CHAPTER 5 WELL REHABILITATION SURVEY

5.1 PRESENT CONDITION OF MWSS WELLS

Of the 258 MWSS wells in MSA in 1991, 52 are abandoned, 131 active and 75 inactive.

Based on site visits and interviews with the operators, the well conditions were classified into four: "Good", "Damaged", "Stand by" and "Others" (Table 5.1.1).

"Good" : wells being operated are in good condition

"Damaged" : wells are damaged as indicated by any of the following: salty water, dirty water, caved-in, dried-up, defective pump unit

"Standby" : wells are on standby, under rehabilitation or an adequate surface water supply is present

"Others" : reason is not clear; inactive or abandoned

Thirty two (32) out of 131 wells which were reported to be active are substantially inactive for they have the characteristics falling under the classification "Damaged" and "Others". Only 99 wells are operating normally.

5.2 DETAILED SURVEY

A detailed survey which included doing pumping tests was conducted at well sites. Out of 28 damaged wells, sixteen (16) were surveyed in order to identify the conditions and requisites for a proper rehabilitation procedure. Seven (7) wells were subsequently selected as candidate wells for experimental well rehabilitation.

The survey revealed that an increase in the discharge rate of 6 wells out of 9 can be affected by the improvement of pumping unit. The condition of the remaining 3 wells are unclear, except for one which is

contaminated by saline water.

5.3 EXPERIMENTAL REHABILITATION WORK

In order that causes of damage may be clarified and technical specifications of the rehabilitation work may be properly established, an experimental work on five (5) wells selected through detailed survey was carried out (Figure 5.3.1). These five wells are: Sumulong in Taytay; Cogeo No.1, Antipolo; Cogeo No.6, Antipolo; IBP No.3, Quezon City; and Naga No.2, Las Piñas.

The standard experimental rehabilitation work involves the following activities.

1) Preparation and mobilization
2) Pulling out of existing pumping unit
3) Measuring of well depth and water level
4) Inspection of existing pumping unit
5) Installation of test pumping unit
6) First pumping test
7) Surging, bailing and airlifting
8) Second pumping test
9) Installation of existing pumping unit
10) Demobilization

Rehabilitation was effective at Sumulong and Cogeo No.1 in terms of specific capacity and well loss constant. In Naga No.2 and Cogeo No.6, these parameters did not improved, indicating the ineffectiveness of rehabilitation (Table 5.3.2). The IBP No.3 well was recommended to be abandoned because of its damaged casing and its low water discharge.

TABLE 5.1.1 WELL CONDITIONS OF MWSS DEEP WELLS

(NUMBER OF WELLS)

WELL CONDITIONS	STATUS			
	ACTIVE	INACTIVE	ABANDONED	TOTAL
IN GOOD CONDITION	99	0	0	99
DAMAGED WELLS				
Defective unit	13	9	3	25
Yields salty water	2	0	17	19
Well caved-in	1	0	14	15
Yields dirty water	3	0	5	8
Well is almost dry	0	0	3	3
TOTAL	19	9	42	70
STAND BY				
Stand by	0	16	0	16
Under Rehabilitation Program	0	25	0	25
Adequate surface water supply	0	23	6	29
TOTAL	0	64	6	70
OTHERS	13	2	4	19
GRAND TOTAL	131	75	52	258

TABLE 5.3.1 WELLS FOR EXPERIMENTAL REHABILITATION WORK

Well Name	Municipality	Status	Total Depth	Casing Pipe Position Size	Well Screen Position	Exist. Pump		Test Pump		Pump After Rehab.	
						Set.	Cap.	Set.	Spec.	Set.	Spec.
Cogeo Antipolo No.1	Antipolo	Inactive	91.44m	0m-9.75m 8" 9.75-91.44 6"	64m-87.78m	66m	7.5 Hp	78m	SP8-21 7.5HP OD 133	3" 78m	Existing Pump Installed
Sumulong	Taytay	Inactive	202.69	0-80.77 8" 80.77-202.7 6"	Unknown	75	30	78m 120m	30 HP 10 HP OD 133mm	NO	No Pump Installed
Naga Road No.2	Las Pinas	Active	243.84	0-243.84 10"	103.63-121.91 128.01-158.49 164.59-170.68 182.88-213.36 219.45-237.74	78	30	120m 102m	SP45-12 30HP OD 150	3" 102m	Existing Pump Installed
IBP (Congress) No.3	Quezon City	Inactive	202.69	0-80 10" 80-202.69 8"	87-99 103-122 129-144 151-166 173-197	120	20	108	20 HP 9 stage OD 140	NO	No Pump Installed
Cogeo Antipolo No.6	Antipolo	Inactive	117.35	0-91.44 8"	91.44-177.35 bore hole	99	20	90	20 HP 9 stage OD 140	NO	No Pump installed

TABLE 5.3.2 RESULTS OF EXPERIMENTAL REHABILITATION WORK

	Sumulong Taytay	I B P No. 3	Cogeo ATP No.1	Cogeo ATP No.6	Naga Road No.2
Well Depth (m)	202.68	202.69	91.44	117.35	243.84
Accumulation (m)	5.68	32.69	4.44	11.35	0
Static Water Level (m)	58.00	39.30	7.25	11.50	55.40
EC-T Logging	684-	92-	335-	316-	517-
ECt (μS/cm)	961	144	390	342	9585
T (°C)	30.2-	27.7-	25.8-	26.4-	30.0-
	30.7	28.1	27.10	27.50	34.20
Micro Current	*	*	*	*	
1st Pumping Test					
Discharge Rate (m^3/d)	285	(25.9)	285	294	544
Drawdown (m)	30.00	(70.7)	48.80	68.40	17.70
Specific Capacity (m^2/d)	9.50	(0.37)	5.84	4.30	30.70
Transmissivity (m^2/d)					
Continuous - Theis	14.6	-	2.83	1.33	36.9
Continuous - Jacob	15.2	-	5.27	7.19	31.1
Recovery - Jacob	11.4	-	32.6	19.8	29.2
Storage Coeff.	7.65×10^{-5}	-	1.19	2.26	3.18×10^{-4}
Aquifer Loss Coeff. (day/m^2)	5.40×10^{-2}	-	8.00×10^{-3}	0.0	3.2×10^{-2}
Well Loss Coeff (day^2/m^5)	1.65×10^{-4}	-	2.55×10^{-4}	8.0×10^{-4}	6.2×10^{-6}
2nd Pumping Test					
Discharge Rate (m^3/d)	328	(54.4)	285	294	518
Drawdown (m)	25.10	(70.70)	19.50	64.20	17.07
Specific Capacity (m^2/d)	13.07	(0.77)	14.60	4.58	31.9
Transmissivity (m^2/d)					
Continuous - Theis	14.6	-	4.37	1.34	36.6
Continuous - Jacob	4.10	-	11.1	4.88	31.1
Recovery - Jacob	44.8	-	17.4	15.2	31.9
Storage Coeff.	1.03×10^{-4}	-	2.05	3.32	3.90×10^{-4}
Aquifer Loss Coeff. (day/m^2)	2.6×10^{-2}	-	2.0×10^{-3}	0.0	2.95×10^{-2}
Well Loss Coeff (day^2/m^5)	1.43×10^{-4}	-	2.10×10^{-4}	7.35×10^{-4}	6.2×10^{-6}

CHAPTER 6 URBAN DEVELOPMENT AND FUTURE WATER DEMAND

6.1 URBAN DEVELOPMENT PLANNING

It is anticipated that by the year 2000 Metro Manila shall have expanded its urban area by an additional 25km radius which would include Cavite, Antipolo, and the coastal area of Laguna de Bay. This expansion which may primarily be led by private sectors could inevitably change the land use pattern and its intensity, and would be marked by an increased number and density of blighted areas, the development of middle and upper class residential subdivisions on the urban periphery, a great increase of townhouses and/or condominiums in the main urban area, and the conversion of agricultural and fishpond areas to residential and/or commercial uses.

Population growth and urbanization in the year 2010 were predicted using the 1990 data of the National Statistics Office (NSO). Total population of the MSA in year 2010 would be approximately 14.1 million, a 4.7 million increase over the year 1990 figure (Table 6.1.1).

Based on 1985 statistics, approximately 2.3 million people in the MSA were living in blighted areas. It increased to around 2.8 million in 1990, about 30% of the population of NCR (7.93 million). The blighted population is projected to reach 4.09 million in 2010.

A basic structure plan of urban development was set up with due regard to the above. The plan lays out Metro Manila as an inner urban core surrounded by a transition zone located between the inner urban core and outlying areas. Industrial concentration areas and intensive residential development areas are laid in the south and north of the outlying areas of the transition zone. Other industrial and residential areas are to be located north of Laguna de Bay (Figure 6.1.1).

The proposed future land use plan of the MSA is divided into two major zones consisting of an Urban Consolidation Zone and Complementary Urban Satellites. Layout of land use was roughly designed according to the trend of urbanization in Metro Manila: as residential and open areas, industrial and tourism areas, agro-industrial and regional open spaces, flooding area, and reservation area.

There is at present a progressive development of residential areas and urban facilities in the Antipolo area because of its contiguity to Metro Manila. The area is still relatively abundant in forest/grass land and agricultural land. Based on population projections for the Antipolo area, the population would reach 435,000 in 2010 from the 208,000 in 1990 (Table 6.1.2). The future land use plan thus incorporated the development of the tourism and agro-forest industries in the Antipolo area (Figure 6.1.2).

6.2 WATER DEMAND PROJECTIONS

Domestic, commercial and industry water demand was projected considering the population projection described in Section 6.1.

From the records of the MWSS Computer Center, daily domestic consumption in the MSA in 1990 was 785,000 CMD, of which 781,000 CMD were for house service connections and 4,000 CMD for public faucets. The served population, estimated by water meters, was 5,037,000 for house service connections and 236,000 for public faucets. Thus the average per capita domestic consumption in the MSA for house service connections and public faucets were 170 lpcd and 19 lpcd, respectively. Water consumption for commercial use was 344,000 CMD and 84,000 CMD for industrial use. Those not served by MWSS use groundwater; their consumptions were estimated at 379,000 CMD for domestic use, 107,000 CMD for commercial purpose and 355,000 CMD for industrial supply (Tables 6.2.1 to 6.2.3).

In projecting water demand, the per capita consumption was set at 180 lpcd in 1995 and 200 lpcd in 2010, in consideration of actual per capita consumption in the area. For some municipalities with high per capita consumption at present, another value was adopted. In the respective areas covered by RPWSP and FAWSP, the per capita consumption employed in each project was also adopted. Based on the population projection, the total domestic water demand in MSA would become 1,596,000 CMD in 2010 and 2,136,000 CMD in 2010. The domestic water demand in the area outside the service of MWSS is estimated at 306,000 CMD in 2000 and 246,000 CMD in 2010 (Table 6.2.4).

The calculation of commercial water demand was done using two factors,

i.e., the economic growth rate and the tariff change planned by CORPLAN of MWSS. Areal allocation was made based on the actual commercial water consumption. In the area covered by RPWSP, the same method was adopted. The total commercial water demand shall become 570,000 CMD in 2000 and shall increase to about 801,000 CMD in 2010. Outside the MSA, the total commercial demand shall become 132,000 CMD in 2000 and 157,000 CMD in 2010 (Table 6.2.5).

Future industrial water demand was calculated basically in the same manner as that for commercial water demand and areal allocation. The total industrial water demand will become 153,000 CMD in 2000 and 224,000 CMD in 2010. It will also become 482,000 CMD in 2000 and 595,000 in 2010 in the area outside the MSA (Table 6.2.6).

Water losses during distribution were added to the estimate of the total water demand in the MSA. Leakage ratios of 30% and 20% for years 2000 and 2010, respectively, were used in projecting total water demand. In the MSA, the respective total water demand for years 2000 and 2010 are 3,306,000 CMD and 4,203,000 CMD. Outside the MSA, these respective demands are 920,000 CMD and 998,000 CMD. (See Tables 6.2.7 to 6.2.10 and Figures 6.2.1 to 6.2.3.)

On the assumption that the planned and ongoing projects, i.e. AWSOP, UATP, etc., shall proceed on schedule, it is predicted that the surface water supply capacity in the area covered by CDS shall exceed the total water demand until the year-2010 (Figure 6.2.4). However, the area outside the CDS must rely on groundwater.

As shown in Tables 6.2.11 and 6.2.12, four scenarios were established for the estimation of future groundwater pumpage in the MSA. This projection of future pumpage aims to predict future groundwater levels and to come up with a tentative permissive yield for the Metro Manila Groundwater Basin.

In Antipolo, the water demand in the years 2000 and 2010 was projected at 27,300 CMD and 45,500 CMD, respectively. Groundwater supply can meet the demand up to 1998 in daily average base by augmentation through rehabilitation and new construction of MWSS-supervised wells. However, the shortage in water supply would become 1,830 CMD in 2000 and 18,150

CMD in 2010. Therefore, the extension of the CDS to cover Antipolo is necessary in the future. (Refer to Table 6.2.13 and Figure 6.2.5.)

