570	1%	0%
CMC	95	0%	0%	6,760	1%	1%	275,680	3%	1%
Commercial institutions	4,903	17%	16%	129,667	19%	11%	4,527,710	46%	19%
Tourist hotels / Guest houses	2	0%	0%	0	0%	0%	0	0%	0%
Industrial / Construction purposes	269	1%	1%	19,156	3%	2%	609,520	6%	3%
Private institutions	134	0%	0%	7,593	1%	1%	30,694	0%	0%
Religious and charitable organisations	30	0%	0%	1,490	0%	0%	50,180	1%	0%
Free water	2	0%	0%	1,544	0%	0%	240	0%	0%
Bulk bowser water	1	0%	0%	443	0%	0%	240	0%	0%
Sub total	29,326	100%	98%	675,957	100%	60%	9,907,199	100%	41%
Priority Users									
Domestic users	1	0%	0%	70	0%	0%	1,261	0%	0%
Government schools	4	1%	0%	661	0%	0%	20,559	0%	0%
Government quarters	1	0%	0%	8	0%	0%	35	0%	0%
Government institutions	111	23%	0%	119,411	26%	11%	3,616,890	25%	15%
Army	4	1%	0%	3,576	1%	0%	108,000	1%	0%
Police	9	2%	0%	3,494	1%	0%	106,260	1%	0%
CMC	7	1%	0%	11,019	2%	1%	332,490	2%	1%
Commercial institutions	304	62%	1%	185,298	41%	16%	5,607,960	39%	23%
Tourist hotels / Guest houses	5	1%	0%	47,590	11%	4%	1,431,900	10%	6%
Shipping	8	2%	0%	13,578	3%	1%	1,633,440	11%	7%
Industrial / Construction purposes	22	4%	0%	41,401	9%	4%	1,248,750	9%	5%
Private institutions	9	2%	0%	25,312	6%	2%	75,980	1%	0%
Religious and charitable organisations	5	1%	0%	1,202	0%	0%	36,900	0%	0%
Free water	1	0%	0%	608	0%	0%	60	0%	0%
Sub total	491	100%	2%	453,228	100%	40%	14,220,485	100%	59%
Total CB1	29,817		100%	1,129,185		100%	24,127,684		100%

*1) Share against either priority user total or non-priority user total.

*2) Share against CB1 total.

*3) Billing includes water charge and service charge.

In the priority user category, the commercial user has the largest share in the number of connections, the consumption volume, and the billing amount, respectively accounting for 62 percent, 41 percent, and 39 percent. The second biggest customer group is government institutions, accounting for 23 percent, 26 percent, and 25 percent, respectively in the number of connections, the consumption volume, and the billing amount.

1.2 Meter Reading and Billing System for Non Priority Users

In CMC area, Meter reading and billing for non priority users are performed by meter readers deployed at each Area Office (Figure 1).

In Greater Colombo, the number of connections that one meter reader should covers is suggested as somewhere between 2,000 and 2,500. Since there are approximately 29,000 connections in CB1, 13 staffs are actually working as meter reader in the CB1 Area Office. In addition, one meter reader inspector is deployed in the Area Office. The meter reader inspector is not assigned any accounts to visit routinely. Instead he checks the meter readers' performances and visits customers to solve claims if they are related to meter reading. It is the Commercial Manager who supervises the meter reader inspector and the meter readers. The Commercial Manager oversees not only meter reading and billing activities but also consumer relations and collection activities for non-priority users in CB1.

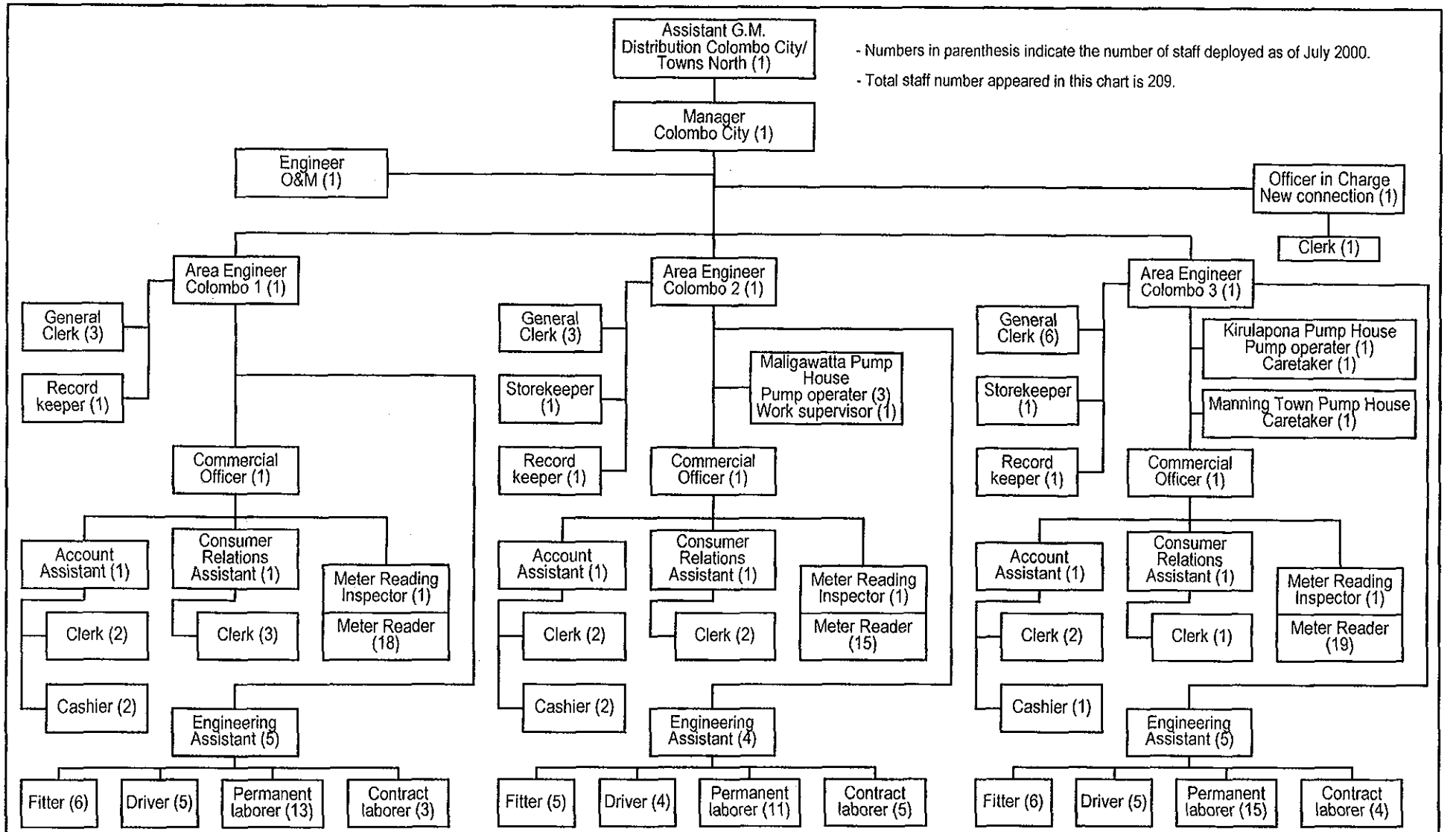


FIG. 1	**Organization Structure around Manager, Colombo City**
SCALE	Not to scale

JICA STUDY TEAM

THE DETAILED DESIGN STUDY ON THE PROJECT FOR REDUCTION OF NON-REVENUE WATER IN THE GREATER COLOMBO AREA IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Meter reading and billing process for non-priority users is illustrated in Figure 2. Activities performed in each step of meter reading and billing path are explained in subsequent paragraphs. It is Computer Section of DGM Commercial Division that processes billing data and produces billing forms. The organization chart of DGM Commercial Department is shown in Figure 3.

Figure 2 Meter Reading and Billing Path for Non-Priority Users

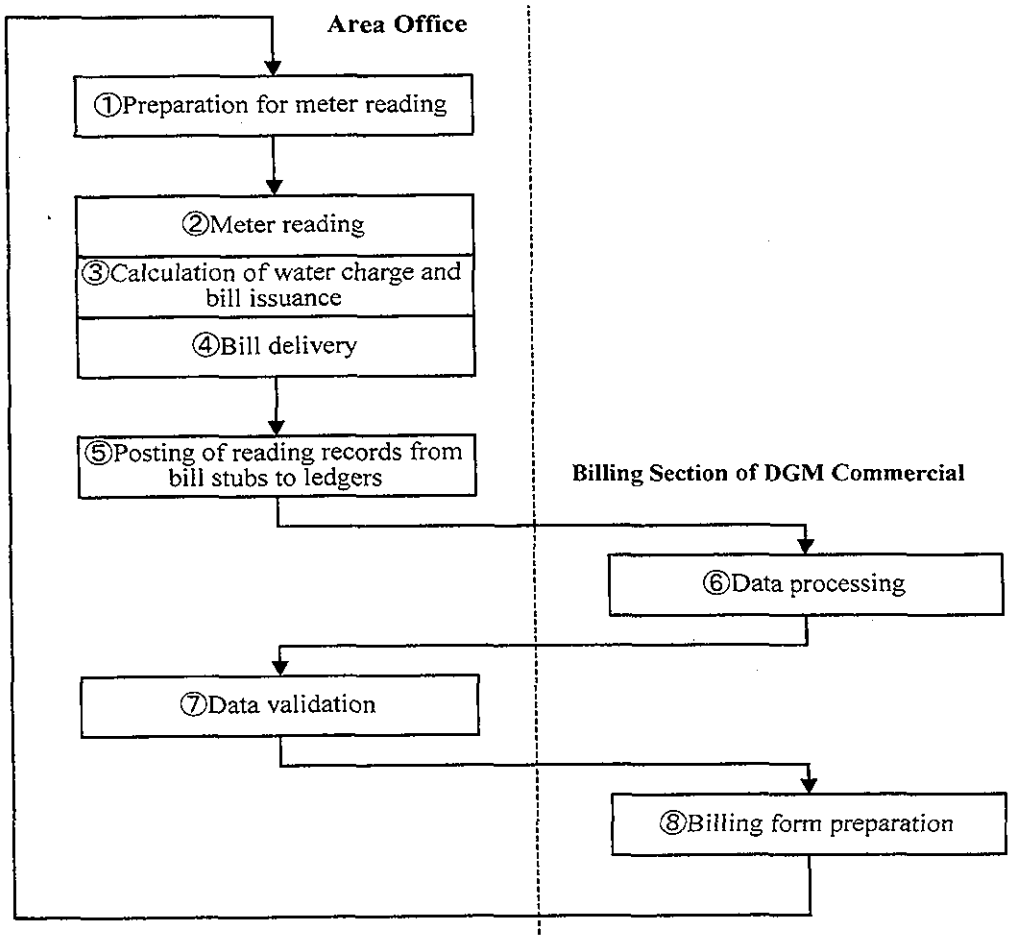
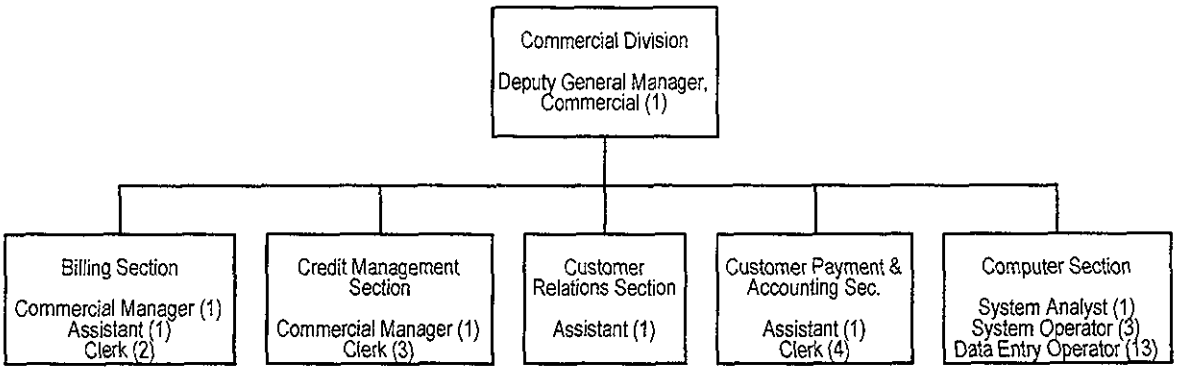