TABLE 6.1.1 POPULATION PROJECTIONS FOR SELECTED YEARS, STUDY AREA

CITY/MUNICIPALITY	1980 (CENSUS)	1990 (CENSUS)	1995	2000	2005	2010
I. NCR	5,970,307	7,928,867	8,971,800	9,948,977	10,847,652	11,649,609
1. Manila	1,642,708	1,598,918	1,666,014	1,705,567	1,723,126	1,723,147
2. Pasay City	289,927	366,623	402,932	433,048	457,147	475,225
3. Quezon City	1,174,605	1,666,766	1,870,519	2,049,017	2,200,635	2,323,154
4. Caloocan City	471,323	761,011	872,801	979,527	1,076,883	1,164,630
5. Las Pinas	137,537	296,851	413,469	551,808	708,704	878,109
6. Makati	375,424	452,734	489,333	517,961	539,315	553,794
7. Malabon	192,433	278,380	305,870	328,653	346,868	360,515
8. Mandaluyong	206,906	244,538	265,870	282,944	296,044	305,315
9. Marikina	213,199	310,010	359,368	405,480	447,289	483,621
10. Muntinlupa	137,704	276,972	346,829	419,918	493,739	565,215
11. Navotas	127,092	186,799	207,567	225,328	240,031	251,550
12. Paranaque	210,115	307,717	369,370	430,253	488,493	541,964
13. Pasig	270,583	397,309	466,552	532,663	593,888	648,283
14. Pateros	40,590	51,401	58,438	64,776	70,318	74,945
15. San Juan	131,063	126,708	133,478	137,583	140,304	141,007
16. Taguig	135,143	266,080	311,031	353,627	392,792	427,323
17. Valenzuela	213,955	340,050	432,359	530,824	632,076	731,811
II. CAVITE	324,273	457,020	534,043	611,062	686,825	756,085
1. Bacoor	90,364	159,685	196,636	235,538	275,150	313,838
2. Cavite City	87,666	91,641	98,576	104,379	109,908	112,628
3. Imus	59,103	92,125	107,162	121,860	135,818	148,542
4. Kawit	39,368	47,755	55,217	62,446	69,254	75,407
5. Noveleta	14,460	20,409	23,325	26,102	28,673	30,955
6. Rosario	33,312	45,405	53,127	60,737	68,022	74,715
III. RIZAL	567,346	980,194	1,150,043	1,325,537	1,503,547	1,667,350
1. Angono	27,136	46,014	55,062	64,219	72,979	80,788
2. Antipolo	70,377	207,842	261,738	319,849	379,154	435,886
3. Baras	11,434	16,880	19,051	21,063	22,808	24,182
4. Binangonan	82,702	127,561	140,791	152,533	162,155	169,117
5. Cainta	60,280	126,839	164,650	206,860	251,447	295,646
6. Cardona	25,024	32,962	35,194	36,995	38,270	38,952
7. Jala-Jala	12,199	16,318	17,814	19,109	20,131	20,826
8. Montalban	42,749	67,074	75,766	83,837	90,845	96,318
9. Morong	25,387	32,165	34,528	36,957	40,222	43,304
10. Pililla	23,716	32,771	36,137	39,119	41,556	43,312
11. San Mateo	53,014	82,310	92,401	101,679	109,620	115,769
12. Tanay	41,303	58,410	65,923	72,889	78,925	83,678
13. Taytay	76,930	112,403	129,481	148,322	173,025	197,131
14. Teresa	15,095	20,645	21,507	22,106	22,410	22,441
T O T A L	6,861,926	9,366,081	10,655,886	11,885,576	13,038,024	14,073,043

Source: Estimation made by the Study Team based on NSO data

TABLE 6.1.2 POPULATION PROJECTIONS FOR SELECTED YEARS, MUNICIPALITY OF ANTIPOLO

MUNICIPALITY/ BARANGAY	1990	1995	2000	2005	2010
ANTIPOLO	207,842	261,738	319,849	379,154	435,886
1. Bagong Nayon	18,002	22,644	27,647	32,752	37,637
2. Beverly Hills	1,034	1,385	1,767	2,161	2,532
3. Calawis	1,662	2,172	2,725	3,293	3,831
4. Cupang	25,696	32,283	39,380	46,620	53,551
5. Dalig	20,344	25,566	31,204	36,956	42,461
6. De La Paz (Pob.)	21,033	26,441	32,269	38,215	43,906
7. Inarawan	4,965	6,312	7,767	9,254	10,673
8. Mambugan	15,636	19,680	24,039	28,487	32,743
9. Mayamot	15,887	19,995	24,423	28,941	33,264
10. San Isidro	19,260	24,220	29,566	35,020	40,240
11. San Jose	26,121	32,815	40,028	47,385	54,428
12. San Juan	1,394	1,838	2,319	2,813	3,280
13. San Luis	6,241	7,910	9,712	11,553	13,311
14. San Roque	17,227	21,673	26,465	31,355	36,034
15. Sta. Cruz	13,340	16,804	20,538	24,349	27,995

Source: Estimation made by the Study Team based on NSO data. Due to the absence of population data at barangay level prior to 1990, population projections at barangay level were based on the growth rate of the whole Antipolo municipality.

TABLE 6.2.1 STATUS OF DOMESTIC WATER SUPPLY BY MWSS AND PRIVATE SYSTEM

CITY/MUNICIPALITY	1990 CENSUS POPULATION	MWSS HOUSE SERVICE CONNECTION							MWSS PUBLIC FAUCETS						EQUIVALENT NO. OF POPULATION SERVED BY MWSS		PRIVATE WELL			EQUIVALENT NO. OF POPULATION SERVED BY MWSS & PRIVATE SYSTEM	
		AVG. DAILY CONSUMPTION		CONNECTIONS			AVERAGE PER CAPITA CONS.	COR'D PER CAPITA CONS.	AVERAGE DAILY CONSUMP.	PUBLIC FAUCETS			AVERAGE PER CAPITA CONS.	COR'D PER CAPITA CONS.			DOMESTIC SUPPLY AMOUNT	ESTIMATED SERVED POPULATION	SHARE IN SUPPLY AMOUNT		
		AMOUNT (M3/D)	% TO TOTAL	NUMBER	EQUIVALENT NO. OF POPULATION	% TO TOTAL POP.	(LPCD)	(LPCD)	(M3/D)	NUMBER	EQUIV. NO. OF POP.	% TO TOTAL POP.	(LPCD)	(LPCD)	TOTAL (HSC+PF)	% TO TOTAL POP.	(M3/D)		(%)	TOTAL	% TO TOTAL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
I. NCR	7,928,867	755,690	96.8	587,778	4,761,002	60.0	158.7	174	3,919	452	224,532	2.8	17.5	19	4,985,534	62.9	266,935	1,355,526	26.3	6,341,059	80.0
1. Manila	1,598,918	207,941	26.6	155,052	1,255,921	78.5	165.6	181	972	86	41,796	2.6	23.3	25	1,297,717	81.2	2,214	12,204	1.0	1,309,921	81.9
2. Pasay City	366,623	27,941	3.6	25,087	203,205	55.4	137.5	151	170	33	15,038	4.4	10.6	12	219,243	59.8	5,827	32,372 *	15.9	251,615	68.6
3. Quezon City	1,666,766	200,035	25.6	147,326	1,193,341	71.6	167.6	184	1,366	157	81,162	4.9	16.8	18	1,274,503	76.5	31,316	170,503	12.4	1,445,006	86.7
4. Caloocan City	761,011	44,115	5.6	44,673	361,851	47.5	121.9	134	324	41	19,526	2.6	16.3	18	381,777	50.2	19,137	106,317 *	28.2	488,094	64.1
5. Las Pinas	296,851	2,966	0.4	7,939	64,306	21.7	46.1	51	37	8	3,888	1.3	9.6	10	68,194	23.0	57,141	317,450 *	94.6	385,644	129.9
6. Makati	452,734	61,236	7.8	40,210	325,701	71.9	188.0	206	21	5	2,430	0.5	8.5	9	328,131	72.5	10,075	48,906	13.1	377,037	83.3
7. Malabon	278,380	17,096	2.2	18,912	145,897	52.4	117.2	128	159	19	9,234	3.3	17.3	19	155,131	55.7	1,892	10,511 *	9.1	165,642	59.5
8. Mandaluyong	244,538	25,901	3.3	21,345	172,895	70.7	149.8	164	140	19	9,234	3.8	15.1	17	182,129	74.5	1,495	9,108	5.0	191,236	78.2
9. Marikina	310,010	37,859	4.8	28,315	229,352	74.0	165.1	181	250	23	11,178	3.6	23.3	26	240,530	77.6	5,340	29,525	11.3	270,054	87.1
10. Muntinlupa	276,972	3,604	0.5	5,505	44,591	16.1	80.2	89	-	-	0	-	-	-	44,591	16.1	49,108	272,822 *	92.6	317,413	114.6
11. Navotas	186,799	8,807	1.1	13,795	111,740	59.8	78.8	86	54	6	2,916	1.6	18.6	20	114,656	61.4	1,691	9,394 *	14.8	124,050	66.4
12. Paranaque	307,717	32,413	4.2	13,552	109,771	35.7	295.3	324	117	17	8,262	2.7	14.2	16	118,033	38.4	47,553	166,979	57.2	265,012	86.1
13. Pasig	397,309	43,316	5.5	32,530	264,303	66.5	163.9	180	124	21	10,206	2.6	12.1	13	274,509	69.1	9,223	51,361	16.2	325,870	82.0
14. Pateros	51,401	1,722	0.2	2,349	19,027	37.0	90.5	99	-	-	0	-	-	-	19,027	37.0	0	0 *	0.0	19,027	37.0
15. San Juan	126,708	23,653	3.0	12,851	104,093	82.2	227.2	249	125	8	3,888	3.1	32.1	35	107,981	85.2	252	1,012	1.0	108,993	86.0
16. Taguig	266,080	3,258	0.4	4,060	32,886	12.4	99.1	109	21	3	1,458	0.5	14.3	16	34,344	12.9	21,514	119,522 *	85.7	153,866	57.8
17. Valenzuela	340,050	15,227	1.8	15,077	122,124	35.9	113.2	124	28	6	2,916	0.9	9.5	10	125,040	36.8	3,151	17,539 *	14.2	142,579	41.9
II. CAVITE	457,020	11,793	1.5	16,879	136,133	29.8	86.6	95	119	17	8,262	1.8	14.4	16	144,395	31.6	46,864	260,354	78.2	404,749	88.6
1. Bacoor	155,685	2,580	0.3	3,881	31,436	19.7	82.1	90	54	5	2,430	1.5	22.3	24	33,866	21.2	31,507	175,039 *	91.6	208,905	130.8
2. Cavite City	91,641	5,433	0.7	7,807	63,237	69.0	85.9	94	47	8	3,888	4.2	12.0	13	67,125	73.2	849	4,717 *	12.4	71,841	78.4
3. Imus	92,125	779	0.1	978	7,335	8.0	106.3	116	-	0	0	0.0	-	-	7,335	8.0	3,268	18,156 *	79.3	25,491	27.7
4. Kawit	47,755	2,262	0.3	3,055	24,746	51.8	91.4	100	18	4	1,944	4.1	9.0	10	26,690	55.9	2,830	15,722 *	53.1	42,412	88.8
5. Noveleta	20,409	323	0.0	507	4,107	20.1	78.6	86	-	0	0	0.0	-	-	4,107	20.1	5,659	31,439 *	94.1	35,546	174.2
6. Rosario	45,405	417	0.1	651	5,273	11.6	79.0	87	-	0	0	0.0	-	-	5,273	11.6	2,751	15,282 *	85.8	20,555	45.3
III. RIZAL	980,194	13,484	1.7	17,116	139,499	14.2	98.1	105	76	9	3,216	0.3	23.5	26	142,715	14.6	65,171	362,861	81.5	504,776	51.5
1. Angono	46,014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Antipolo	207,842	3,606	0.5	4,445	36,005	17.3	100.1	110	4	1	54	0.0	11.8	13	36,059	17.3	29,387	163,150 *	88.1	199,209	95.8
3. Baras	16,880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Binangonan	127,561	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Cainta	126,839	2,728	0.3	3,003	24,324	19.2	112.2	123	11	2	972	0.8	11.7	13	25,296	19.9	9,273	51,517 *	75.5	76,813	60.6
6. Cardona	32,562	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. Jala-Jala	16,318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Montalban	67,074	1,498	0.2	2,039	15,904	23.7	94.2	103	0	0	0	0.0	-	-	15,904	23.7	4,244	23,578 *	72.1	39,482	58.9
9. Morong	32,165	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10. Pililla	32,771	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. San Mateo	82,310	2,305	0.3	3,673	31,263	38.0	73.7	81	33	4	1,218	1.5	27.5	30	32,481	39.5	2,647	14,706 *	50.8	47,187	57.3
12. Taney	58,410	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13. Taytay	112,403	1,268	0.4	3,951	32,003	28.5	102.1	112	27	2	972	0.9	27.6	30	32,975	29.3	19,640	109,111 *	84.5	142,086	126.4
14. Teresa	20,645	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	9,366,081	780,888	100.0	621,773	5,036,634	53.8	155.9	170	4,113	488	236,010	2.5	17.4	19	5,272,644	56.3	378,970	1,977,941	30.6	7,250,585	77.4

(5)=(4)x8.1 (7)=(2)/(5)x1000 (8)=(7)x1.0957 (11)=(10)x486 (13)=(9)/(11)x1000 (14)=(13)x1.0957 (15)=(5)+(11) (18)=(17)/(8)x1000 (19)=(17)/{[(2)+(9)]*1.0957+(17)}*100 (20)=(15)+(18)

* Assumed per capita consumption of 180 lpcd was used instead of estimated per capita consumption considering suppressed water supply condition.