Figure 3 Organization under DGM Commercial



- Numbers in parenthesis indicate the number of staff deployed as of Nov. 2000.
- Total staff number appeared in this chart is 32.

① Preparation for meter reading

The Billing Section of the DGM Commercial Division produces the billing forms in which basic information are printed such as customer's name, account number, last month consumption, meter record of previous month, and dues outstanding. Upon receipt of the half-completed billing forms, meter readers assort the billing forms of customers to whom they pay a visit according to their call schedules. Meter readers are supposed to read all the metered connections every month.

② Meter reading

Meter readers carry the assorted half-completed billing forms on the day of visit. At each customer's meter site, meter readers read the accumulated consumption volume indicated by the meter and check whether it is consistent with the data appeared in the half-completed form. There are however, a number of connections whose meters cannot be actually read but estimated. The reasons of illegible meters include problems of meter itself such as broken gauge and due formation inside meter, but the majority stems from external factors such as inaccessibleness to meter caused by locked-up premise, construction work, parked car, etc. If a water meter cannot be read, the consumption of last month that is already printed in the billing form is taken as estimated consumption.

③ Calculation of water charge and bill issuance

Meter readers compute the consumption volume of the latest month by subtracting the accumulated consumption in the previous month from the new accumulated consumption that they have just finished reading. Then they find the water charge of the month by

referring to a quick tariff computation table. The total amount due, which is summation of the due outstanding of previous month and the current month charge, is calculated by meter readers and is written on the billing form.

④ Bill delivery

Meter readers hand out the completed bill to the customer when the customer is present. If not, the bill is dropped into the post box or the door's crevice.

⑤ Posting of reading records of bill stubs to ledgers

After the bills are delivered to the customers, the stubs of billing form are left to the meter readers. The reading records are carbon-copied on the stubs. Upon coming back to the Area Office, clerical staff and meter reader inspector post those reading records from the bill stubs to Meter Reading Record Sheets. The Meter Reading Record Sheets are kept at the Area Office. The bill stubs are forwarded to the Billing Section of the DGM Commercial Division for data entry and processing.

⑥ Data processing

The bill stubs contain billing data, whether they are actually read or estimated, and the reason of estimation if estimated. There are other transaction data such as customer payments during the previous month. Those data are entered and processed at the DGM Commercial Division to produce printouts in which customers' consumption data are shown. Those printouts are sent back to the Area Offices.

⑦ Data validation

The printout data are checked at the Area Offices. In case that consumption data seem to be anomalous, the meter readers in charge or the meter reader inspector may be sent to the customers to clarify the reason. Validated printout data are sent back to the DGM Commercial Division.

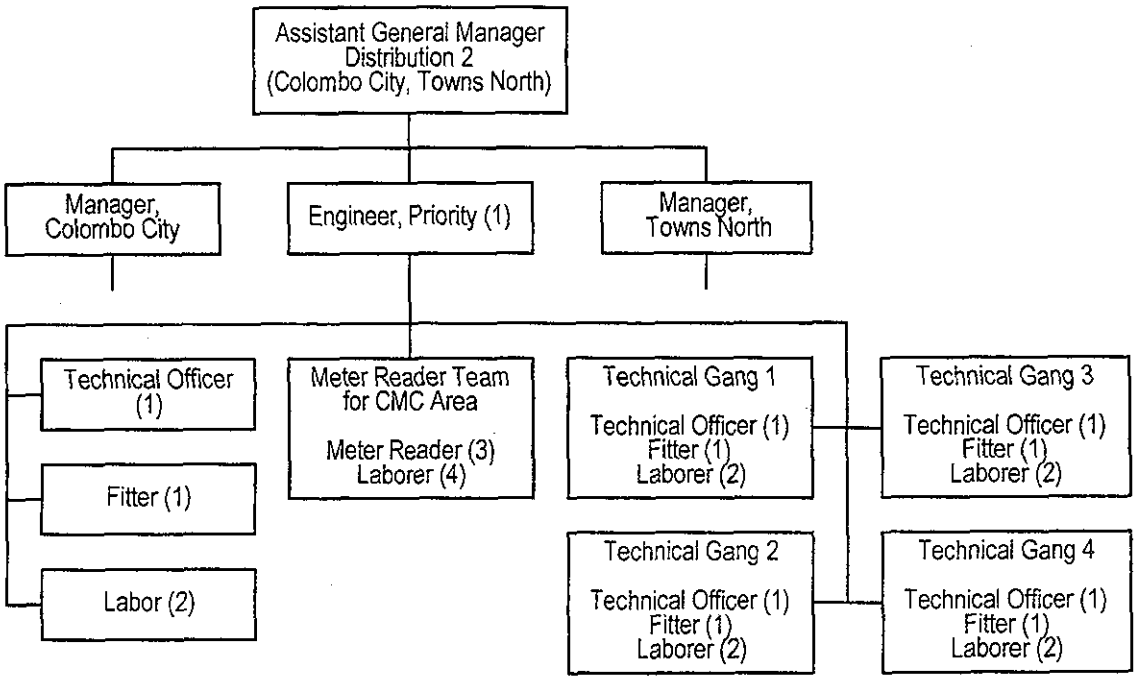
⑧ Production of billing forms

Based on original meter reading records and correction at the Area Offices, half-completed billing forms for subsequent month are prepared by Billing Section of DGM Commercial Division. Those billing forms are forwarded to the Area Offices.

1.3 Meter Reading and Billing System for Priority Users

Meter reading and billing for priority users are carried out at Engineer, Priority and Leak Detection Section (Figure 4). There are three meter readers and four labourers to cover meter readings and billings in CMC area. One of the meter readers covers high-consumption priority users in CMC area. The other two meter readers are charged with low-consumption priority users. The meter readers go to meter reading with one of the labourers. The labourers assist the meter readers, opening heavy lids of bulk meters and wiping counter panel covered with mud. Priority users outside CMC area are attended by four Technical Officers and their gangs.

Figure 4 Organization around Engineer Priority Section



Numbers in parenthesis indicate the number of staff deployed as of Nov. 2000.

The meter reading and billing process for priority users are depicted in Figure 5. Although that looks almost same as the path for non-priority users (Figure 2), there are some differences in steps and applications, which are summarized in Table 3.

Figure 5 Meter Reading and Billing Path for Priority Users

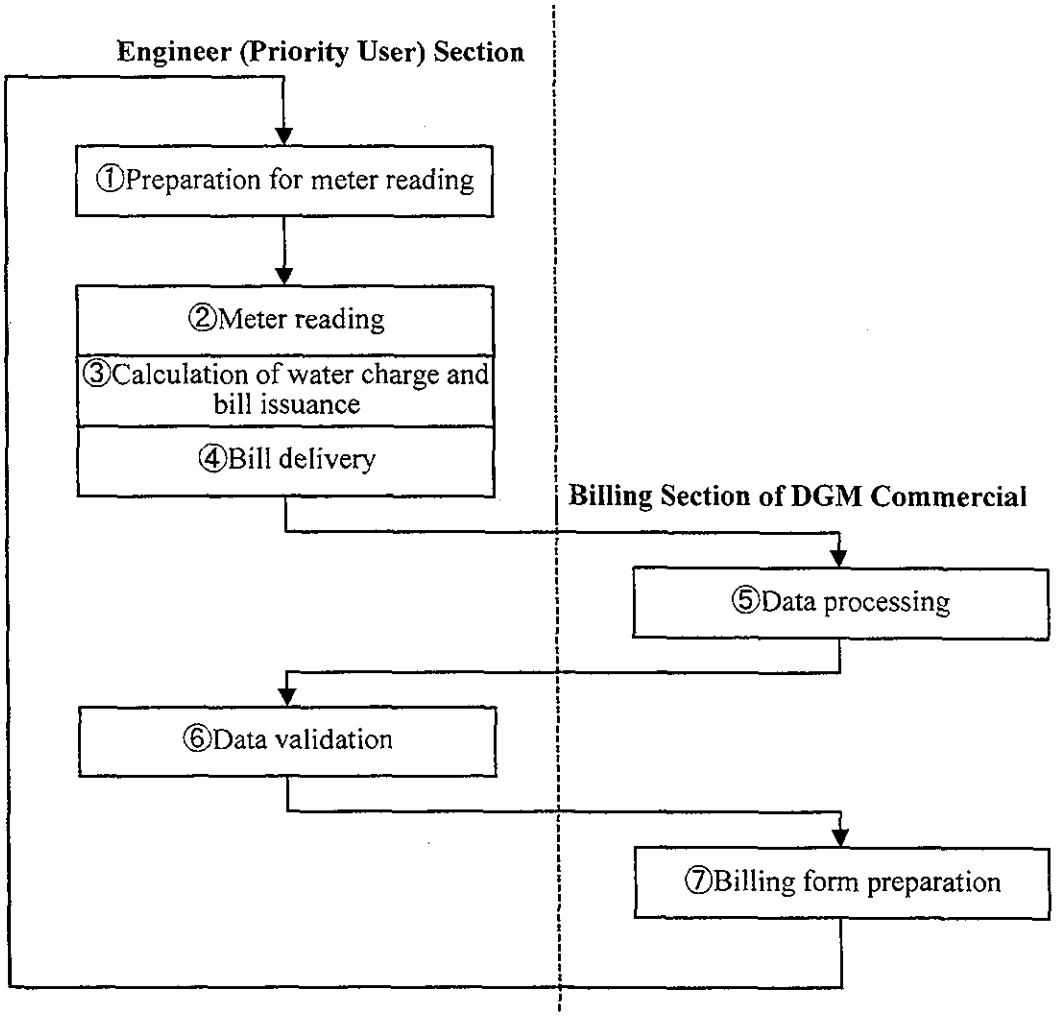


Table 3 Difference in Meter Reading and Billing System

	Non priority user	Priority user
Reading cycle	4 cycle per month	1 cycle per month
Meter recording book	Still in use	Not used
Spot billing	Yes	About 5 % of bills are not issued on the spot.
Allowance paid to meter readers	- Piece rate (Rp. 5 per reading in excess of 1450 reading per month) - Delivery allowance (Rp. 1 per bill) - No overtime work allowance	- No piece rate - No delivery allowance - Overtime allowance is paid

Under the four billing cycle system, customers who meter readers visit are divided into four batches. By processing billing data in four batches a month, the data processing capacity at

DGM Commercial Division is more efficiently utilized than before. In addition, the workloads of meter reading in the four billing cycle system are more evenly spread over a month. By this way idling period that meter readers used to have in the one billing cycle system decreased to certain extent and additional workable time has been created. The meter reading cycle for priority users is still one cycle. This is because the number of priority users assigned for one meter reader is small compared with that of non-priority users. If that would be further split into four groups, visits to customers might become inefficient.

Meter recording books are still used in the Area Offices. Meter recording data are stored at the database and accessible from all the Area Offices, however due to limitation of hardware and networking system, manually recorded data are still needed at the Area Office level.

Some of priority users are not spot-billed. Some priority users have their meters installed far from the administration section. Therefore, sometimes the meter readers cannot simply hand out a bill to a security guard or a receptionist who works near the meter. Also, certain governmental offices require the meter readers to follow time-consuming administrative procedures for a water bill to be delivered to the right place. To such priority users, the meter readers only record the consumption on the spot, and prepare bills back in the office. The bills prepared in such a way are forwarded to DGM Commercial Division, that handles mailing.

The meter readers for non-priority users receive the piece rate of Rs. 5 per reading in excess of 1,450 monthly reading. The delivery allowance is Rs. 1 per bill delivered on the spot. The meter readers for priority-users are entitled to receive neither of them.

1.4 Problems of Meter Reading and Billing System

(a) Control over meter readers

Under the current organization structure of CB1 Area Office, the meter readers and the meter reader inspector are subordinate to the Commercial Officer. The Commercial Officer can set the load of each meter reader, but by nature of job, the control over the meter readers hardly exists once they have left the office. The role of the meter reader inspector is nominal. Unlike the job title, he does not inspect the performance of meter readers. He usually does clerical works at the office, checking the stubs of billing form brought by the meter readers, posting those reading records from the bill stubs to Meter Reading Record Sheets, and arranging Meter Reading Sheets in order.

(b) Estimated reading

One of the symptoms caused by inadequate control over meter readers is the high rate of estimated readings. Table 4 shows the classification of customers based on how their meters are read by meter readers of NWSDB. In CB1 area, 37 percent of non priority users are billed on the estimated consumption. Some of estimated readings are attributable to problems of meter itself such as broken gauge and due formation inside meter. Others stem from external factors such as inaccessibleness to meter caused by inappropriate connection work, ongoing construction work, parked car, etc. Although no statistics are available, it is said that negligence of meter readers also contributes to the high rate of estimated readings. Under the current salary structure, the meter reader receives the piece rate allowance that is related to the number of customers to whom the meter readers issue the bills. If the number of bill issuance is same, the piece rate allowance amount is also same whether they are estimated or actually read

Table 4 Customer Classification by Meter Reading

As of Aug. 2000

		CB1		CB2		CB3		Total CMC	
		No. of connect.	%	No. of connect.	%	No. of connect.	%	No. of connect.	%
Non Priority Users	Normal	15,318	52%	12,429	55%	18,706	69%	46,453	59%
	Unmetered	614	2%	655	3%	1,400	5%	2,669	3%
	Estimated	10,773	37%	7,516	34%	6,267	23%	24,556	31%
	Disconnected	2,620	9%	1,808	8%	774	3%	5,202	7%
	Sub total	29,325	100%	22,408	100%	27,147	100%	78,880	100%
Priority Users	Normal	360	73%	350	83%	403	81%	1,113	79%
	Unmetered	0	0%	0	0%	0	0%	0	0%
	Estimated	48	10%	33	8%	20	4%	101	7%
	Disconnected	82	17%	40	9%	72	15%	194	14%
	Sub total	490	100%	423	100%	495	100%	1,408	100%
	Total	29,815		22,831		27,642		80,288	

(c) Computation error in spot billing

Under the spot billing system, handling a quick tariff table and a pocket calculator at meter sites requires meter readers more brainwork and handwork than before. Some erroneous entering may be reduced because the determination process of billing amount requires meter readers to follow a logical computation. However, the computation error cannot be eliminated even a pocket calculator is used. In fact, the use of a pocket calculator is not strictly required. Instead, many computations in spot billing are still done on paper or in meter reader's mind. The data

of meter readers' computation errors is not available because the computer system is not developed to distinguish meter readers' errors and errors originated in the system.

(d) Meter reader's capability

The Training Center under the AGM Manpower Development and Training is presently charged with employee training. There are two types of training course available to meter readers. One is called "orientation course" which is an induction course for newly employed meter readers. This course covers both technical aspects as to how to read meters and consumer relation aspect as to how to deal with customers. The other is called "refresher course" which is for experienced meter readers and covers both technical and commercial aspects in billing and collection.

Table 5 shows training courses executed in 1999 and 2000. In 2000, only spot billing courses have been executed. With the introduction of the spot billing system in Greater Colombo in 1999, meter readers in this area were convened to acquire further knowledge and skills such as computation and data entry steps to issue the bills on the spot. A meter reader is supposed to attend a refresher course every two years. Considering the refresher course is only one-day course covering extensively from technical to commercial aspects, this frequency is regarded minimal.

Table 5 Training Course for Meter Reader

Year	1999		2000 Jan.-Sep.
Course	Customer relations	Spot billing	Spot billing
No. of courses	7	8	11
No. of participants	82	150	172
Duration (day)	1	1	1
Total Man-Days	82	150	172
Participants from CB1	0	14	0
Participants from Engineer, Priority Sec.	0	4	0

1.5 Recommendation on Meter Reading and Billing System

Table 6 summarizes corrective measures to improve the problems identified in meter reading and billing system. Each recommendation is further explained in subsequent paragraphs.

Table 6 Recommendation on Meter Reading and Billing System

Problems	Recommendation
Control over meter readers	• Create a meter reader inspection section outside Area Office
Estimated reading for non priority user	• Establish a special reading team (night time and week end reading) • Introduce self-reading system + periodical check by NWSDB • Introduce a penalty for dishonest or negligent reading + Revise the piece rate • Modify the list of 25 reasons on the reverse of billing form and use the cause data more efficiently
Computation error of spot billing	• Promote maximum use of calculator by finding or devising a board with built-in calculator • Enable the data processing system to isolate meter reader's error + Increase the piece rate + Introduce a penalty for miscomputation
Meter reader's capability	• Increase the number of training courses, focusing on (1) practical ways of reading difficult meters and reducing miscomputations, and (2) ethics • Introduce uniform • Equip meter readers with a set of tools

(a) Control over meter readers

A meter reader inspection section should be established, not within the Area Offices but under a superior authority to the Area Engineers for example, Manager Colombo City or DGM, Greater Colombo. The meter reader inspection section selects customers randomly or out of dubious estimated billing-customers and actually reads their meters. By this way, the meter reader inspection section can check whether or not the reason of estimated billing was appropriate. Punitive rules should be established for the cases where the estimated billing is judged groundless and attributable to the meter reader's negligence.

(b) Estimated billing for non priority users

A special meter reading team should be established. That team will cover customers by continuous estimated readings due to the customer's absence at home. The team will visit those customers on night and weekend.

For chronically absent customers, the self-reading system could be also introduced. The customers will be given pre-notice of meter reader's next visit date and stickers. Before the

visit date, the customers themselves read their meters, enter the data in the sticker, and put the sticker outside house where visible to meter readers.

A penalty for dishonest or negligent reading should be imposed on meter readers. But this has to go with the establishment of a meter reader inspection section, which can detect negligence. The current piece rate also needs revision in compliance with a new load per meter reader and an expected rate of penalty per meter reader.

The present billing form has the list of 25 reasons of estimated reading and on the reverse side. Meter readers are supposed to indicate the number of reason when they estimate. The 25 reasons shown in the current billing form need streamlining. It is unpractical for meter readers to select the reason out of so many choices. If the reasons were logically grouped into fewer items, the subsequent data processing would be more efficient and the resultant statistical data would be more reliable and useful.

(c) Computation error of spot billing

Spot billing is an economical and the fastest way of issuing bill. However, as long as a human being performs a critical part of computation, computation error is inevitable. Promoting calculator is the only way to reduce errors. However understandably meter readers are reluctant to use a calculator for apparently simple computations and it takes time if they do. It is therefore important to provide a neat device to meter readers so that they do not feel inconvenience in using a calculator habitually. A board with built-in calculator is one of the examples. Or a normal calculator can be just glued to a board that meter readers always use.

The present data processing system is able to figure out the computation error rate for each meter reader. By making use of this data, a penalty for miscomputation should be imposed on meter readers. However, the current piece rate also needs revision in compliance with a new load per meter reader and an expected rate of penalty per meter reader.

(d) Meter reader's capability

The principle is that a meter reader reads a meter and issues a bill honestly and correctly. Other functions such as handling customer's complaint and finding dubious connections should not be considered as a meter reader's main job. There should be a one-day refresher training course for all meter readers at least once a year. The course should have two focuses. The first focus should be to teach and hear from meter readers about best practices on how to read

difficult meters and issue correct bills by reducing miscomputations. The second focus should be work ethics as a meter reader.

Introduction of uniform is a way of boosting meter reader's morale. A set of work cloths also enables a meter reader to work more efficiently and gives him a sense of certain degree of tension, which is necessary for executing his task diligently. Customers can easily recognize a meter reader in uniform, which works favorably for meter reader's job.

Meter readers should also be issued with adequate tools to make problematic meters readable. The tools should include a small iron hook and a torch.

1.6 Outsourcing of Meter Reading and Billing

In order to establish an efficient organization, other than strengthening the existing organization itself, there are always options of outside entrustment such as outsourcing, Private Sector Participation, formation of subsidiary, etc. Meter reading, billing, and collection systems can be considered in a same way. In fact, NWSDB has already contracted out a part of bill collection to banks and some post offices.