TABLE 6.2.2 STATUS OF COMMERCIAL CONSUMPTION IN 1990

CITY/MUNICIPALITY	AVG. DAILY BILLED MWSS COMMERCIAL CONSUM.			NUMBER OF MWSS METER CONNECTION	CONSUMPTION PER METER CONNECTION		PRIVATE WELL COMM'L PUMPAGE (M3/DAY)	ESTIMATED TOTAL COMM'L CONSUM. (M3/DAY)	% TO TOTAL (%)	SHARE OF PRIVATE WELL (%)
	AMOUNT (M3/DAY)	CORRECTED (M3/DAY)	% TO TOTAL		BILLED (M3/DAY)	CORRECTED (M3/DAY)				
I. NCR	301,200	341,350	99.2	41,010	7.345	8.324	93,315	434,665	96.4	21.5
1. Manila	116,049	131,518	38.2	14,452	8.030	9.100	4,665	136,183	30.2	3.4
2. Pasay City	14,597	16,543	4.8	1,907	7.655	8.675	8,795	25,338	5.6	34.7
3. Quezon City	76,185	86,340	25.1	10,695	7.123	8.073	27,641	113,981	25.3	24.3
4. Calookan City	10,071	11,414	3.3	2,535	3.973	4.502	3,674	15,088	3.3	24.4
5. Las Pinas	547	620	0.2	315	1.738	1.970	3,678	4,299	1.0	85.6
6. Makati	41,955	47,548	13.8	3,189	13.156	14.910	11,721	59,269	13.1	19.8
7. Malabon	2,831	3,208	0.9	989	2.862	3.244	2,016	5,224	1.2	38.6
8. Mandaluyong	9,891	11,210	3.3	1,123	8.808	9.982	2,128	13,338	3.0	16.0
9. Marikina	3,424	3,881	1.1	1,288	2.659	3.013	1,400	5,280	1.2	26.5
10. Muntinlupa	69	78	0.0	106	0.648	0.734	8,230	8,308	1.8	99.1
11. Navotas	1,795	2,035	0.6	471	3.812	4.320	621	2,655	0.6	23.4
12. Paranaque	5,920	6,709	1.9	1,045	5.665	6.420	4,914	11,624	2.6	42.3
13. Pasig	8,247	9,346	2.7	1,105	7.463	8.458	6,658	16,004	3.5	41.6
14. Pateros	49	56	0.0	34	1.446	1.639	0	56	0.0	0.0
15. San Juan	7,237	8,201	2.4	920	7.866	8.915	97	8,299	1.8	1.2
16. Taguig	319	361	0.1	61	5.222	5.918	3,655	4,016	0.9	91.0
17. Valenzuela	2,014	2,282	0.7	775	2.598	2.944	3,423	5,705	1.3	60.0
II. CAVITE	1,080	1,224	0.4	731	1.477	1.674	5,175	6,399	1.4	80.9
1. Bacoor	237	268	0.1	132	1.793	2.032	703	971	0.2	72.4
2. Cavite City	642	727	0.2	398	1.612	1.827	3,480	4,207	0.9	82.7
3. Imus	57	65	0.0	54	1.058	1.199	644	709	0.2	90.9
4. Kawit	108	122	0.0	119	0.905	1.025	0	122	0.0	0.0
5. Noveleta	4	5	0.0	5	0.872	0.989	0	5	0.0	0.0
6. Rosario	32	36	0.0	23	1.399	1.585	348	385	0.1	90.5
III. RIZAL	1,452	1,646	0.5	654	2.220	2.516	8,338	9,983	2.2	83.5
1. Angono	-	-	-	-	-	-	-	-	-	-
2. Antipolo	533	604	0.2	223	2.390	2.709	2,763	3,367	0.7	82.1
3. Baras	-	-	-	-	-	-	-	-	-	-
4. Binangonan	-	-	-	-	-	-	-	-	-	-
5. Cainta	396	449	0.1	134	2.958	3.353	3,173	3,622	0.8	87.6
6. Cardona	-	-	-	-	-	-	-	-	-	-
7. Jala-Jala	-	-	-	-	-	-	-	-	-	-
8. Montalban	37	42	0.0	36	1.019	1.155	844	886	0.2	95.3
9. Morong	-	-	-	-	-	-	-	-	-	-
10. Pililla	-	-	-	-	-	-	-	-	-	-
11. San Mateo	164	186	0.1	107	1.530	1.734	390	576	0.1	67.8
12. Tanay	-	-	-	-	-	-	-	-	-	-
13. Taytay	322	365	0.1	154	2.092	2.371	1,167	1,532	0.3	76.2
14. Teresa	-	-	-	-	-	-	-	-	-	-
TOTAL	303,732	344,219	100.0	42,395	7.164	8.119	106,828	451,047	100.0	23.7

TABLE 6.2.3 STATUS OF INDUSTRIAL CONSUMPTION IN 1990

CITY/MUNICIPALITY	AVG. DAILY BILLED MWSS INDUSTRIAL CONSUM.			NUMBER OF MWSS METER CONNECTION	CONSUMPTION PER METER CONNECTION		PRIVATE WELL IND'L PUMPAGE (M3/DAY)	ESTIMATED TOTAL IND'L CONS. (M3/DAY)	% TO TOTAL	SHARE OF PRIVATE WELL (%)
	BILLED (M3/DAY)	CORRECTED (M3/DAY)	% TO TOTAL		BILLED (M3/DAY)	CORRECTED (M3/DAY)				
I. NCR	71,792	81,361	96.3	6,291	11.412	12.933	280,687	362,048	82.4	77.5
1. Manila	15,545	17,617	20.9	795	19.554	22.160	5,786	23,403	5.3	24.7
2. Pasay City	810	918	1.1	169	4.793	5.432	3,375	4,293	1.0	78.6
3. Quezon City	17,066	19,341	22.9	1,988	8.585	9.729	32,368	51,708	11.8	62.6
4. Caloocan City	8,170	9,259	11.0	723	11.300	12.806	4,665	13,923	3.2	33.5
5. Las Pinas	138	156	0.2	51	2.702	3.062	20,959	21,115	4.8	99.3
6. Makati	4,110	4,658	5.5	302	13.609	15.423	3,383	8,041	1.8	42.1
7. Malabon	5,270	5,972	7.1	369	14.281	16.184	14,565	20,537	4.7	70.9
8. Mandaluyong	6,881	7,799	9.2	261	26.365	29.879	5,353	13,151	3.0	40.7
9. Marikina	1,241	1,406	1.7	506	2.452	2.779	6,833	8,239	1.9	82.9
10. Muntinlupa	71	80	0.1	106	0.667	0.756	34,280	34,360	7.8	99.8
11. Navotas	1,785	2,023	2.4	129	13.836	15.681	1,739	3,762	0.9	46.2
12. Paranaque	1,482	1,679	2.0	171	8.666	9.821	17,691	19,370	4.4	91.3
13. Pasig	7,128	8,079	9.6	277	25.734	29.165	60,077	68,156	15.5	88.1
14. Pateros	3	4	0.0	3	1.037	1.175	1,756	1,760	0.4	99.8
15. San Juan	1,059	1,200	1.4	147	7.201	8.161	59	1,259	0.3	4.7
16. Taguig	8	9	0.0	9	0.926	1.049	41,198	41,208	9.4	100.0
17. Valenzuela	1,026	1,162	1.4	285	3.599	4.079	26,600	27,763	6.3	95.8
II. CAVITE	1,014	1,149	1.4	1,346	0.753	0.853	5,889	7,037	1.6	83.7
1. Bacoor	62	70	0.1	61	1.014	1.149	0	70	0.0	0.0
2. Cavite City	210	238	0.3	250	0.840	0.952	0	238	0.1	0.0
3. Imus	6	7	0.0	7	0.906	1.027	530	538	0.1	98.7
4. Kawit	507	574	0.7	672	0.754	0.854	0	574	0.1	0.0
5. Noveleta	78	88	0.1	105	0.741	0.840	0	88	0.0	0.0
6. Rosario	151	171	0.2	251	0.602	0.682	5,358	5,530	1.3	96.9
III. RIZAL	1,747	1,980	2.3	195	8.959	10.153	68,328	70,308	16.0	97.2
1. Angono	-	-	-	-	-	-	-	-	-	-
2. Antipolo	1,565	1,773	2.1	44	35.561	40.301	12,025	13,798	3.1	87.1
3. Baras	-	-	-	-	-	-	-	-	-	-
4. Binangonan	-	-	-	-	-	-	-	-	-	-
5. Cainta	42	48	0.1	34	1.247	1.414	36,173	36,221	8.2	99.9
6. Cardona	-	-	-	-	-	-	-	-	-	-
7. Jala-Jala	-	-	-	-	-	-	-	-	-	-
8. Montalban	15	17	0.0	13	1.151	1.305	2,941	2,958	0.7	99.4
9. Morong	-	-	-	-	-	-	-	-	-	-
10. Pililla	-	-	-	-	-	-	-	-	-	-
11. San Mateo	48	55	0.1	47	1.029	1.166	604	658	0.1	91.7
12. Tanay	-	-	-	-	-	-	-	-	-	-
13. Taytay	77	87	0.1	57	1.343	1.522	16,586	16,672	3.8	99.5
14. Teresa	-	-	-	-	-	-	-	-	-	-
TOTAL	74,552	84,490	100.0	7,832	9.519	10.788	354,904	439,394	100.0	80.8

Billed Water Consumption categorized in Others are included in Industrial Consumption