Meter reading and billing has not yet been contracted out. However the Corporate Plan (1999 - 2005) sets out activities considered for Institutional Strengthening, one of which is formation of a subsidiary company to facilitate ①provision of consumer connections, ②carrying out disconnections, ③construction of extensions to distribution systems, and ④meter reading activities.

To form a public company as subsidiary and to transfer some functions to the company may require legal steps. Although an opinion of legal specialist should be obtained, the procedural steps are regarded as follows if the provisions of the Companies Act No. 23 of 1987 are invoked:

① A decision of the Cabinet of Ministers that a company should be incorporated to take over the functions of a part of NWSDB.

② The Minister of Urban Development, Construction and Public Utilities' forwarding of required documents to the Registrar of Companies.

③ The Registrar of Companies' gazzetment declaring of formation of the company and takeover of the function of that part of NWSDB

Before going to subsidiary option or outsourcing option, it is necessary for the NWSDB to implement various corrective measures recommended here. Later the know-how and the personnel can be transferred to the subsidiary or the outside contractor.

When NWSDB initiates the evaluation of subsidiary or outsourcing option, it is also necessary to perform a series of non-legal analysis that covers the following:

- Functions deemed suitable for transfer or outsourcing
- Comparison between subsidiary option and outsourcing option
- Organization and staff planning
- Estimate of capital costs required at commencement of operations
- Estimate of recurrent cost
- Estimate of revenue
- Cost/Benefit analysis

2 Collection System

2.1 Collection Process

The collection process is illustrated in Figure 6. Both priority users and non-priority users are basically under the same collection system. Activities performed in each step of meter reading and billing path are explained in subsequent paragraphs.

① Receipt of bill

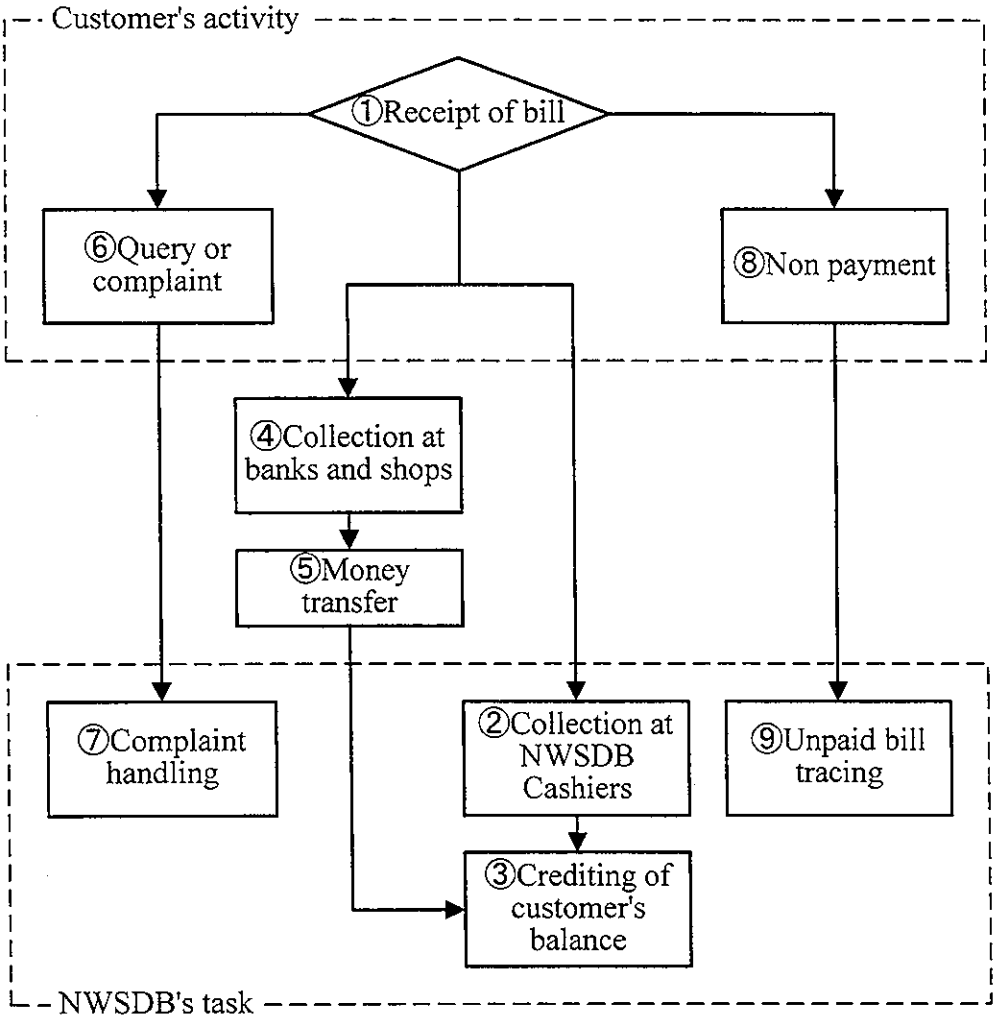
As the spot billing system has been introduced, most of bills are delivered to the customers upon meter reader's reading.

② Collection at NWSDB Cashiers

Currently there are three types of collection point, which are NWSDB cashiers, banks, and other selected shops. The due date is set at 21 days after bill issuance date. There exist a rebate for prompt payment and a surcharge for late payment. NWSDB's Headquarter and

each Area Office have the cashier window. At the NWSDB cashiers, both cash and check are accepted. Customers can go to any of the cashiers of NWSDB and pay the bill.

Figure 6 Collection Process



③ Crediting of customer's balance

After a customer's payment is confirmed, NWSDB credits the customer's due balance. Customers can pay more than the due amount, in which case, they have credit balance in their accounts. There exist a rebate for having certain level of credit balance.

④ Collection at banks and shops

Customers can pay the bills in cash also at major banks, selected private offices and private shops. At certain banks, telephone payment and internet payment is also accepted

⑤ Money transfer

Banks charge no commission for bill handling and money transfer. Instead, money collected from customers can be pooled at the banks until the first working day of the subsequent week of the customer's payment. Private offices and shops are paid certain handling fees by NWSDB, instead, money collected has to be transferred to NWSDB by the next working day of the customer's payment.

⑥ Query or complaint

If non priority customers have uncertainties to their billed amounts, they may ask or complain to the Area Engineer for revaluation. Priority customers can ask to the DGM Commercial.

⑦ Handling of queries and complaints

Non-priority customers can make questions or complaints regarding bills to the Area Managers. From priority users, DGM Commercial Division receives questions and claims. The Engineer Priority Section handles technical complaints from priority users such as broken meter and leakage.

⑧ Non payment

Some customers do not pay the bills properly. For example, meter readers visit disconnected customers who have still arrears to check if they are not reconnecting illegally and to deliver to them the bills of arrears. Many of those disconnected customers are usually not found and their bills are simply left to the premises.

⑨ Tracing of unpaid bills

The Credit Management Section of the DGM Commercial Division monitors outstanding arrears of priority users. It is the Commercial Officers of the Area Offices who are in charge of reduction of arrears. The Commercial Officers monitors the level of arrears in his area and carry out disconnection program periodically, following the collection target set by the DGM Commercial Division. If a customer's outstanding arrears exceed certain limit, depending on the amount, the delinquent customer receives either a reminder letter or a disconnection notice. Non-payment after disconnection notice will result in disconnection. Due to limited disconnection capacity of Technical Gangs under the Area Offices and the Engineer, Priority Section, the water supply is often not disconnected until long after the disconnection notice. For customers who still do not pay within a month of disconnection, a legal action notice is sent. If those customers do not possibly pay within

14 days from the notice, the DGM Commercial Division takes over the handling and initiates a legal action for recovery of the arrears.

2.2 Problems of Collection System

(a) Lower collection efficiency of non priority users

Table 7 shows the billing, collection, collection efficiency, and arrears of CMC area. The collection efficiency is to indicate collectibility of billing, which is defined as : Collected amount ÷ Billed amount. The nearer to 100 percent, the better. Theoretically the collected amount should be recovery from the original bills. However, NWSDB uses collected amounts and billed amounts during a same period in computing the collection efficiency due to limited traceability of billing data. Also customers can pay future water bills in advance, which are included in collections in current period. Therefore, the collection efficiency can sometimes exceed 100 percent.

Table 7 Billing and Collection Data in CMC Area

(Rs. Million)

		Billing (Jan.-Sep. 2000)		Collection (Jan.-Sep. 2000)		Collection efficiency	Arrears (Dec. 1999)		Arrears (Sep. 2000)	
Non Priority Users	CB1	95	14%	84	13%	89%	126	26%	131	27%
	CB2	85	12%	77	12%	91%	116	24%	119	25%
	CB3	135	20%	127	19%	94%	109	23%	115	24%
	Sub total	314	46%	288	43%	92%	350	73%	365	76%
Priority Users	CB1	139	20%	137	21%	99%	39	8%	34	7%
	CB2	129	19%	140	21%	109%	61	13%	49	10%
	CB3	96	14%	98	15%	103%	30	6%	31	7%
	Sub total	363	54%	375	57%	103%	130	27%	115	24%
Total CMC		677	100%	664	100%	98%	480	100%	479	100%

The CMC data show that non priority users pay less loyally than priority users do. The collection efficiencies of non priority users and priority users are respectively 92 percent and 103 percent from January through September 2000. As a result, the arrears of non priority users accumulated much more than those of priority users. The non priority users have arrears of 11 months billing, while the priority users have 3 months.

Table 8 shows a breakdown of arrears. In terms of age, arrears of over 1 year are majority, accounting for 76 percent in non priority users. Customer category wise, domestic users and commercial users of have biggest shares in non priority users, both accounting for 44 percent.