TABLE 6.2.4 PROJECTED DOMESTIC WATER CONSUMPTION BY CITY/MUNICIPALITY IN 2010

CITY/MUNICIPALITY	TOTAL POPULATION (2010)			PER CAPITA CONSUMPTION		DOMESTIC CONSUMPTION (2010)			MWSS CONNECTED %			MWSS CONNECTED POPULATION			MWSS DOMESTIC CONSUMPTION			PRIVATE DOM. CONSUMPTION		
	TOTAL	GENERAL	WATER BLIGHTED	GEN'L (LPCD)	BL'D (LPCD)	GENERAL (M3/D)	WATER BLIGHTED (M3/D)	TOTAL (M3/D)	GEN'L POP.	WATER BL'D POP.	MWSS TOTAL POP.	GENERAL POP.	WATER BLIGHTED POP.	TOTAL POP.	GENERAL (M3/D)	WATER BLIGHTED (M3/D)	TOTAL (M3/D)	GENERAL (M3/D)	WATER BLIGHTED (M3/D)	TOTAL (M3/D)
I. NCR	11,649,608	9,319,686	2,329,922	204	35	1,905,235	81,547	1,986,777	92	75	89	8,581,840	1,747,441	10,329,281	1,753,085	61,160	1,814,246	152,144	20,387	172,531
CITY OF MANILA	1,721,147	1,464,188	258,959	200	35	292,838	9,064	301,901	95	75	92	1,390,978	194,219	1,585,198	278,196	6,798	284,993	14,642	2,266	16,908
PASAY CITY *a	475,225	326,828	148,397	200	35	65,366	5,194	70,560	95	75	89	310,487	111,298	421,784	62,097	3,895	65,993	3,268	1,298	4,567
QUEZON CITY	2,323,154	1,860,880	462,274	200	35	372,176	16,180	388,356	95	75	91	1,767,836	346,705	2,114,542	353,567	12,135	365,702	18,609	4,045	22,654
CALOOCAN CITY *a	1,164,630	838,274	326,356	200	35	167,655	11,422	179,077	90	75	86	754,446	244,767	999,214	150,889	8,567	159,456	16,765	2,856	19,621
LAS PINAS *s	878,109	767,379	110,730	200	35	153,476	3,876	157,351	85	75	84	652,272	83,047	735,320	130,454	2,907	133,361	23,021	969	23,990
MAKATI	553,794	482,794	70,997	220	35	106,215	2,485	108,700	95	75	92	458,657	53,248	511,905	100,904	1,864	102,768	5,311	621	5,932
MALABON *a	360,515	288,282	72,233	200	35	57,656	2,528	60,185	90	75	87	259,454	54,175	313,629	51,891	1,896	53,787	5,766	632	6,398
MANDALUYONG	305,315	242,650	62,665	200	35	48,530	2,193	50,723	95	75	91	230,517	46,999	277,516	46,103	1,645	47,748	2,426	548	2,975
MARIKINA	483,621	395,470	88,151	200	35	79,094	3,085	82,179	95	75	91	375,697	66,113	441,810	75,139	2,314	77,453	3,955	771	4,726
MUNTINLUPA *s	565,215	451,573	113,642	200	35	90,315	3,977	94,292	85	75	83	383,837	85,232	469,069	76,767	2,983	79,750	13,547	994	14,542
NAVOTAS *a	251,550	180,739	70,811	200	35	36,148	2,478	38,626	95	75	89	171,702	53,109	224,810	34,340	1,859	36,199	1,807	620	2,427
PARANAQUE *s	541,964	502,098	39,866	256	35	125,525	1,395	126,920	85	75	84	426,783	29,899	456,683	106,696	1,046	107,742	18,829	349	19,178
PASIG	648,283	519,301	128,982	200	35	103,860	4,514	108,375	95	75	91	493,336	96,736	590,072	98,667	3,386	102,053	5,193	1,129	6,322
PATEROS *a	74,945	66,282	8,663	200	35	13,256	303	13,560	90	75	88	59,654	6,497	66,151	11,931	227	12,158	1,326	76	1,401
SAN JUAN	141,007	130,635	10,372	250	35	32,659	363	33,022	95	75	94	124,103	7,779	131,882	31,026	272	31,298	1,633	91	1,724
TAGUIG *a	427,323	352,472	74,851	200	35	70,494	2,620	73,114	90	75	87	317,224	56,139	373,363	63,445	1,965	65,410	7,049	655	7,704
VALENZUELA *a	731,811	449,840	281,971	200	35	89,968	9,869	99,837	90	75	84	404,856	211,479	616,334	80,971	7,402	88,373	8,997	2,467	11,464
II. CAVITE	756,085	744,387	11,698	200	35	148,877	409	149,287	87	56	86	644,697	6,494	651,190	128,939	227	129,167	19,938	182	20,120
BACOOR *f,s	313,836	309,444	4,394	200	35	61,889	154	62,043	85	75	85	263,027	3,296	266,323	52,605	115	52,721	9,283	38	9,322
CAVITE CITY *f	112,628	111,952	676	200	35	22,390	24	22,414	100	100	100	111,952	676	112,628	22,390	24	22,414	0	0	0
IMUS *f	148,542	146,579	1,963	200	35	29,316	69	29,385	85	51	84	124,258	995	125,253	24,852	35	24,888	4,464	34	4,498
KAWIT *f	75,407	75,106	301	200	35	15,021	11	15,032	100	100	100	75,105	302	75,407	15,021	11	15,032	0	0	0
NOVELETA	30,955	30,476	479	200	35	6,095	17	6,112	87	69	86	26,422	328	26,751	5,284	11	5,296	811	5	816
ROSARIO *f	74,715	70,830	3,885	200	35	14,356	136	14,302	62	23	60	43,932	897	44,829	8,706	31	8,818	5,380	105	5,484
III. RIZAL	1,667,207	1,242,272	424,936	186	36	230,791	15,185	245,976	81	14	64	1,006,835	61,112	1,067,947	190,411	2,405	192,815	40,381	12,780	53,161
ANGONO *r	80,788	56,552	24,236	205	35	11,583	848	12,431	100	0	70	56,552	0	56,552	11,583	0	11,583	0	848	848
ANTIPOLO *f	435,886	376,317	59,569	162	46	60,883	2,740	63,623	58	19	53	218,993	11,261	230,254	35,430	518	35,948	25,453	2,222	27,675
BARAS *r	24,182	3,412	20,770	205	30	699	630	1,329	100	0	14	3,412	0	3,412	699	0	699	0	630	630
BINANGONAN *r	169,117	108,067	61,050	205	34	22,135	2,063	24,198	100	0	64	108,067	0	108,067	22,135	0	22,135	0	2,063	2,063
CAINTA *s	295,546	266,082	29,565	200	35	53,216	1,035	54,251	90	75	89	239,473	22,173	261,647	47,895	776	48,671	5,322	259	5,580
CARDONA *r	38,952	5,348	33,604	205	30	1,095	1,020	2,115	100	0	14	5,348	0	5,348	1,095	0	1,095	0	1,020	1,020
JALA-JALA *r	20,826	4,821	16,005	205	31	988	490	1,478	100	0	23	4,821	0	4,821	988	0	988	0	490	490
MONTALBAN *f	96,318	85,317	11,001	129	46	10,969	506	11,475	83	44	78	70,530	4,788	75,318	9,068	220	9,288	1,901	286	2,187
MORONG *r	43,304	11,947	31,357	205	31	2,447	966	3,413	100	0	28	11,947	0	11,947	2,447	0	2,447	0	966	966
PILILLA *r	43,312	14,971	28,341	205	31	3,067	882	3,949	100	0	35	14,971	0	14,971	3,067	0	3,067	0	882	882
SAN MATEO *f	115,769	83,360	32,409	219	46	18,260	1,491	19,750	77	25	63	64,384	8,105	72,489	14,103	373	14,476	4,157	1,118	5,274
TANAY *r	83,535	40,939	42,596	205	32	8,385	1,366	9,751	100	0	49	40,939	0	40,939	8,385	0	8,385	0	1,366	1,366
TAYTAY *s	197,131	177,418	19,713	200	35	35,484	690	36,174	90	75	89	159,676	14,785	174,461	31,935	517	32,453	3,548	172	3,721
TERESA *r	22,441	7,721	14,720	205	31	1,581	458	2,039	100	0	34	7,721	0	7,721	1,581	0	1,581	0	458	458
TOTAL	14,072,900	11,306,345	2,766,555	202	35	2,284,899	97,141	2,382,040	91	66	86	10,233,371	1,815,047	12,048,418	2,072,436	63,792	2,136,228	212,463	33,349	245,812

NOTE: 1. Areas with (*a) have suppressed demand due to low water pressure, and be expected to be improved by AWSOP.
2. Areas with (*s) also have suppressed demand due to low water pressure, and be expected to be improved by MSWDP.
3. Areas with (*f) have suppressed demand due to limited water sources, and be expected to be improved by PAWSP.
4. Areas with (*r) are merged area under RP799, and be expected to be improved by RPWSIP.

TABLE 6.2.5 MWSS COMMERCIAL CONSUMPTION PROJECTION

CITY/MUNICIPALITY	1990 ESTIMATED CONSUMPTION				1995			2000			2005			2010		
	TOTAL QT'TY (M3/DAY)	% IN TOTAL	MWSS SHARE (%)	PRIV. SHARE (%)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)
I. NCR	434,665	96.4	78.5	21.5	550,461	448,632	101,829	671,952	561,191	110,761	792,069	672,476	119,593	913,196	784,697	128,498
1. Manila *	136,183	30.2	96.6	3.4	172,462	167,797	4,665	210,526	205,861	4,665	248,160	243,494	4,665	286,109	281,444	4,665
2. Pasay City *	25,338	5.6	65.3	34.7	32,088	23,293	8,795	39,170	30,375	8,795	46,172	37,377	8,795	53,233	44,438	8,795
3. Quezon City *	113,981	25.3	75.7	24.3	144,346	116,705	27,641	176,204	148,563	27,641	207,702	180,061	27,641	239,464	211,824	27,641
4. Caloocan City *	15,088	3.3	75.6	24.4	19,107	15,433	3,674	23,324	19,650	3,674	27,494	23,820	3,674	31,698	28,024	3,674
5. Las Pinas	4,299	1.0	14.4	85.6	5,444	786	4,658	6,646	959	5,686	7,833	1,131	6,703	9,031	1,303	7,728
6. Makati *	59,269	13.1	80.2	19.8	75,058	63,337	11,721	91,624	79,903	11,721	108,003	96,282	11,721	124,519	112,798	11,721
7. Malabon *	5,224	1.2	61.4	38.6	6,616	4,600	2,016	8,076	6,060	2,016	9,519	7,504	2,016	10,975	8,959	2,016
8. Mandaluyong *	13,338	3.0	84.0	16.0	16,891	14,763	2,128	20,620	18,491	2,128	24,305	22,177	2,128	28,022	25,894	2,128
9. Marikina	5,280	1.2	73.5	26.5	6,687	4,914	1,773	8,163	5,999	2,164	9,622	7,071	2,551	11,094	8,153	2,941
10. Muntinlupa	8,308	1.8	0.9	99.1	10,521	99	10,423	12,843	120	12,723	15,139	142	14,997	17,454	163	17,291
11. Navotas *	2,655	0.6	76.6	23.4	3,363	2,742	621	4,105	3,484	621	4,839	4,218	621	5,578	4,958	621
12. Paranaque	11,624	2.6	57.7	42.3	14,720	8,497	6,223	17,969	10,372	7,597	21,181	12,226	8,955	24,420	14,096	10,324
13. Pasig	16,004	3.5	58.4	41.6	20,268	11,836	8,431	24,741	14,448	10,292	29,163	17,031	12,132	33,623	19,636	13,987
14. Pateros	56	0.0	100.0	0.0	71	71	0	86	86	0	102	102	0	117	117	0
15. San Juan *	8,299	1.8	98.8	1.2	10,510	10,412	97	12,829	12,732	97	15,122	15,025	97	17,435	17,338	97
16. Taguig	4,016	0.9	9.0	91.0	5,086	457	4,629	6,208	558	5,650	7,318	658	6,660	8,437	758	7,679
17. Valenzuela	5,705	1.3	40.0	60.0	7,224	2,880	4,335	8,819	3,528	5,291	10,395	4,158	6,237	11,985	4,794	7,191
II. CAVITE	6,399	1.4	19.1	80.9	8,103	1,550	6,554	9,892	1,892	8,000	11,660	2,220	9,430	13,443	2,571	10,873
1. Bacoor	971	0.2	27.6	72.4	1,230	340	890	1,502	415	1,087	1,770	489	1,281	2,041	564	1,477
2. Cavite City	4,207	0.9	17.3	82.7	5,327	921	4,406	6,503	1,124	5,379	7,666	1,325	6,341	8,838	1,528	7,310
3. Imus	709	0.2	9.1	90.9	898	82	816	1,096	100	996	1,292	118	1,174	1,490	136	1,354
4. Kawit	122	0.0	100.0	0.0	155	155	0	189	189	0	222	222	0	256	256	0
5. Noveleta	5	0.0	100.0	0.0	6	6	0	8	8	0	9	9	0	10	10	0
6. Rosario	385	0.1	9.5	90.5	487	46	441	595	56	539	701	66	635	808	77	732
III. RIZAL	9,983	2.2	16.5	83.5	15,668	5,109	10,559	20,285	7,396	12,889	25,513	10,320	15,193	31,370	13,854	17,517
1. Angono	-	-	-	-	623	623	0	1,028	1,028	0	1,585	1,585	0	2,317	2,317	0
2. Antipolo	3,367	0.7	17.9	82.1	4,264	765	3,499	5,205	934	4,271	6,136	1,101	5,035	7,074	1,269	5,805
3. Baras	-	-	-	-	25	25	0	38	38	0	80	80	0	140	140	0
4. Binangonan	-	-	-	-	1,402	1,402	0	2,180	2,180	0	3,183	3,183	0	4,427	4,427	0
5. Cainta	3,622	0.8	12.4	87.6	4,587	569	4,018	5,500	695	4,905	6,601	819	5,782	7,610	944	6,667
6. Cardona	-	-	-	-	98	98	0	126	126	0	168	168	0	219	219	0
7. Jala-Jala	-	-	-	-	15	15	0	54	54	0	114	114	0	198	198	0
8. Montalban	886	0.2	4.7	95.3	1,122	53	1,069	1,370	64	1,305	1,614	76	1,539	1,861	87	1,774
9. Morong	-	-	-	-	191	191	0	251	251	0	354	354	0	489	489	0
10. Pililla	-	-	-	-	141	141	0	232	232	0	432	432	0	613	613	0
11. San Mateo	576	0.1	32.2	67.8	729	235	494	890	287	603	1,049	338	711	1,209	390	819
12. Tanay	-	-	-	-	434	434	0	785	785	0	1,176	1,176	0	1,677	1,677	0
13. Taytay	1,532	0.3	23.8	76.2	1,941	462	1,478	2,369	565	1,804	2,792	665	2,127	3,219	767	2,452
14. Teresa	-	-	-	-	96	96	0	158	158	0	229	229	0	316	316	0
TOTAL	451,047	100.0	76.3	23.7	574,232	455,291	118,941	702,129	570,478	131,651	829,242	685,026	144,216	958,009	801,121	156,888

TABLE 6.2.6 MWSS INDUSTRIAL CONSUMPTION PROJECTION

CITY/MUNICIPALITY	1990 ESTIMATED CONSUMPTION				1995			2000			2005			2010		
	TOTAL QT'TY (M3/DAY)	% IN TOTAL	MWSS SHARE (%)	PRIV. SHARE (%)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)	TOTAL QT'TY (M3/D)	MWSS QT'TY (M3/D)	PRIVATE QT'TY (M3/D)
I. NCR	362,048	82.4	22.5	77.5	437,871	113,331	324,540	515,868	146,218	369,650	588,825	176,980	411,845	659,386	206,731	452,655
1. Manila *	23,403	5.3	75.3	24.7	28,394	22,519	5,786	33,346	27,560	5,786	38,062	32,276	5,786	42,623	38,837	5,786
2. Pasay City *	4,293	1.0	21.4	78.6	5,192	1,817	3,375	6,116	2,742	3,375	6,981	3,607	3,375	7,818	4,443	3,375
3. Quezon City *	51,708	11.8	37.4	62.6	62,538	30,170	32,368	73,677	41,310	32,368	84,097	51,730	32,368	94,175	61,807	32,368
4. Caloocan City *	13,923	3.2	66.5	33.5	16,839	12,175	4,665	19,839	15,174	4,665	22,644	17,980	4,665	25,358	20,693	4,665
5. Las Pinas	21,115	4.8	0.7	99.3	25,537	189	25,348	30,086	222	29,863	34,341	254	34,087	38,456	284	38,171
6. Makati *	8,041	1.8	57.9	42.1	9,725	6,342	3,383	11,458	8,074	3,383	13,078	9,694	3,383	14,645	11,262	3,383
7. Malabon *	20,537	4.7	29.1	70.9	24,838	10,273	14,565	29,263	14,698	14,565	33,401	18,836	14,565	37,404	22,839	14,565
8. Mandaluyong *	13,151	3.0	59.3	40.1	15,906	10,553	5,353	18,739	13,386	5,353	21,389	16,036	5,353	23,952	18,599	5,353
9. Marikina	8,239	1.9	17.1	82.9	9,965	1,701	8,264	11,739	2,004	9,736	13,400	2,287	11,113	15,005	2,561	12,444
10. Muntinlupa	34,360	7.8	0.2	99.8	41,556	97	41,459	48,958	114	48,844	55,882	130	55,751	62,578	146	62,432
11. Navotas *	3,752	0.9	53.8	46.2	4,550	2,811	1,739	5,360	3,621	1,739	6,118	4,379	1,739	6,852	5,112	1,739
12. Paranaque	19,378	4.4	8.7	91.3	23,427	2,031	21,396	27,600	2,393	25,207	31,503	2,731	28,772	35,278	3,059	32,220
13. Pasig	68,156	15.5	11.9	88.1	82,430	9,770	72,659	97,113	11,511	85,602	110,847	13,139	97,708	124,130	14,713	109,417
14. Pateros	1,760	0.4	0.2	99.8	2,128	4	2,124	2,507	5	2,502	2,862	6	2,856	3,205	6	3,198
15. San Juan *	1,259	0.3	95.3	4.7	1,522	1,463	59	1,794	1,735	59	2,047	1,988	59	2,293	2,234	59
16. Taguig	41,208	9.4	0.0	100.0	49,838	11	49,826	58,715	13	58,702	67,019	15	67,004	75,050	17	75,033
17. Valenzuela	27,763	6.3	4.2	95.8	33,577	1,406	32,171	39,558	1,656	37,902	45,153	1,891	43,262	50,564	2,117	48,446
II. CAVITE	7,037	1.6	16.3	83.7	8,511	1,389	7,122	10,027	1,637	8,391	11,445	1,868	9,577	12,817	2,092	10,725
1. Bacoor	70	0.0	100.0	0.0	85	85	0	100	100	0	114	114	0	128	128	0
2. Cavite City	238	0.1	100.0	0.0	288	288	0	339	339	0	387	387	0	433	433	0
3. Imus	536	0.1	1.3	98.7	650	9	641	766	10	756	874	12	863	979	13	966
4. Kawit	574	0.1	100.0	0.0	694	694	0	818	818	0	934	934	0	1,045	1,045	0
5. Novelete	88	0.0	100.0	0.0	107	107	0	126	126	0	143	143	0	161	161	0
6. Rosario	5,530	1.3	3.1	96.9	6,688	207	6,481	7,879	244	7,635	8,993	278	8,715	10,071	312	9,759
III. RIZAL	70,308	16.0	2.8	97.2	90,479	3,347	87,131	108,913	5,440	103,472	127,524	9,149	118,375	146,764	14,834	131,930
1. Angono	-	-	-	-	1,121	196	925	1,850	555	1,295	2,854	1,284	1,570	4,170	2,502	1,668
2. Antipolo	13,798	3.1	12.9	87.1	16,698	2,145	14,543	19,661	2,527	17,134	22,441	2,884	19,557	25,130	3,230	21,901
3. Baras	-	-	-	-	46	8	38	68	20	48	144	65	79	252	151	101
4. Binangonan	-	-	-	-	2,523	442	2,081	3,924	1,177	2,747	5,729	2,578	3,151	7,968	4,781	3,187
5. Cainta	36,221	8.2	0.1	99.9	43,807	58	43,748	51,610	68	51,541	58,909	78	58,831	65,968	88	65,880
6. Cardona	-	-	-	-	177	31	146	227	68	159	303	136	167	395	237	158
7. Jala-Jala	-	-	-	-	27	5	22	97	29	68	204	92	112	355	213	142
8. Montalban	3,958	0.7	0.6	99.4	3,578	21	3,557	4,215	24	4,191	4,811	28	4,784	5,386	31	5,357
9. Morong	-	-	-	-	344	60	284	451	135	316	636	286	350	881	529	352
10. Pililla	-	-	-	-	253	44	209	417	125	292	778	350	428	1,104	662	442
11. San Mateo	658	0.1	8.3	91.7	796	66	730	938	78	860	1,071	89	982	1,199	100	1,099
12. Taney	-	-	-	-	782	137	645	1,413	424	989	2,118	953	1,165	3,019	1,811	1,208
13. Taytay	16,672	3.8	0.5	99.5	20,164	105	20,059	23,756	124	23,632	27,116	141	26,975	30,365	158	30,207
14. Teresa	-	-	-	-	173	30	143	286	86	200	411	185	226	570	342	228
TOTAL	439,394	100.0	19.2	80.8	536,861	118,068	418,793	634,808	153,295	481,513	727,795	187,997	539,798	818,967	223,657	595,310

* Future demand increase was assumed to be shouldered by MWSS only.

TABLE 6.2.7 SUMMARY OF PROJECTED WATER DEMAND IN 1995 (CASE 3)

CITY/ MUNICIPALITY	MWSS SERVED WATER DEMAND (M3/D)						PRIVATELY SERVED WATER DEMAND (M3/D)				TOTAL WATER DEMAND (M3/D)					MWSS SERVICE RATIO (%)			
	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	LOSS %	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	TOTAL	D	C	I	T
I. NCR	1,126,290	448,632	113,331	909,059	35.0	2,597,312	315,907	101,829	324,540	742,276	1,442,197	550,461	437,871	909,059	3,339,588	78.1	81.5	25.9	77.8
1. Manila	252,399	167,797	22,519	238,385	35.0	681,100	19,345	4,665	5,786	29,796	271,745	172,462	28,304	238,385	710,897	92.9	97.3	79.6	95.8
2. Pasay City	43,524	23,293	1,817	36,957	35.0	105,590	10,561	8,795	3,375	22,731	54,085	32,088	5,192	36,957	128,321	80.5	72.6	35.0	82.3
3. Quezon City	270,472	116,705	30,170	224,725	35.0	642,072	23,246	27,641	32,368	83,254	293,717	144,346	62,538	224,725	725,326	92.1	80.9	48.2	88.5
4. Caloocan City	81,416	15,433	12,175	58,705	35.0	167,729	39,838	3,674	4,665	48,176	121,254	19,107	16,839	58,705	215,905	67.1	80.8	72.3	77.7
5. Las Pinas	29,775	786	189	16,558	35.0	47,307	37,007	4,658	25,348	67,013	66,782	5,444	25,537	16,558	114,320	44.6	14.4	0.7	41.4
6. Makati	80,974	63,337	6,342	81,121	35.0	231,774	10,477	11,721	3,383	25,581	91,451	75,058	9,725	81,121	257,355	88.5	84.4	65.2	90.1
7. Malabon	31,384	4,600	10,273	24,908	35.0	71,165	14,689	2,016	14,565	31,270	46,074	6,616	24,838	24,908	102,435	68.1	69.5	41.4	69.5
8. Mandaluyong	36,610	14,763	10,553	33,345	35.0	95,271	3,248	3,128	3,353	10,729	39,858	16,891	15,906	33,345	106,000	91.9	87.4	66.3	88.9
9. Marikina	52,397	4,914	1,701	31,776	35.0	90,788	4,343	1,773	8,264	14,380	56,741	6,687	9,965	31,776	105,169	92.3	73.5	17.1	86.3
10. Muntinlupa	20,636	99	97	11,217	35.0	32,049	31,571	10,423	41,459	83,453	52,208	10,521	41,556	11,217	115,501	39.5	0.9	0.2	27.7
11. Navotas	24,677	2,742	2,811	16,278	35.0	46,507	4,120	621	1,739	6,480	28,797	3,363	4,550	16,278	52,987	85.7	81.5	61.8	87.8
12. Paranaque	62,384	8,497	2,031	39,583	35.0	113,096	42,310	6,223	21,396	69,929	105,294	14,720	23,427	39,583	183,025	59.8	57.7	8.7	61.8
13. Pasig	52,935	11,836	9,770	45,522	35.0	130,063	9,182	9,431	72,659	90,273	72,117	20,268	82,430	45,522	220,336	87.3	58.4	11.9	59.0
14. Pateros	4,252	71	4	2,330	35.0	6,657	5,277	0	2,124	7,401	9,529	71	2,128	2,330	14,057	44.6	100.0	0.2	47.4
15. San Juan	29,410	10,412	1,463	22,231	35.0	63,517	1,731	97	59	1,887	31,141	10,510	1,522	22,231	65,404	94.4	99.1	96.1	97.1
16. Taguig	9,793	457	11	5,525	35.0	15,787	38,207	4,629	49,826	92,662	48,000	5,086	49,838	5,525	108,449	20.4	9.0	0.0	14.6
17. Valenzuela	32,651	2,890	1,406	19,894	35.0	56,841	20,755	4,335	32,171	57,261	53,406	7,224	33,577	19,894	114,101	61.1	40.0	4.2	49.8
II. CAVITE	44,332	1,550	1,389	20,259	30.0	67,529	49,094	6,554	7,122	62,769	93,425	8,103	8,511	20,259	130,299	47.5	19.1	16.3	51.8
1. Bacoor	15,408	340	85	6,785	30.0	22,617	18,918	890	0	19,808	34,325	1,230	85	6,785	42,425	44.9	27.6	100.0	53.3
2. Cavite City	10,954	921	288	5,213	30.0	17,375	6,511	4,406	0	10,917	17,465	5,327	288	5,213	28,293	62.7	17.3	100.0	61.4
3. Imus	7,731	82	9	3,374	30.0	11,245	11,023	816	641	12,480	18,804	898	650	3,374	23,725	41.4	9.1	1.3	47.4
4. Kawit	6,802	155	694	3,279	30.0	10,929	3,041	0	0	3,041	9,843	155	694	3,279	13,971	69.1	100.0	100.0	78.2
5. Noveleta	1,022	6	107	486	30.0	1,621	3,059	0	0	3,059	4,080	6	107	486	4,680	25.0	100.0	100.0	34.6
6. Rosario	2,366	46	207	1,123	30.0	3,742	6,542	441	6,481	13,464	8,908	487	6,688	1,123	17,205	26.6	9.5	3.1	21.7
III. RIZAL	47,536	5,109	3,347	20,750	27.0	76,743	71,104	10,559	87,131	168,794	118,640	15,668	90,479	20,750	245,537	40.1	32.6	3.7	31.3
1. Angono	3,115	623	196	694	15.0	4,628	1,156	0	925	2,081	4,271	623	1,121	694	6,709	72.9	100.0	17.5	69.0
2. Antipolo	11,090	765	2,145	6,000	30.0	19,999	19,774	3,499	14,543	37,816	30,864	4,264	16,688	6,000	57,816	35.9	17.9	12.9	34.6
3. Baras	127	25	8	28	15.0	188	558	0	38	596	685	25	46	28	784	18.5	100.0	17.4	23.9
4. Binangonan	7,008	1,402	442	1,562	15.0	10,414	3,109	0	2,081	5,190	10,117	1,402	2,523	1,562	15,604	69.3	100.0	17.5	66.7
5. Cainta	6,273	569	58	3,716	35.0	10,616	18,589	4,018	43,748	66,356	24,862	4,587	43,807	3,716	76,972	25.2	12.4	0.1	13.8
6. Cardona	490	98	31	109	15.0	728	966	0	146	1,112	1,456	98	177	109	1,840	33.7	100.0	17.5	39.6
7. Jala-Jala	73	15	5	16	15.0	109	542	0	22	564	615	15	27	16	673	11.9	100.0	18.5	16.2
8. Montalban	3,903	53	21	1,704	30.0	5,680	3,292	1,069	3,557	7,918	7,195	1,122	3,578	1,704	13,599	54.2	4.7	0.6	41.8
9. Morong	955	191	60	213	15.0	1,419	861	0	284	1,145	1,816	191	344	213	2,564	52.6	100.0	17.4	55.3
10. Pililla	703	141	44	157	15.0	1,045	993	0	209	1,202	1,696	141	253	157	2,247	41.5	100.0	17.4	46.5
11. San Mateo	4,352	235	66	1,994	30.0	6,648	6,273	494	730	7,502	10,630	729	796	1,994	14,150	40.9	32.2	8.3	47.0
12. Tanay	2,170	434	137	484	15.0	3,225	1,656	0	645	2,301	3,826	434	782	484	5,526	56.7	100.0	17.5	58.4
13. Taytay	6,798	462	105	3,966	35.0	11,331	12,754	1,478	20,059	34,291	19,552	1,941	20,164	3,966	45,622	34.8	23.8	0.5	24.8
14. Teresa	480	96	30	107	15.0	713	575	0	143	718	1,055	96	173	107	1,431	45.5	100.0	17.3	49.8
TOTAL	1,218,158	455,291	118,068	950,068	34.7	2,741,584	436,105	118,941	418,793	973,839	1,654,262	574,232	536,861	950,068	3,715,423	73.6	79.3	22.0	73.8