Table 8 Breakdown of Arrears in CB1

As of Sep. 2000

	Current mth (Rs. Million)	2-6 month (Rs. Million)	7-12 month (Rs. Million)	Over 1 year (Rs. Million)	Total (Rs. Million)	(%)
Non Priority Users						
Domestic users	3.9	11.5	10.0	31.8	57.2	44%
Board quarters	0.0	0.0	0.0	0.0	0.0	0%
Government schools	0.1	0.0	0.0	0.0	0.1	0%
Government quarters	0.1	0.3	0.4	1.1	1.9	1%
Stand posts	0.0	0.0	0.0	0.2	0.2	0%
Tenement gardens	0.0	0.0	0.0	0.1	0.1	0%
Government institutions	0.4	0.8	0.5	1.9	3.5	3%
Police	0.1	0.2	0.5	0.2	1.1	1%
CMC	0.3	0.2	0.0	0.0	0.5	0%
Commercial institutions	4.2	9.5	6.9	37.0	57.6	44%
Tourist hotels / Guest houses	0.0	0.0	0.0	0.1	0.1	0%
Industrial / Construction purposes	0.6	1.9	1.4	2.1	6.1	5%
Private institutions	0.0	0.6	0.1	0.4	1.1	1%
Religious and charitable organisations	0.1	0.1	0.1	0.3	0.6	0%
Free water	0.0	0.0	0.0	0.3	0.3	0%
Bulk bowser water	0.0	0.0	0.0	0.1	0.1	0%
Sub total	9.8	25.2	19.8	75.7	130.5	100%
Priority Users						
Domestic users	0.0	0.0	0.0	0.0	0.0	0%
Government schools	0.0	0.0	0.0	0.0	0.0	0%
Government quarters	0.0	0.0	0.0	0.0	0.0	0%
Government institutions	3.5	4.2	1.9	3.8	13.4	39%
Army	0.1	0.4	0.3	0.1	0.9	3%
Police	0.1	0.5	0.4	0.3	1.3	4%
CMC	0.3	0.0	0.0	0.0	0.3	1%
Commercial institutions	5.2	2.3	1.1	2.7	11.3	33%
Tourist hotels / Guest houses	1.3	0.6	0.0	0.0	1.9	5%
Shipping	2.3	0.0	0.6	0.0	2.8	8%
Industrial / Construction purposes	1.1	0.7	0.0	0.0	1.8	5%
Private institutions	0.1	0.0	0.1	0.0	0.2	1%
Religious and charitable organisations	0.0	0.2	0.2	0.2	0.5	2%
Free water	0.0	0.0	0.0	0.0	0.0	0%
Sub total	13.9	8.9	4.6	7.1	34.5	100%
Total CB1	23.7	34.1	24.4	82.8	165.0	

(b) Rebates and surcharge

Presently there exist prompt payment rebate, credit balance rebate, and late payment surcharge. The due date is set at 21 days after bill issuance date. The prompt payment rebate is applied to

those who pay their bills within about 15 days from bill issuance. By this rebate, current month's billing amount is reduced by 2 percent. The credit balance rebate is applied to those who have credit balance equal to or more than current month's billing amount. By this rebate, the current month bill is reduced by 4 percent. Those rebates however are not any more strong incentive for most of customers. The majorities of those who receive the rebates are considered not to expect the rebates themselves. They pay enough amounts in advance, trying to reduce the number of visits to NWSDB cashier or banks for payment, which happens to result in rebates.

Those who fail to pay the bills by the due date are subject to the late payment surcharge, whose rate is 2.5 percent per month of billing amount. This surcharge however, is not applied strictly because NWSDB cannot recognize the receipt in real time when the payment is made at banks or other shops. In fact, this surcharge is applied only when disconnected customers do not pay the arrears by the due date.

2.3 Recommendation on Collection System

Table 9 summarizes corrective measures to improve the problems identified in collection system. Each corrective measure is further explained in subsequent paragraphs.

Table 9 Recommendation on Collection System

Problems	Recommendation
Lower collection efficiency of non priority users	• Strengthen unpaid bill tracing and delinquent user handling • Introduce automatic transfer from customer's bank account
Rebates and surcharge	• Decrease rebate rates and finally abolish them • Apply late payment surcharge more stringently

(a) Lower collection efficiency of non priority users

It goes without saying the most effective method to improve the collection efficiency is to strictly enforce disconnection once the arrears reach the certain level. From the collection system's point of view, the present system is considered to have incorporated necessary measures. Further improvement can be materialized if the current system is run more rigidly. The computer network should be also improved so that the Area Offices can get useful information more smoothly.

Another effective method is to ask customers to use the automatic transfer of billing amounts from their bank accounts. This system is not popular in Sri Lanka, however, with the advent of new banking systems such as computer banking and internet banking, customer's mind is also changing. The customer's benefit from the automatic transfer system is the freedom from procedures of payment. However, it is imperative as a precondition that the NWSDB issue correct bills to the customers.

(b) Rebates and surcharge

The prompt payment rebate and the credit balance rebate should be abolished at the earliest convenience. It may however have another rate cut before abolishment, if grievance from customers is much stronger than expected.

On the other hand, the late payment surcharge should be applied more strictly. The computer system should be engineered so that delinquent users with more than 1-month-old arrears have to be located and surcharged properly.

APPENDIX 4D-3

INVENTORY MANAGEMENT SYSTEM

INVENTORY MANAGEMENT SYSTEM

1 Present Level of Inventory

The inventory of NWSDB, classified as "stocks and goods in transit" in the Balance Sheets mostly comprises pipes, bulbs, and equipment that are used for various capital projects. Those stocks of materials are held in a network of over 350 stores. Those stores are classified into 5 types:

① Transit Store-----The Main Store acts as a transit point and coordinates the distribution of stores items to Regional Support Centers, construction sites, and other operational units.
② RSC Stores-----One in each of the 5 Regional Support Centers. These act as the distribution centers for the stores network within a RSC.
③ Regional Stores managed by each of the Regional Offices-----Each Regional Support Center has around 2-4 regional offices.
④ Stores attached to each scheme-----They have items used for O&M activities.
⑤ Stores located at work sites (construction sites) and operational units-----They operate during the period of construction of schemes. These are either closed or are converted into O&M stores once the scheme is operational.

The level of inventory of the past two years is shown in Table 1. At the end of the year 1999, the inventory amounts to Rs. 1,709 Million, accounting for 28 percent of the current assets. This level of inventory is regarded rather high considering that the inventory has practically no liquidity. This high level of inventory further stands out when compared with the value of fixed assets, which is represented by property, plant and equipment plus construction work in progress. The inventory accounts for 6 percent of the fixed assets. Assuming that the average service life of the fixed assets is 30 years, this 6 percent is interpreted as roughly 2 year's value of fixed assets.

Table 1 Level of Inventory

Year end	1999	1998
①Stocks & goods in transit (Rs. Million)	1,709	1,752
②Current assets (Rs. Million)	6,128	5,344
③Property, plant & equipment + construction work in progress (Rs. Million)	30,716	27,099
①÷②	28%	33%
①÷③	6%	6%

Several factors account for the high level of inventory such as:

- Costing is not performed correctly;
- Order volume in procurement is beyond necessity;
- Lack of a policy or guidelines relating to the minimum and maximum levels for stock;
- Stock is frequently purchased with a percentage added for contingencies or maintenance;
- Redundant inventory is included without proper treatment

2 Inventory Management Policy and Action Plan

A task force was created in NWSDB in 1998, in order to identify issues to be discussed towards improvements to the stores and inventory management. The key issues identified included:

① Overall organizational arrangements
② Stock movement and related documentation
③ Stock records
④ Accounting treatment
⑤ Physical verification procedures
⑥ Inventory management information system
⑦ Audit of stores & inventory

In response to each key issue, recommendations were presented, which are summarized as follows:

① Overall organizational arrangements

- An inventory management policy should be developed for stores and inventory management in the NWSDB.
- Specific goals to be achieved with appropriate time frames need to be clearly identified with the overall policy framework.

- The inventory management function should be given a more prominent position in the organization structure of the NWSDB.
- A phased rationalization of stores needs to be undertaken. This will entail the analysis of the locations and types of stores needed by the NWSDB together with an assessment and recommendation of the type and quantities of stocks to be held at each location.
- The physical stores facilities need improvement. And overall strategy should be developed to construct new stores or improve existing stores facilities on a planned basis.

②Stock Movement and Related Documentation

- Storing and handling procedures need to be improved considerably and training need to be given for all levels of staff in the stores area.

③Stock records

- The procedure for disposal of excesses, damaged, obsoletes or slow moving stocks need to be defined and adopted in order to expedite the disposal of these items.
- The setting up of a costing function within the NWSDB is an immediate priority. Storekeepers should not be allowed to undertake costing functions and these duties should be transferred to the proposed costing unit(s).

④Accounting treatment

- The revision of the existing accounting treatment relating to stocks is urgently required. This will include:
  - ➢ Procedures to record movement of goods
  - ➢ Reconciliation of finance division ledger with those generated by inventory management system.
  - ➢ Provision for liabilities when goods are received at stores as opposed to at the time of payment
  - ➢ Treatment of differences which are identified at physical verification

⑤Physical verification procedures

- The physical verification procedures need to be formalized.
- The verifications should not only be limited to checking the physical existence of items reflected in the stock records but should encompass a wider objective where the condition of the stocks, the facilities available to store those stocks, the stock holding in relation to usage, etc. are reviewed by the teams.

⑥Inventory management information system

- A comprehensive stores recording and information system should be introduced throughout the NWSDB. The system should have the facility to provide management at all decision making levels with the up to date stock holdings at all stores locations of NWSDB.

⑦Audit of stores & inventory

- The internal Audit should take a more active role where it could be used as a monitoring and control mechanism in inventory management activities.
- The internal audit could be of assistance in the systems implementation stage and thereafter once the system is in place, through constant review to ensure that set procedure is clearly followed.

Some of those recommendations have been put into practice and some of them remain intact. As a result, the Action Plans 2001 have been prepared as shown Tables 2 and 3.

Table 2 Action Plan 2001 – Logistics Division

Item	Target	Responsible officer	Resources / Remarks
Establishment of quality assurance procedure	June 30	AGM Supplies, DGM Logistics, Additional G.M.	Present scheme to be reviewed.
Reorganization of central stores	Dec. 31	Ditto	Consultant service to be required. Estimated cost Rs. 20 Million.
Software development at Central Stores	June 30	Ditto	Consultant service to be required. Estimated cost Rs. 3.5 Million.
Computer Training	June 30	Ditto	Training to be given by AGM (MP&DT)
Creation of separate unit for redundant items & disposal of same	June 30	Ditto	Additional staff necessary

Table 3 Action Plan 2001 – Financial Division
(Items on Stocks Verification & costing, and Fixed Assets & Inventory)

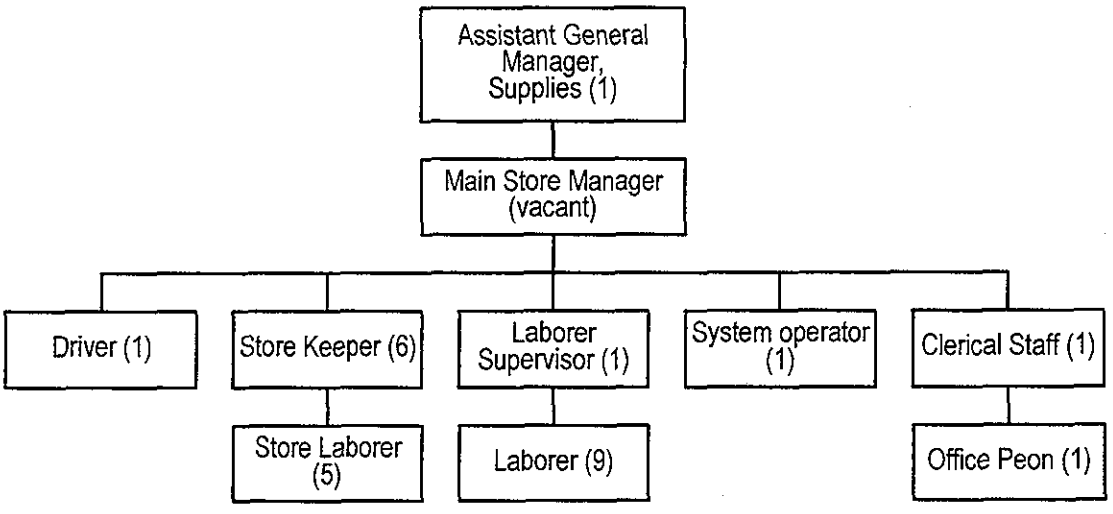
Item	Target	Responsible officer	Resources / Remarks
Complete verification in selected stores	Feb. 1	DGM Finance, G.M.	SMC approval is required for the new suggested procedure
Prepare a report of non-moving items etc.	Feb. 15	CA (Stores), DGM Finance	
Establish costing units at Head Office to cost imports and to monitor main stores	Feb. 1	DGM Finance, G.M.	Software package for costing / Since H.O. is involved in imports, it si necessary to establish the costing unit at H.O.
Establish costing units under the present regional accountants in the regions	Mar. 1	RSC (CA), AGM Finance	Clerical staff at regions / Instead of recruiting cost accountants to use the present set of accountants with clerical support.
Continuous verification to cover all stores within 2001	Quarterly	CA (Stores), DGM Finance	Training to be given by AGM (MP&DT)
Reconcile ledger accounts with verified balances	Mar. 15	CA (Stores), DGM Finance	
Appoint a committee to look into differences in verification	Mar. 20	DGM Finance, G.M.	
Obtain committee report	Apr. 20	DGM Finance, G.M.	
Prepare action plan for a proper verification for 31.12.2001	Sep. 1	CA (Stores), DGM Finance	
Complete verification of all Board vehicles	Jan. 1	DGM Logistics, GM	This is a requirement for the audit 2000
Update motor vehicle register and ledger accounts as at 31.12.2001	Feb. 1	CA (Stores), DGM Finance	This year we must update all our vehicles and reconcile all ledger accounts
Capitalize all completed work in progress as at 31.12.2001	Feb. 1	CA (Man), DGM Finance	All RSC DGMM and DGM Commercial need to support
Physically verify all inventory items and balance books	Dec.	Heads of Divisions, DGMM	
Prepare fixed assets schedule & depreciation for 2000	Feb.	CA (Stores), AGM Finance	
Prepare a complete fixed assets register for Board	June 1	CA (Stores), DGM Finance	Suitable software to prepare a complete FA register

3 Reorganization of Central Stores

The store reorganization program is yet to be materialized although it has been pointed out as a key activity to establish a better inventory management system. The delay in executing the store reorganization is because the GOSL's stringent spending policy affected NWSDB, delaying its major construction projects. In 2001 at last, the reorganization of Central Stores

will be implemented. The Central Stores are located approximately 2 kilometers from the Head Office. Currently 10 stores exist in an area of 6 acres of land. Those stores are collectively taken care of by 25 staff under AGM Supplies (Figure 1). The reorganization project is to construct buildings, drains, internal roads and storm water detention pond for the Central Stores Complex. An outside contractor to be selected by a local bid will undertake the construction. The new stores complex, composed of 7 stores, will replace 9 out of 10 stores. The construction period is divided into two stages and will last beyond 2001. The three stores are to be constructed in the stage 1 to accommodate ground water project equipment, chemical, and office equipment. In the stage 2, other stores will be constructed for pipes, fittings, pumps, electrical tools, meters, etc.

Figure 1 Staff Structure at Central Stores



- Numbers in parenthesis indicate the number of staff deployed as of Dec. 2000.
- AGM Supplies works at the Head Office, other staffs are deployed at Central Stores.

4 Software Development and Networking

The introduction of software and networking between the NWSDB Head Office and the Central Store are scheduled in 2001. The application software will cover inventory management and purchase management.

Development of inventory management system is phased process. In the first phase, only stocks stored at the Central Store are included in the system. Stocks stored at other regional stores may be integrated after confirming smooth introduction of a computerized database system at the Central Store.

Purchase management system will be also developed in the phased basis. In the first phase, purchases done by Head Office are included. Purchases done by Regional Support Centers will be integrated after launching the system at the Head Office.

A network is required to provide connection to the system form two buildings in the Head Office and the new Stores Complex. The network is to consist of a backbone linking distribution equipment, wiring linking workstations and printers.

The outside contractor in charge of constructing the Store Complex will subcontract a computer system engineering company to undertake the system construction.

5 Recommendation on Inventory Management

The Action Plan 2001 has been prepared in response to the key issues and the recommendations described in earlier chapters. Some of the key issues however, have not been even spelled out in the past action plan. However, to carry out the plan as scheduled means to solve many of the inventory management problems that currently exist. The current situation of progress toward inventory management improvement is summarized in Table 4.

Table 4 Progress of Inventory Management Improvement

IM item	Key issues	Evaluation on progress
Overall organizational arrangements	An inventory management policy should be developed.	- "Improvement of operational efficiency through reduction of NRW and resource optimization" is set out as a corporate objective, suggesting that IM is included here. - "Restructuring of central stores facilities" is listed as one of corporate activities for institutional strengthening.
	Specific goals to be achieved with appropriate time frames need to be clearly identified with the overall policy framework.	- Action Plan of sets target dates of some IM activities for only subsequent year.
	The inventory management function should be given a more prominent position.	- DGM Logistic, DGM Finance, and DGM Internal Audit have been reinforcing the IM functions.

	A phased rationalization of stores needs to be undertaken.	- After a few years delay, the construction of central stores complex will start in 2001.
	The physical stores facilities need improvement.	- Ditto
Stock movement and related documentation	Storing and handling procedures need to be improved and training need to be given for all levels of staff in the stores area.	- New slips were introduced in 1999 and the training courses were held to familiarize staff in charge with the use.
Stock records	The procedure for disposal of excesses, damaged, obsoletes or slow moving stocks need to be defined and adopted.	- Creation of separate unit for redundant items & disposal of same is identified in Action Plan 2001.
	The setting up of a costing function within the NWSDB is an immediate priority.	-Costing section was created in 2000 under DGM Finance. In 2001, costing unit will expand to regional level.
Accounting treatment	The revision of the existing accounting treatment relating to stocks is required. This will include (1) procedures to record movement of goods, (2) reconciliation of finance division ledger with those generated by inventory management system, (3) provision for liabilities when goods are received at stores as opposed to at the time of payment, and (4) treatment of differences which are identified at physical verification.	- Those accounting treatments have been put in practice.
Physical verification procedures	The physical verification procedures need to be formalized.	- Efforts have been made with some progress. Further corrective measures are identified in Action Plan 2001.
	The verifications should not only be limited to checking the physical existence of items reflected in the stock records but should encompass a wider objective.	- Efforts have been made with some progress. Further corrective measures are identified in Action Plan 2001.
Inventory management information system	A comprehensive stores recording and information system should be introduced throughout the NWSDB.	- Computerization of IM information system and networking will start in 2001 with a limited and reasonable scale.
Audit of stores & inventory	The Internal Audit could be of assistance in the systems implementation stage. Thereafter once the system is in place, the Internal Audit should take a more active role where it could be used as a monitoring and control mechanism in inventory management activities.	- Internal Audit has not been positively involved in preparation stage.

Based on the above evaluation on progress and the analysis of current situation, in order to establish a desirable inventory management system, it is recommended that NWSDB make further efforts to clarify or pursue the following points.

① Development of slips geared for computer data processing----------New slips for stock movement were introduced in 1999. Those forms should be adjusted or fine-tuned in accordance with a new necessity. The introduction of purchase and inventory management software will be the next timing. The new software should be able to avoid duplication of data entry task. Simultaneous printing function of necessary documents will be also required.

② Revision of stock code----------The present stock code used at the Central Store consists of seven alpha/numerics for stock item identification. The code has not been carefully planned and the allocation of item numbers has been conducted in an arbitrary manner with insufficient sub-classifications. As a result, the stock information cannot be sufficiently extracted from only the stock codes. The revision of existing stock code is vital, which should be done in cooperation with the inventory management software development.

③ Development of stock level guideline----------There is no policy or guidelines clearly set out concerning the minimum and maximum levels of stock in the stores. Stock is frequently purchased with a percentage added for contingencies or maintenance. It is said that the Central Stores accommodate more than 10,000 items at present. At least large value items or fast moving items should be selected and the stock level guidelines for each of them have to be established as a first step. This task should be paralleled or included in the development of inventory management software.

④ Separation of Transit Store, RSC Store, and Groundwater Store----------The new stores complex will be composed of three operational units, which are transit store, RSC store of Greater Colombo, and groundwater equipment store. The stocks stored in the transit store will be controlled under DGM Logistics. The stocks in the main store of RSC Greater Colombo and the ground water equipment store are respectively controlled under DGM Greater Colombo and DGM ADB/Rural Water Supply. Ideally it is better for each operation unit to have exclusive stores so as to avoid mixing up of similar inventory items belonging to different operational units. In fact, the groundwater equipment store will be stand-alone. However, the transit store and the RSC store will share some buildings due to

space and cost problems, in which case, careful mapping of store space and strict system to locate stored items should be established.

⑤ Improvement of physical verification procedure----------The main objective of physical stock verification is to ensure stocks as per ledger physically exists in stores or vice versa. It has been said that the annual physical verification procedure at NWSDB is not sufficiently conducted due to various reasons, by which inaccurate inventory valuation has been overlooked. Efforts have been made to correct the situation by DGMs Logistics, Finance, and Internal Audit. Further corrective actions should take into account the following recommendations:

- Verification teams should consist of persons independent of the stores functions having engineering background and be familiar with verification procedures.
- Counterpart verifiers should be also conversant with stores accounting.
- Time allocated to perform verification should be sufficient, in consideration of the large number of stocked items.

⑥ Creation of separate unit for redundant items & disposal---------It is said that some items are overstocked and are not fully scrutinized by the annual verification procedure. The overstocking is partly because the officers responsible for purchase can increase the quantities of goods to be purchased in order to have stock available with a percentage added for contingencies or maintenance purposes. Under the present system, the surplus stock after project completion is not usually returned to the Central Store from regional stores. The surplus stock is supposed to be disposed off by sale or tendering, but this rule has not been entirely enforced. As listed in Action Plan 2001, the creation of unit for redundant items & disposal is necessary to improve the situation.

⑦ Consideration of safety of stores personnel----------Presently the safety of store staff is considered to certain extent only when handling heavy equipment or chemical items. However sufficient consideration is not given to cover slighter tasks at the stores. Further effort should be made to issue adequate safety gear and routinize its wearing.