TABLE 6.2.8 SUMMARY OF PROJECTED WATER DEMAND IN 2000 (CASE 3)

CITY/ MUNICIPALITY	MWSS SERVED WATER DEMAND (M3/D)						PRIVATELY SERVED WATER DEMAND (M3/D)				TOTAL WATER DEMAND (M3/D)					MWSS SERVICE RATIO (%)			
	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	LOSS %	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	TOTAL	D	C	I	T
I. NCR	1,420,282	561,191	146,218	911,833	30.0	3,039,444	211,812	110,761	369,650	692,223	1,632,014	671,952	515,868	911,833	3,731,667	87.0	83.5	28.3	81.5
1. Manila	267,582	205,861	27,560	214,759	30.0	715,862	17,415	4,665	5,786	27,866	285,097	210,526	33,346	214,759	743,728	93.9	97.8	82.6	96.3
2. Pasay City	52,747	30,375	2,742	36,799	30.0	122,662	7,448	8,795	3,375	19,618	60,195	39,170	6,116	36,799	142,280	87.6	77.5	44.8	86.2
3. Quezon City	307,254	148,563	41,310	213,055	30.0	710,182	21,462	27,541	32,368	81,471	328,717	176,204	73,677	213,055	791,653	93.5	84.3	56.1	89.7
4. Caloocan City	110,825	19,650	15,174	62,421	30.0	208,070	30,123	3,674	4,665	38,462	140,948	23,324	19,839	62,421	246,532	78.6	84.2	76.5	84.4
5. Las Pinas	56,920	959	222	30,043	30.0	100,145	23,463	5,686	29,863	59,013	92,383	6,646	30,086	30,043	159,158	74.6	14.4	0.7	62.9
6. Makati	92,691	79,903	8,074	77,429	30.0	258,098	5,740	11,721	3,383	20,844	98,432	91,624	11,458	77,429	278,943	94.2	87.2	70.5	92.5
7. Malabon	40,574	6,060	14,698	26,285	30.0	87,616	10,723	2,016	14,565	27,304	51,297	8,076	29,263	26,285	114,921	79.1	75.0	50.2	76.2
8. Mandaluyong	41,038	18,491	13,386	31,250	30.0	104,166	2,914	2,128	5,353	10,395	43,952	20,620	18,739	31,250	114,560	93.4	89.7	71.4	90.9
9. Marikina	61,462	5,999	2,004	29,770	30.0	99,235	4,194	2,164	9,736	16,094	65,656	8,163	11,739	29,770	115,328	93.6	73.5	17.1	86.0
10. Muntinlupa	48,677	120	114	20,962	30.0	69,874	16,821	12,723	48,844	78,387	65,498	12,843	48,958	20,962	148,261	74.3	0.9	0.2	47.1
11. Navotas	29,978	3,484	3,621	15,893	30.0	52,977	2,401	621	1,739	4,761	32,379	4,105	5,360	15,893	57,737	92.6	84.9	67.6	91.8
12. Paranaque	92,068	10,372	2,393	44,928	30.0	149,761	23,296	7,597	25,207	56,100	115,364	17,969	27,600	44,928	205,861	79.8	57.7	8.7	72.7
13. Pasig	79,047	14,448	11,511	45,003	30.0	150,009	5,536	10,292	85,602	101,430	84,583	24,741	97,113	45,003	251,439	93.5	58.4	11.9	59.7
14. Pateros	7,638	86	5	3,312	30.0	11,041	3,311	0	2,502	5,813	10,949	86	2,507	3,312	16,854	69.8	100.0	0.2	65.5
15. San Juan	30,409	12,732	1,735	19,232	30.0	64,108	1,732	97	59	1,888	32,141	12,829	1,794	19,232	65,996	94.6	99.2	96.7	97.1
16. Taguig	39,371	556	13	17,118	30.0	57,060	17,185	5,650	58,702	81,537	56,556	6,206	58,715	17,118	138,597	69.6	9.0	0.0	41.2
17. Valenzuela	49,820	3,528	1,656	23,573	30.0	78,578	18,048	5,291	37,902	61,241	67,868	8,819	39,558	23,573	139,818	73.4	40.0	4.2	56.2
II. CAVITE	78,768	1,892	1,637	35,270	30.0	117,566	32,641	8,000	8,391	49,032	111,409	9,892	10,027	35,270	166,598	70.7	19.1	16.3	70.6
1. Bacoor	34,252	415	100	14,900	30.0	49,666	8,626	1,087	0	9,713	42,878	1,502	100	14,900	59,379	79.9	27.6	100.0	83.6
2. Cavite City	14,987	1,124	339	7,050	30.0	23,500	4,270	5,379	0	9,649	19,256	6,503	339	7,050	33,148	77.8	17.3	100.0	70.9
3. Imus	12,683	100	10	5,483	30.0	18,277	9,599	996	756	11,351	22,283	1,096	766	5,483	29,628	56.9	9.1	1.3	61.7
4. Kawit	9,723	189	818	4,598	30.0	15,328	1,855	0	0	1,855	11,578	189	818	4,598	17,183	84.0	100.0	100.0	89.2
5. Noveleta	3,057	8	126	1,367	30.0	4,558	1,702	0	0	1,702	4,759	8	126	1,367	6,260	64.2	100.0	100.0	72.8
6. Rosario	4,066	56	244	1,871	30.0	6,238	6,590	538	7,635	14,763	10,656	595	7,879	1,871	21,001	38.2	9.5	3.1	29.7
III. RIZAL	96,991	7,396	5,440	39,070	26.2	148,897	61,900	12,889	103,472	178,262	158,891	20,285	108,913	39,070	327,159	61.0	36.5	5.0	45.5
1. Angono	5,138	1,028	555	1,186	15.0	7,907	1,124	0	1,295	2,419	6,262	1,028	1,850	1,186	10,326	82.1	100.0	30.0	76.6
2. Antipolo	17,690	934	2,521	9,064	30.0	30,215	23,877	4,271	17,134	45,283	41,567	5,205	19,661	9,064	75,498	42.6	17.9	12.9	40.0
3. Baras	189	38	20	44	15.0	291	610	0	48	658	799	38	68	44	949	23.7	100.0	29.5	30.6
4. Binangonan	10,902	2,180	1,177	2,516	15.0	16,775	2,873	0	2,747	5,620	13,775	2,180	3,924	2,516	22,395	79.1	100.0	30.0	74.9
5. Cainta	24,761	695	68	10,939	30.0	36,463	10,715	4,905	51,541	67,162	35,476	5,600	51,610	10,939	103,625	69.8	12.4	0.1	35.2
6. Cardona	631	126	68	146	15.0	971	1,005	0	159	1,164	1,636	126	227	146	2,135	38.6	100.0	30.0	45.5
7. Jala-Jala	269	54	29	62	15.0	414	542	0	68	610	811	54	97	62	1,024	33.2	100.0	29.9	40.4
8. Montalban	5,644	64	24	2,467	30.0	8,189	3,070	1,305	4,191	8,566	8,714	1,370	4,215	2,467	16,755	64.8	4.7	0.5	48.9
9. Morong	1,253	251	135	289	15.0	1,928	900	0	316	1,216	2,153	251	451	289	3,144	58.2	100.0	29.9	61.3
10. Pililla	1,161	232	125	268	15.0	1,786	1,010	0	292	1,302	2,171	232	417	268	3,088	53.5	100.0	30.0	57.8
11. San Mateo	6,883	287	78	3,106	30.0	10,354	6,381	603	860	7,844	13,264	890	938	3,106	18,198	51.9	32.2	8.3	56.9
12. Tanay	3,924	785	424	906	15.0	6,039	1,570	0	989	2,559	5,494	785	1,413	906	8,598	71.4	100.0	30.0	70.2
13. Taytay	17,754	565	124	7,904	30.0	26,346	7,683	1,804	23,632	33,120	25,437	2,369	23,756	7,904	59,466	69.8	23.8	0.5	44.3
14. Teresa	792	158	86	183	15.0	1,219	539	0	200	739	1,331	158	286	183	1,958	59.5	100.0	30.1	62.3
TOTAL	1,595,962	570,478	153,295	986,173	29.8	3,305,908	306,353	131,651	481,513	919,517	1,902,314	702,129	634,808	986,173	4,225,424	83.9	81.2	24.1	78.2

TABLE 6.2.9 SUMMARY OF PROJECTED WATER DEMAND IN 2005 (CASE 2 & 3)