⑧ Conceptual design of chemical store---------One of alternative concepts in designing the chemical store is "Strict FIFO base system", which was proposed in 1999. Under this concept, incoming new materials are placed nearby the receiving end. Outgoing old materials are placed nearby the dispatch end, from which the materials are loaded for

dispatch. This means that stored materials have to be moved continuously toward the dispatch end as the materials become older. That concept is not recommendable because of higher storage cost and greater risk associated with frequent moving of chemical substance. FIFO control should be supported by other means such as precise application of bin cards and logical location system of stored items.

APPENDIX 4E

NRW MONITORING SYSTEM FOR CB1

APPENDIX 4E-1

METHODOLOGIES PROPOSED FOR MONITORING BY NWSDB

APPENDIX 4E-1 METHODOLOGIES PROPOSED FOR MONITORING BY NWSDB

My No:

NRW Project Unit
Telawala Road
Ratmalana.

11 July, 2000

Project Manager (SAPS)

Methodology to establishing Non Revenue Water in CB1 area (Colombo City)

The proposed methodology of measuring non-revenue water in CB1 area is as given below:

The non revenue-water is established by the total integrated flow method which is defined as the difference between the total quantity supplied to the distribution system and the total quantity billed by meter reading, estimating, billing as unmetered basis.

The inflows & out flows are obtained by meter readings of the district. The water meters are installed at the following spots for measuring flows into the zone and out of the zone. Besides this, boundary valves are provided for the isolation of the zone. The locations of these boundary points are given in the attached drawing. The locations of the meters are as follows.

	Location	Address & Pipe Size	Meter Type	Flow Direct. In/Out	
1	DM1	T20 Wellampitiya Bridge, 20"	Telemetry	In flow +	+
2	DM2	D20 Wellampitiya Bridge , 20"	Telemetry	In flow +	+
3	DM3	S 20	Insertion	In flow +	+
4	DM4	Maradana Bridge Opp. Railway St., Maradana , 27"	Insertion	In flow +	+
5	DM5	D.R. Wijewardena Mw. Gamini Hall Junction (Shipping Line), 20"	Insertion	In flow +	+
6	DM6	New Kelani Bridge Ferguson Road, 6"Ø	Bulk Meter	In flow +	+
7	DM7	Base Line Rd, Orugodawatta Junction, 10"Ø	Insertion	Out flow -	-
8	DM8	Jayantha Weerasekara Mw. 6"	Bulk Meter	Out flow -	-
9	DM9	Jayantha Weerasekara Mw. 15"Ø	Insertion	Out flow -	-
10	DM10	D.R. Wijewardena Mw Opp Lake House, 12"Ø	Insertion	Out flow -	-
11	DM11	Baladaksha Rd, Galle Face 8"Ø	Bulk Meter	Out flow -	-

Mr. Sawara. (Team Leader)
Forwarded for n.a. Please.
P.M. (12/07/00)

The Boundary Valves that will be closed as follows :

		Location
1.	D.R. Wijewardena Mawatha/T.B. Jaya Mawatha 3"Ø -	BV1
2.	Sir Chittampalam Gardiner Mawatha Opp. Regal Hall 4"Ø-	BV2

Quantity supplied per day

Let the quantity supply to CBI area = DM1+DM2+DM3+DM4+DM5+DM6

Let the quantity flows out from CBI = DM7+DM8+DM9+DM10+DM11

∴ The total quantity distributed in CBI area = (DM1+DM2+DM3+DM4+DM5+DM6) - (DM7+DM8+DM9+DM10+DM11)

= DM m^3/d

Quantity consumed per day

The consumption is categorised mainly into; priority consumers, non-priority consumers and public stand posts; whose daily average consumption; could be obtained from the billing facilities available in the Commercial Section.

Let the consumption of priority consumers be = C1 m^3

Let the consumption of non priority consumers be = C2 m^3

Let the consumption of stand posts = C3 m^3

∴ Total consumption (C) - C1 + C2 + C3 m^3/d

Non Revenue Water

If C is the total consumption of the CB1 area and DM is the net quantity supplied into CBI,

$$\text{Then NRW} = \frac{\text{Total net supply} - \text{Total billed consumption}}{\text{Total net supply}} \times 100$$

$$= \frac{DM - C}{DM} \times 100$$

Please note that the boundaries of CB1 billing area was fixed by this Unit in the year 1999 with the commencement of spot billing to take the consumption within the zone precisely

The flows into the system will be measured for a week period and the daily average flow will be established. For the measurement, insertion meter, telemeter and bulk meters will be used. To measure the quantity flows out from the CB1 area, bulk

meters, insertion metes will be used as shown in the table along with programmed data loggers of the software package of Spectrascan.

Once this Unit establishes the NRW percentage of the area as the bench mark level at the initial stage, the effects of future non revenue water reduction activities will be assessed on calculating the percentages monthly.

It is highly appreciated that the Consultant would study this proposal and comment for any further improvements or alterations please.

D Hewage

AGM (NRW)

Copy to	-	DGM (GC)	-	f.i.p
		AGM (JPU)	-	f.i.p
		AGM (CC/TNC)/ M (CC)	-	f.i.p

APPENDIX 4E-2

RESULTS OF EXAMINATION AND RECOMMENDATIONS

APPENDIX 4E-2 RESULTS OF EXAMINATION AND RECOMMENDATIONS

No.	Diameter (inch)/ Material/Function	Location of Water Meter	Existing Condition	Recommendation	Remarks	Inflow (+) / Outflow (-)
BM 1	20/CI/T	Ambatale Junction	A bulk meter has already been installed in a meter chamber; the meter is connected to the telemetry system.	It is recommended to confirm that there is no existing connection between Ambatale Junction and CB1 boundary.	"Triplicate Main"	+
BM 2	20/CI/T	Under Wellampiyiya Bridge	A bulk meter has already been installed in a meter chamber; the meter is connected to telemetry system; digital display is available locally.	It is recommended to confirm that there is no existing connection between Wellampitiya Bridge and CB1 boundary.	"Duplicate Main"	+
BM 3	20/ST/T	Under wellampitiya Bridge	A bulk meter has already been installed in a meter chamber; the meter is connected to telemetry system; digital display is available locally.	Since many connections exist between Wellampitiya Bridge and CB1 boundary, it is recommended not to use the existing bulk meter but to install an insertion meter at the CB1 boundary. In this case, a 2-inch ferrule and a meter chamber needs to be provided at the CB1 boundary.	"Steel Main"	+
BM 4	27/CI/D	Located on a platform by the side of Maradana Bridge and above railway line.	A 2-inch ferrule has already been provided in a meter chamber.	An insertion meter needs to be installed.	From Maligakanda to Fort	+
BM5	20/CI/D	Located on parking area away from the road (embankment of canal) at the Maradana end of D.R. Wijewardene Road	Although an 1-inch ferrule is already in place, it is completely buried underground without a meter chamber.	Due to the existence of many existing underground cables around the pipe, it may be not possible to construct a water meter. It is therefore recommended to construct a meter chamber at other location and provide a new tapping in the chamber.	Shipping line from Maligakanda to Harbor	+

BM 6	6/ PVC/D	Under New Japanese Friendship Bridge at Ground level	Although a bulk meter has already been installed in a meter chamber, the chamber is completely buried underground because of the bridge construction work. Working condition of the meter is unknown.	The meter chamber should be raised and working condition of the bulk meter needs to be confirmed.	Supply from TNC	+
BM7	10/DI/D	On the Walkway of Orugodawatta Bridge on Baseline Road	An 1-inch ferrule has been provided at only few inches deep from the ground surface.	An insertion meter needs to be installed. Construction of a meter chamber may not be necessary at this place, as RDA agrees that it will provide loose tiles above the tapping for meter installation.	Supply to Baseline Rd.	–
BM8	6/CI/D	At the center divider of Jayantha Weerasekara Mawatha, immediately close to Maradana Junction	No provision has been made.	A meter chamber needs to be constructed and a bulk meter should be installed in the chamber. It may be necessary to construct the meter chamber partly under the roadway.		–
BM9	15/CI/D	At the walkway/ road curb of Jayantha Weerasekara Mawatha , very close to Maradana Junction	No provision has been made.	A meter chamber needs to be constructed and an 1-inch tapping should be provided in the chamber. It may be necessary to construct the meter chamber partly under the roadway. (CMC permission for excavation and construction of the meter chamber has already been obtained.) An insertion meter needs to be installed for flow measurement.		–
BM 10	12/CI/D	On the walkway of D.R. Wijewardene Mawatha, opposite Lake House	No provision has been made.	A meter chamber needs to be constructed under the walkway and an 1-inch tapping should be provided in the chamber. (RDA permission for excavation and construction of the meter chamber has already been		–

				obtained.) An insertion meter needs to be installed for flow measurement.		
BM 11	8/CI/D	Baladaksha Mawatha, Galle Face	An 8-inch bulk meter has already been installed in a meter chamber.	A permission from the Army may be required for meter reading, as the site is located just inside the security wall of the Army Headquarters.	Bulk supply line to the Army Headquarters	
BV 1	3/CI/D	D.R. Wijewardene Mawatha,/T.B. Jayah Mawatha and partly under multi-storied buildings	A valve has already been installed with a surface valve cover.	The closure of this valve may result in the interruption of service in the areas between the valve and CB1 boundary. If it is the case, it is recommended to end-cap this distribution main at both sides of the canal.		
BV 2	4/CI/D	Chittampalam A. Gardiner Mawatha, Opposite Regal Cinema	A valve has already been installed with a surface valve cover.	This valve needs to be shut off to isolate CB1 area. However, if many service connections exist between the Lake House Roundabout and Inland Revenue Dept., it is recommended to install a new valve on the CB1 boundary.		

BM: Boundary Meter, BV: Boundary Valve, CI: Cast Iron, ST: Steel, DI: Ductile Iron, PVC: Polyvinyl Chloride, T: Transmission, D: Distribution

APPENDIX 4E-3

RESULTS OF FLOW MEASUREMENT

APPENDIX 4E-3 RESULTS OF FLOW MEASUREMENT

1. INSERTION METER (NWSDB)			
	Input diameter	760	mm
A	Internal area of pipe of Dia. 760mm	0.453	m2
	Blockage	0	mm
B	Velocity profile	0.833	m/3
C	Flow rate (A*B)	**0.378**	m3/sec
	Accumulated flow rate		
	Time	Flow rate	
	15:30	413.29	
	15:35	465.81	
	15:40	333.37	
	15:45	342.51	
	Total	1554.98	
D	Measured average flow rate for 15 min.	388.745	l/sec
		0.389	m3/sec
2. ULTRASONIC METER (JICA Study Team)			
E	Input diameter in the data logger	750	mm
F	Input mortal lining thickness	20	mm
G	Calculated diameter in the data logger (E-F)	710	mm
H	Measured average flow rate for 30 min.	0.326	m3/sec
I	Internal area of pipe. Diameter: 710mm	0.396	m2
J	Calculated average velocity (H/I)	0.824	m/sec
	Converted diameter (by NWSDB input data)	760	mm
K	Internal area of pipe. Diameter: 760mm	0.453	m2
L	Converted flow rate (J*K)	**0.374**	m3/sec
	Difference of flow rate: (A/L)	1.011	
	Difference of flow rate: (D/L)	1.040	
	(Percentage of Difference of flow rate)	(1.1% - 4.0%, Ave.2.5%)	

CHAPTER 5

APPENDIX 5A

MANUALS FOR LEAKAGE SURVEY AND PIPE ASSESSMENT

APPENDIX 5A

MANUALS FOR LEAKAGE SURVEY AND PIPE ASSESSMENT

I. LEAKAGE SURVEY

(1) Organization of survey team

It is recommended that each leakage survey team comprises one (1) NWSDB engineer, one (1) leak detector and two (2) labours.

(2) Equipment and materials required for leakage survey

The following equipment and materials will be required for assessment.

- Pipe locator
- Pressure gauge with recorder
- Sounding bar
- Leak detector
- Correlator
- Electromagnetic wave leak detector

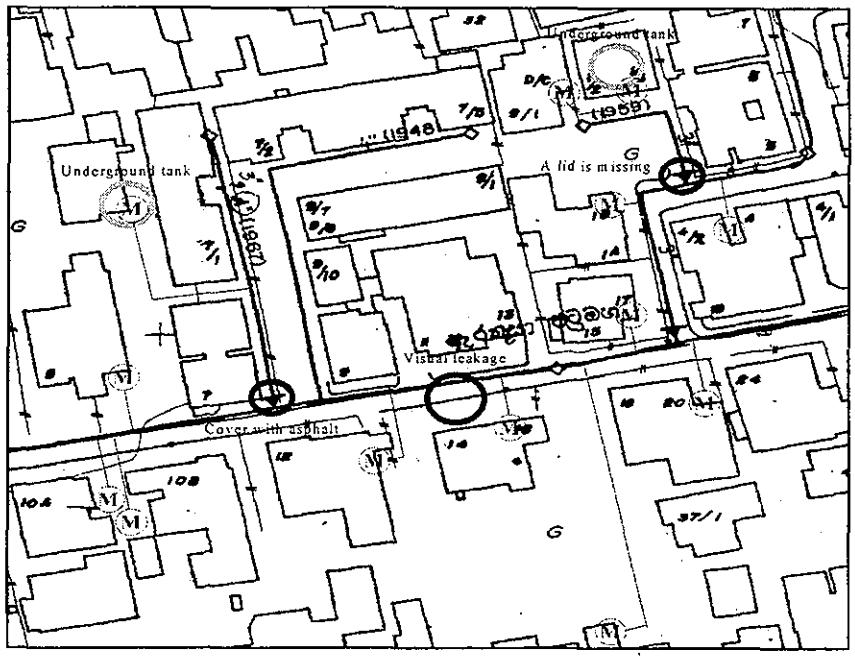
(3) Procedures of leakage survey

Step 1 Preparation

Prepare a detailed work plan and time schedule. Prior to the commencement of field work, inform the residents about the leakage survey work. Investigate the survey site while referring to NWSDB's 1/1000-scaled pipe network drawings to obtain the following information.

- Location of existing distribution pipelines
- Location of nearby valves, fire hydrants and public standposts
- Topographical conditions of the site, traffic density and noise level
- Existing services such as telecom and power supply cables
- Visible leaks on the ground

Mark on a 1/1000-scaled pipe network drawing the locations of water meters and service connection pipes in the area where investigation is to be conducted. Also mark all the findings gained during this Step on the drawing.



Step 2 Water pressure measurement

Install portable pressure gauges at several points in the survey area and measure and record the water pressures at least for 24 hours continuously. Determine the time and method of leak detection survey based on the level of water pressure (Daytime leak detection is generally difficult where water pressure is below 0.5kgf/cm2).

Step 3 Leak sound detection and confirmation

Conduct leak detection in two steps. In the first step, detect leak sounds by placing the tip of a sounding bar at each of the valves, fire hydrants, standposts and individual water meters which exist in the survey area. In the second step, detect leak sounds using a leak detector at an interval of every 0.5 to 1.0 m along the pipe alignment. If any abnormal sound is detected, use an electromagnetic wave leak detector to confirm whether it is indeed a leak sound, and to pinpoint the location of the leak. If electromagnetic wave leak detector is not available, use a correlator to confirm the leak and its location by attaching the sensors to existing valves, fire hydrants, standposts or water meters depending on the location of the abnormal sound detected.

Step 4 Recording of survey results

Enter all the information and survey results in a special record format. Mark the location of the surveyed are on a 1/1000-scaled pipe network drawing with a sequential number.

Step 5 Report to Repair Section

Send a report on any leakage detected during the survey to the section responsible for repair. Include a copy of the leak survey record format in the report.

II. Pipe Assessment

(1) Organization of assessment team

It is recommended that each pipe assessment team comprises one (1) NWSDB engineer and five (5) pipe fitters.

(2) Equipment and materials required for pipe assessment

The following equipment and materials will be required for assessment.

- Pipe locator
- Excavator
- Asphalt Breaker
- Rigidscope with mountable camera
- Drilling machine
- Repair materials
- Safety equipment
- Drainage pump
- Lighting device
- Generator
- Pressure gauge

(3) Procedures of pipe assessment

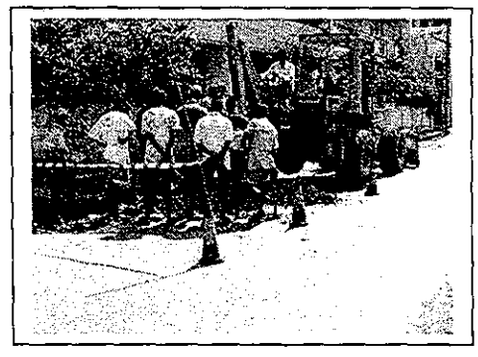
Step 1 Preparation

Inspect the site conditions and obtain necessary permissions for excavation from local authorities concerned such as police department and CMC road department. Look for the nearby existing surface valve covers and hydrants to determine the exact location of the pipeline to be investigated. Use a pipe locator, if necessary. Prepare a detailed work and a time schedule. It is recommended that pipe assessment work be conducted during daytime wherever possible.

Step 2 Excavation

Make sure that all necessary permissions for excavation have already been obtained.

Breaking pavement should be done by a breaker to minimize the damage to the pavement and to facilitate excavation. Exercise utmost care during excavation by a mechanical excavator not to damage existing underground utilities, such as telecom line, power cable and service connection. As soon as the location of pipe is confirmed, the use of mechanical excavator should be discontinued and further excavation should be continued manually. Use a drain pump if necessary to keep the excavated pit always at a dry condition.



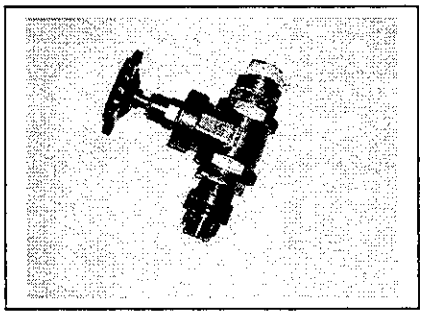
Step 3 Cleaning of pipe surface

Remove soil and rust on the exterior surface of the pipe by scraping completely so that the tapping machine can be mounted on the pipe properly and firmly.

Step 4 Drilling and tapping

Attach a straight ferrule at the bottom end of a tapping machine. Mount the tapping machine on the pipe. Make sure that the tapping machine is securely fastened. Cut a hole through the pipe wall by turning the shaft of the tapping machine.

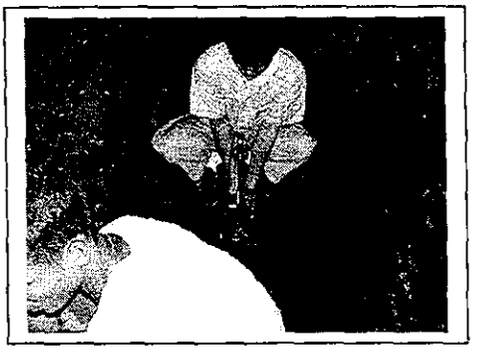
After a hole has been cut through the pipe wall, insert the straight ferrule into the hole by turning the shaft of the tapping machine.

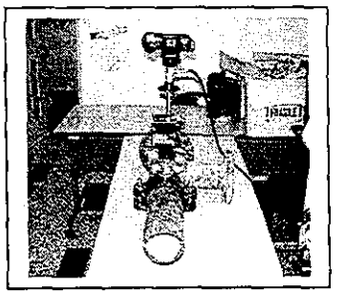


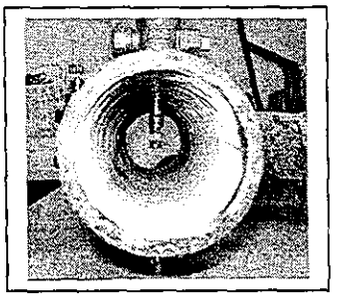
Step 5 Observation of internal conditions

Replace the tapping machine with a rigidscope. Measure the thickness of the pipe wall and encrustation inside the pipe while the rigidscope is being inserted into the pipe. Make a thorough observation of the internal conditions by slowly turning the handle of the rigidscope 360 degrees and by adjusting the light intensity. Assess the following points during this Step.

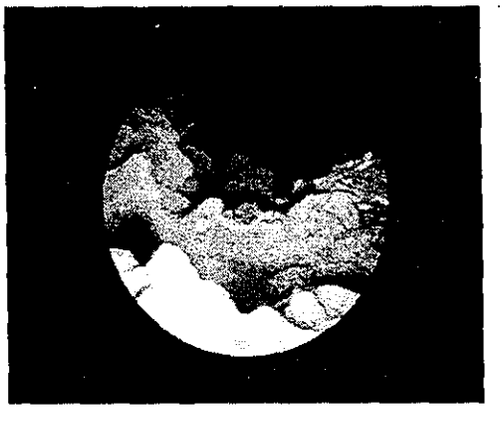
- outside diameter of pipe
- pipe wall thickness
- reduction of cross-sectional area by encrustation
- thickness and shape of encrustation
- *flow direction*
- water pressure
- residual chlorine (optional)
- pH-value (optional)







Mount a special camera on the upper end of the rigidscope and take at least three (3) shots: two along the pipe axis (both upstream and downstream), and one perpendicular to the pipe axis.



Step 6 Repair work

Remove the rigidscope and attach a plug to the upper end of the straight ferrule to fill the hole tightly. Ensure that the plug is placed tightly.

Step 7 Backfilling and site restoration

Backfill the excavated pit and request the CMC road department to restore the road surface to

its original conditions. Pay the cost of road surface restoration to CMC.

Step 8 Recording of assessment results

Enter all the information and assessment results in a special record format. Mark the location of assessment point on a 1/1000-scaled pipe network drawing with a sequential number.