CITY/ MUNICIPALITY	MWSS SERVED WATER DEMAND (M3/D)						PRIVATELY SERVED WATER DEMAND (M3/D)				TOTAL WATER DEMAND (M3/D)					MWSS SERVICE RATIO (%)			
	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	LOSS %	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	TOTAL	D	C	I	T
I. NCR	1,634,341	672,476	176,980	827,932	25.0	3,311,729	180,476	119,593	411,846	711,915	1,814,818	792,069	588,825	827,932	4,023,644	90.1	84.9	30.1	82.3
1. Manila	277,955	243,494	32,276	184,575	25.0	738,301	17,021	4,665	5,786	27,472	294,976	248,160	38,062	184,575	765,773	94.2	98.1	84.8	96.4
2. Pasay City	61,177	37,377	3,607	34,054	25.0	136,214	4,538	8,795	3,375	16,708	65,715	46,172	6,981	34,054	152,922	93.1	81.0	51.7	89.1
3. Quezon City	338,611	180,061	51,730	190,134	25.0	760,536	21,866	27,641	32,368	81,874	360,477	207,702	84,097	190,134	842,410	93.9	86.7	61.5	90.3
4. Caloocan City	134,651	23,820	17,980	58,817	25.0	235,267	25,631	3,674	4,865	33,970	160,282	27,494	22,644	58,817	269,237	84.0	86.6	79.4	87.4
5. Las Pinas	103,932	1,131	254	35,105	25.0	140,422	18,894	6,703	34,087	59,684	122,826	7,833	34,341	35,105	200,105	84.6	14.4	0.7	70.2
6. Makati	98,362	96,282	9,694	68,113	25.0	272,451	5,816	11,721	3,383	20,920	104,178	108,003	13,078	68,113	293,371	94.4	89.1	74.1	92.9
7. Malabon	47,256	1,504	18,836	24,532	25.0	98,128	8,770	2,016	14,565	25,351	56,026	3,519	33,401	24,532	123,479	84.3	78.8	56.4	79.5
8. Mandaluyong	44,675	22,177	16,036	27,629	25.0	110,518	2,913	2,128	5,353	10,394	47,587	24,305	21,389	27,629	120,911	93.9	91.2	75.0	91.4
9. Marikina	69,793	7,071	2,287	26,384	25.0	105,535	4,426	2,551	11,113	18,090	74,219	9,622	13,400	26,384	123,625	94.0	73.5	17.1	85.4
10. Muntinlupa	67,217	142	130	22,496	25.0	89,985	12,477	14,997	55,751	83,225	79,694	15,139	55,882	22,496	173,211	84.3	0.9	0.2	52.0
11. Navotas	33,300	4,218	4,379	13,966	25.0	55,863	2,377	621	1,739	4,737	35,677	4,839	6,118	13,966	60,600	93.3	87.2	71.6	92.2
12. Paranaque	104,101	12,226	2,731	39,686	25.0	158,744	18,593	8,955	28,772	56,320	122,694	21,181	31,503	39,686	215,064	84.8	57.7	8.7	73.8
13. Pasig	90,921	17,031	13,139	40,364	25.0	161,455	5,877	12,132	97,708	115,717	96,798	29,163	110,847	40,364	277,172	93.9	58.4	11.9	58.3
14. Pateros	9,815	102	6	3,307	25.0	13,229	2,489	0	2,856	5,346	12,304	102	2,862	3,307	18,575	79.8	100.0	0.2	71.2
15. San Juan	31,086	15,025	1,988	16,033	25.0	64,133	1,731	97	59	1,888	32,818	15,122	2,047	16,033	66,020	94.7	99.4	97.1	97.1
16. Taguig	51,771	658	15	17,481	25.0	69,925	13,245	6,660	67,004	86,909	65,015	7,318	67,019	17,481	156,834	79.6	9.0	0.0	44.6
17. Valenzuela	69,719	4,158	1,891	25,256	25.0	101,024	13,812	6,237	43,262	63,311	83,531	10,395	45,153	25,256	164,335	83.5	40.0	4.2	61.5
II. CAVITE	104,412	2,230	1,868	36,170	25.0	144,680	25,861	9,430	9,577	44,868	130,273	11,660	11,445	36,170	189,548	80.1	19.1	16.3	76.3
1. Bacoor	44,303	489	114	14,968	25.0	59,874	7,858	1,281	0	9,140	52,161	1,770	114	14,968	69,014	84.9	27.6	100.0	86.8
2. Cavite City	19,634	1,325	387	7,115	25.0	28,461	1,440	6,341	0	7,781	21,074	7,666	387	7,115	36,242	93.2	17.3	100.0	78.5
3. Imus	17,516	118	12	5,882	25.0	23,527	8,309	1,174	863	10,346	25,825	1,292	874	5,882	33,873	67.8	9.1	1.3	69.5
4. Kawit	12,721	222	934	4,626	25.0	18,502	603	0	0	603	13,323	222	934	4,626	19,105	95.5	100.0	100.0	96.8
5. Noveleta	4,154	9	143	1,436	25.0	5,742	1,284	0	0	1,284	5,439	9	143	1,436	7,027	76.4	100.0	100.0	81.7
6. Rosario	6,085	66	278	2,143	25.0	8,573	6,366	635	8,715	15,715	12,451	701	8,993	2,143	24,288	48.9	9.5	3.1	35.3
III. RIZAL	139,950	10,320	9,149	45,319	22.1	204,739	60,142	15,193	118,375	193,711	200,092	25,513	127,524	45,319	398,449	69.9	40.4	7.2	51.4
1. Angono	7,927	1,585	1,284	1,905	15.0	12,701	1,022	0	1,570	2,592	8,949	1,585	2,854	1,905	15,293	88.6	100.0	45.0	83.1
2. Antipolo	25,514	1,101	2,884	9,833	25.0	39,332	25,593	5,035	19,557	51,175	52,097	6,136	22,441	9,833	90,506	49.0	17.9	12.9	43.5
3. Baras	491	80	65	96	15.0	642	629	0	79	708	1,030	80	144	96	1,350	32.9	100.0	45.1	47.6
4. Binangonan	15,915	3,183	2,578	3,825	15.0	25,501	2,520	0	3,151	5,671	18,435	3,183	5,729	3,825	31,172	86.3	100.0	45.0	81.8
5. Cainta	33,617	819	78	12,171	25.0	46,686	9,014	5,782	58,831	73,627	44,632	6,601	58,909	12,171	122,313	79.8	12.4	0.1	39.8
6. Cardona	841	168	136	202	15.0	1,347	1,021	0	167	1,188	1,862	168	303	202	2,535	45.2	100.0	44.9	53.1
7. Jala-Jala	568	114	92	137	15.0	911	526	0	112	638	1,094	114	204	137	1,549	51.9	100.0	45.1	58.8
8. Montalban	7,538	76	28	2,547	25.0	10,188	2,614	1,539	4,784	8,936	10,152	1,614	4,811	2,547	19,124	74.3	4.7	0.6	53.3
9. Morong	1,768	354	286	425	15.0	2,833	940	0	350	1,290	2,708	354	636	425	4,123	65.3	100.0	45.0	68.7
10. Pililla	2,161	432	350	519	15.0	3,462	928	0	428	1,356	3,089	432	778	519	4,818	70.0	100.0	45.0	71.9
11. San Mateo	10,166	338	89	3,531	25.0	14,124	6,141	711	982	7,833	16,307	1,049	1,071	3,531	21,958	62.3	32.2	8.3	64.3
12. Tanay	5,882	1,176	953	1,414	15.0	9,425	1,497	0	1,165	2,662	7,379	1,176	2,118	1,414	12,087	79.7	100.0	45.0	78.0
13. Taytay	24,509	665	141	8,439	25.0	33,754	6,203	2,127	26,975	35,304	30,712	2,792	27,116	8,439	69,058	79.8	23.8	0.5	48.9
14. Teresa	1,143	229	185	275	15.0	1,832	504	0	226	730	1,647	229	411	275	2,562	69.4	100.0	45.0	71.5
TOTAL	1,878,704	685,026	187,997	909,422	24.8	3,661,148	266,479	144,216	539,798	950,493	2,145,183	829,242	727,795	909,422	4,611,641	87.6	82.6	25.8	79.4

TABLE 6.2.10 SUMMARY OF PROJECTED WATER DEMAND IN 2005 (CASE 2 & 3)

CITY/ MUNICIPALITY	MWSS SERVED WATER DEMAND (M3/D)						PRIVATELY SERVED WATER DEMAND (M3/D)				TOTAL WATER DEMAND (M3/D)					MWSS SERVICE RATIO (%)			
	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	LOSS %	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	TOTAL	DOMESTIC	COMMERCIAL	INDUSTRIAL	LOSS	TOTAL	D	C	I	T
I. NCR	1,814,246	784,697	206,731	935,225	25.0	3,740,899	172,531	128,498	452,655	753,685	1,986,777	913,196	659,386	935,225	4,494,583	91.3	85.9	31.4	83.2
1. Manila	284,993	281,444	36,837	201,092	25.0	804,366	16,908	4,665	5,786	27,359	301,901	286,109	42,623	201,092	831,725	94.4	98.4	86.4	96.7
2. Pasay City	55,993	44,438	4,443	38,291	25.0	153,165	4,567	8,795	3,375	16,736	70,560	53,233	7,818	38,291	169,901	93.5	83.5	56.8	90.1
3. Quezon City	365,702	211,824	61,807	213,111	25.0	852,444	22,854	27,641	32,368	82,662	388,556	239,464	94,175	213,111	935,106	94.2	88.5	65.6	91.2
4. Caloocan City	159,456	28,024	20,693	69,391	25.0	277,565	19,621	3,674	4,665	27,960	179,077	31,698	25,358	69,391	305,524	89.0	88.4	81.6	90.8
5. Las Pinas	133,361	1,303	284	44,983	25.0	179,932	23,990	7,728	38,171	69,889	157,351	9,031	38,456	44,983	249,821	84.8	14.4	0.7	72.0
6. Makati	102,758	112,798	11,262	75,609	25.0	302,437	5,932	11,721	3,383	21,036	108,700	124,519	14,645	75,609	323,473	94.5	90.6	76.9	93.5
7. Malabon	53,787	8,959	22,839	28,528	25.0	114,113	6,398	2,016	14,565	22,979	60,185	10,975	37,404	28,528	137,092	89.4	81.6	61.1	83.2
8. Mandaluyong	47,748	25,894	18,599	30,747	25.0	122,989	2,975	2,128	5,353	10,456	50,723	28,022	23,952	30,747	133,445	94.1	92.4	77.7	92.2
9. Marikina	77,453	8,153	2,561	29,389	25.0	117,556	4,726	2,941	12,444	20,112	82,179	11,094	15,005	29,389	137,668	94.2	73.5	17.1	85.4
10. Muntinlupa	79,750	163	145	26,687	25.0	106,746	14,542	17,291	62,432	94,265	94,292	17,454	62,578	26,687	201,011	84.6	0.9	0.2	53.1
11. Navotas	36,199	4,958	5,112	15,423	25.0	61,692	2,427	621	1,739	4,787	38,626	5,578	6,852	15,423	66,479	93.7	88.9	74.6	92.8
12. Paranaque	107,742	14,096	3,059	41,632	25.0	166,529	19,178	10,324	32,220	61,722	126,920	24,420	35,278	41,632	228,251	84.9	57.7	8.7	73.0
13. Pasig	102,053	19,636	14,713	45,467	25.0	181,869	6,322	13,987	109,417	129,726	108,375	33,623	124,130	45,467	311,595	94.2	58.4	11.9	58.4
14. Pateros	12,158	117	6	4,094	25.0	16,376	1,401	0	3,198	4,600	13,560	117	3,205	4,094	20,975	89.7	100.0	0.2	78.1
15. San Juan	31,298	17,338	2,234	16,956	25.0	67,826	1,724	97	59	1,880	33,022	17,435	2,293	16,956	69,706	94.8	99.4	97.4	97.3
16. Taguig	65,410	758	17	22,062	25.0	88,247	7,704	7,679	75,033	90,416	73,114	8,437	75,050	22,062	178,664	89.5	9.0	0.0	49.4
17. Valenzuela	88,373	4,794	2,117	31,761	25.0	127,045	11,464	7,191	48,446	67,101	99,837	11,985	50,564	31,761	194,147	88.5	40.0	4.2	65.4
II. CAVITE	129,167	2,571	2,092	44,610	25.0	178,439	20,120	10,873	10,725	41,718	149,287	13,443	12,817	44,610	220,157	86.6	19.1	16.3	81.1
1. Bacoor	52,721	564	128	17,804	25.0	71,216	9,322	1,477	0	10,799	62,043	2,041	128	17,804	82,015	85.0	27.6	100.0	86.8
2. Cavite City	22,414	1,528	433	8,125	25.0	32,500	0	7,310	0	7,310	22,414	8,838	433	8,125	39,810	100.0	17.3	100.0	81.6
3. Imus	24,886	136	13	8,345	25.0	33,381	4,498	1,354	966	6,818	29,385	1,490	979	8,345	40,199	84.7	9.1	1.3	83.0
4. Kawit	15,032	256	1,045	5,444	25.0	21,778	0	0	0	0	15,032	256	1,045	5,444	21,778	100.0	100.0	100.0	100.0
5. Noveleta	5,296	10	161	1,822	25.0	7,289	816	0	0	816	6,112	10	161	1,822	8,105	86.6	100.0	100.0	89.9
6. Rosario	8,818	77	312	3,069	25.0	12,275	5,484	732	9,759	15,975	14,302	808	10,071	3,069	28,250	61.7	9.5	3.1	43.5
III. RIZAL	192,815	13,854	14,834	62,289	21.9	283,791	53,161	17,517	131,930	202,608	245,976	31,370	146,764	62,289	486,399	78.4	44.2	10.1	58.3
1. Angono	11,583	2,317	2,502	2,894	15.0	19,296	848	0	1,668	2,516	12,431	2,317	4,170	2,894	21,812	93.2	100.0	60.0	88.5
2. Antipolo	35,948	1,269	3,230	13,482	25.0	53,929	27,675	5,805	21,901	55,380	63,623	7,074	25,130	13,482	109,309	56.5	17.9	12.9	49.3
3. Baras	699	140	151	175	15.0	1,165	630	0	101	731	1,329	140	252	175	1,896	52.6	100.0	59.9	61.4
4. Binangonan	22,135	4,427	4,781	5,531	15.0	36,874	2,063	0	3,187	5,250	24,198	4,427	7,968	5,531	42,124	91.5	100.0	60.0	87.5
5. Cainta	48,671	944	88	16,567	25.0	66,270	5,580	6,667	65,880	78,127	54,251	7,610	65,968	16,567	144,397	89.7	12.4	0.1	45.9
6. Cardona	1,095	219	237	274	15.0	1,825	1,020	0	158	1,178	2,115	219	395	274	3,003	51.8	100.0	60.0	60.8
7. Jala-Jala	988	198	213	247	15.0	1,646	490	0	142	632	1,478	198	355	247	2,278	66.8	100.0	60.0	72.3
8. Montalban	9,288	87	31	3,135	25.0	12,542	2,187	1,774	5,357	9,318	11,475	1,861	5,388	3,135	21,860	80.9	4.7	0.6	57.4
9. Morong	2,447	489	529	611	15.0	4,076	966	0	352	1,318	3,413	489	881	611	5,394	71.7	100.0	60.0	75.6
10. Pililla	3,067	613	662	766	15.0	5,108	882	0	442	1,324	3,949	613	1,104	766	6,432	77.7	100.0	60.0	79.4
11. San Mateo	14,476	390	109	4,989	25.0	19,954	5,274	819	1,099	7,193	19,750	1,209	1,199	4,989	27,147	73.3	32.2	8.3	73.5
12. Tanay	8,385	1,677	1,811	2,995	15.0	13,968	1,366	0	1,208	2,574	9,751	1,677	3,019	2,095	16,542	86.0	100.0	60.0	84.4
13. Taytay	32,453	767	158	11,126	25.0	44,504	3,721	2,452	30,207	36,380	36,174	3,219	30,365	11,126	80,884	89.7	23.8	0.5	55.0
14. Teresa	1,581	316	342	395	15.0	2,634	458	0	228	686	2,039	316	570	395	3,320	77.5	100.0	60.0	79.3
TOTAL	2,136,228	801,121	223,657	1,042,123	24.8	4,203,129	245,812	156,888	595,310	998,010	2,382,040	958,009	818,967	1,042,123	5,201,139	89.7	83.6	27.3	80.8

TABLE 6.2.11 ASSUMPTION IN EACH PUMPING SCENARIO

Scenario No.	MWSS Surface Water Supply Projects	Future Pumpage of Commercial & Industrial Private Wells	CDS Connection in Cavite MSA
1	On-schedule completion of ongoing projects	Increasing(1	Bacoor 100% covered, Kawit 50%, others 0%
2	Same as Scenario 1	Increasing(2 up to year-2000, thereafter pumpage is constant	All municipalities covered
3	Same as Scenario 1	Increasing(2 up to year-1995, thereafter pumpage is constant	All municipalities covered
4	Two years delay of completion of ongoing projects	Same as Scenario 1	Same as Scenario 1

NOTE: (1 With respect to future demand increases but maintaining year-1990 percentage shares
(2 With respect to future demand increases and up to the year indicated

Groundwater Pumpage (m3/day)

Year	2000			2010		
	MWSS	PRIVATE	TOTAL	MWSS	PRIVATE	TOTAL
Scenario 1	201,855	919,517	1,121,372	280,159	998,010	1,278,170
Scenario 2	201,855	919,517	1,121,372	247,128	892,062	1,139,190
Scenario 3	183,465	919,517	1,102,982	228,738	835,304	1,064,041
Scenario 4	194,508	1,000,620	1,195,128	272,756	1,022,363	1,295,119
Year-1990	89,739	840,702	930,441			

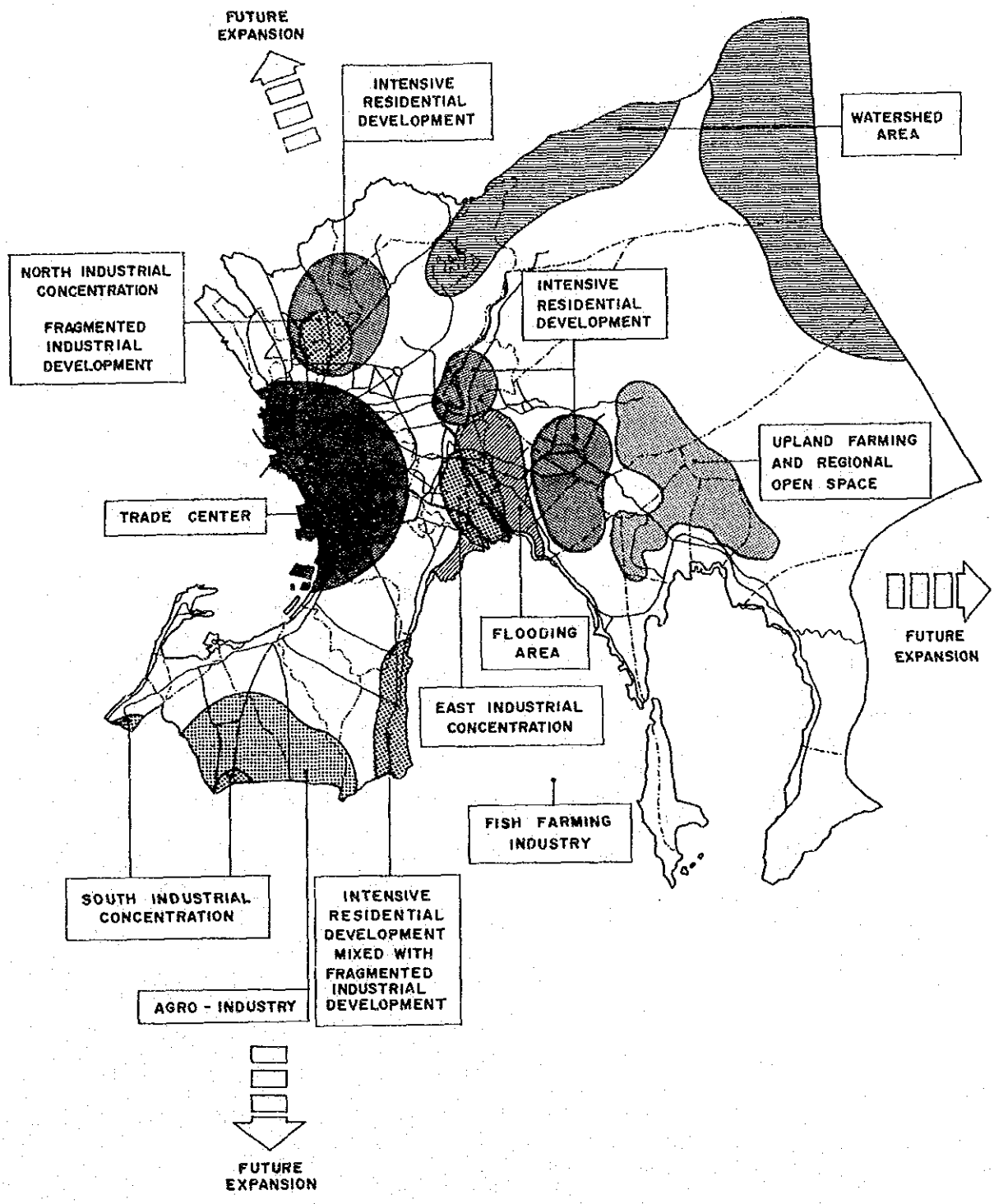
TABLE 6.2.12 SUMMARY OF GROUNDWATER DISCHARGE (SCENARIO 1)

SYSTEM	MWSS WELL					PRIVATE WELL					TOTAL				
CITY/MUNICIPALITY	1990	1995	2000	2005	2010	1990	1995	2000	2005	2010	1990	1995	2000	2005	2010
I. NCR	32,961	44,898	44,898	44,898	44,898	640,937	666,580	692,223	711,915	753,685	673,898	711,478	737,121	756,813	798,583
1. Manila	0	0	0	0	0	12,665	20,265	27,866	27,472	27,359	12,665	20,265	27,866	27,472	27,359
2. Pasay City	4,461	5,082	5,082	5,082	5,082	17,997	18,807	19,618	16,708	16,736	22,458	23,889	24,700	21,790	21,818
3. Quezon City	14,186	18,326	18,326	18,326	18,326	91,324	86,397	81,471	81,874	82,662	105,510	104,723	99,797	100,200	100,988
4. Caloocan City	0	0	0	0	0	27,476	32,969	38,462	33,970	27,960	27,476	32,969	38,462	33,970	27,960
5. Las Pinas	1,527	1,734	1,734	1,734	1,734	81,778	70,395	59,013	59,684	69,889	83,305	72,129	60,747	61,418	71,623
6. Makati	3,772	7,360	7,360	7,360	7,360	25,179	23,012	20,844	20,920	21,036	28,951	30,372	28,204	28,280	28,396
7. Malabon	554	1,244	1,244	1,244	1,244	18,473	22,889	27,304	25,351	22,979	19,027	24,133	28,548	26,595	24,223
8. Mandaluyong	0	0	0	0	0	8,976	9,685	10,395	10,394	10,456	8,976	9,685	10,395	10,394	10,456
9. Marikina	0	0	0	0	0	13,573	14,833	16,094	18,090	20,112	13,573	14,833	16,094	18,090	20,112
10. Muntinlupa	5,777	7,019	7,019	7,019	7,019	91,618	85,003	78,387	83,225	94,265	97,395	92,022	85,406	90,244	101,284
11. Navotas	106	313	313	313	313	4,051	4,406	4,761	4,737	4,787	4,157	4,719	5,074	5,050	5,100
12. Paranaque	1,167	1,768	1,768	1,768	1,768	70,158	63,129	56,100	56,320	61,722	71,305	64,897	57,868	58,088	63,490
13. Pasig	49	256	256	256	256	75,958	88,694	101,430	115,717	129,726	76,007	88,950	101,686	115,973	129,982
14. Pateros	0	0	0	0	0	1,756	3,785	5,813	5,346	4,600	1,756	3,785	5,813	5,346	4,600
15. San Juan	0	0	0	0	0	408	1,148	1,888	1,888	1,880	408	1,148	1,888	1,888	1,880
16. Taguig	640	847	847	847	847	66,367	73,952	81,537	86,909	90,416	67,007	74,799	82,384	87,756	91,263
17. Valenzuela	742	949	949	949	949	33,180	47,210	61,241	63,311	67,101	33,922	48,159	62,190	64,260	68,050
II. CAVITE	26,970	47,610	70,858	84,961	103,890	57,927	53,479	49,032	44,868	41,718	84,897	101,090	119,890	129,829	145,608
1. Bacoor	6,314	7,556	7,556	7,556	7,556	32,210	20,961	9,713	9,140	10,799	38,524	28,517	17,269	16,696	18,355
2. Cavite City	6,714	11,926	20,988	27,133	32,500	4,328	6,988	9,649	7,781	7,310	11,042	18,914	30,637	34,914	39,810
3. Imus	1,654	9,965	18,277	23,527	33,381	4,443	7,897	11,351	10,346	6,818	6,097	17,862	29,628	33,873	40,199
4. Kawit	4,329	7,529	10,730	11,101	10,889	2,830	2,342	1,855	603	0	7,159	9,872	12,585	11,704	10,889
5. Noveleta	7,070	7,070	7,070	7,070	7,289	5,659	3,680	1,702	1,284	816	12,729	10,750	8,772	8,354	8,105
6. Rosario	889	3,563	6,238	8,573	12,275	8,457	11,610	14,763	15,715	15,975	9,346	15,173	21,001	24,288	28,250
III. RIZAL	29,808	58,898	86,098	105,008	131,371	141,838	160,050	178,262	193,711	202,608	171,646	218,948	264,360	298,718	333,979
1. Angono	-	0	0	0	0	-	1,210	2,419	2,592	2,516	-	1,210	2,419	2,592	2,516
2. Antipolo	11,621	19,999	28,381	30,760	35,780	44,155	44,719	45,283	51,175	55,380	55,776	64,718	73,664	81,934	91,160
3. Baras	-	145	291	642	1,165	-	329	658	708	731	-	474	949	1,350	1,896
4. Binangonan	-	8,388	16,775	25,501	36,874	-	2,810	5,620	5,671	5,250	-	11,198	22,395	31,172	42,124
5. Cainta	3,786	4,786	5,786	5,786	5,786	48,619	57,891	67,162	73,627	78,127	52,404	62,676	72,948	79,413	83,913
6. Cardona	-	485	971	1,347	1,825	-	582	1,164	1,188	1,178	-	1,067	2,135	2,535	3,003
7. Jala-Jala	-	207	414	911	1,646	-	305	610	638	632	-	512	1,024	1,549	2,278
8. Montalban	3,243	5,680	6,684	6,684	6,684	8,030	8,298	8,566	8,936	9,318	11,273	13,978	15,250	15,620	16,002
9. Morong	-	964	1,928	2,833	4,076	-	606	1,216	1,290	1,318	-	1,572	3,144	4,123	5,394
10. Pililla	-	893	1,786	3,462	5,108	-	651	1,302	1,356	1,324	-	1,544	3,088	4,818	6,432
11. San Mateo	4,706	6,646	8,130	8,130	8,130	3,641	5,743	7,844	7,833	7,193	8,347	12,391	15,974	15,963	15,323
12. Tanay	-	3,019	6,039	8,425	13,968	-	1,280	2,559	2,662	2,574	-	4,299	8,598	12,087	16,542
13. Taytay	5,453	7,074	7,695	7,695	7,695	37,393	35,256	33,120	35,304	36,380	43,846	42,330	40,815	42,999	44,075
14. Teresa	-	609	1,219	1,832	2,634	-	370	739	730	686	-	979	1,958	2,562	3,320
TOTAL	89,739	151,406	201,855	234,866	280,159	840,702	880,109	919,517	950,493	998,010	930,441	1,031,515	1,121,372	1,185,360	1,278,170

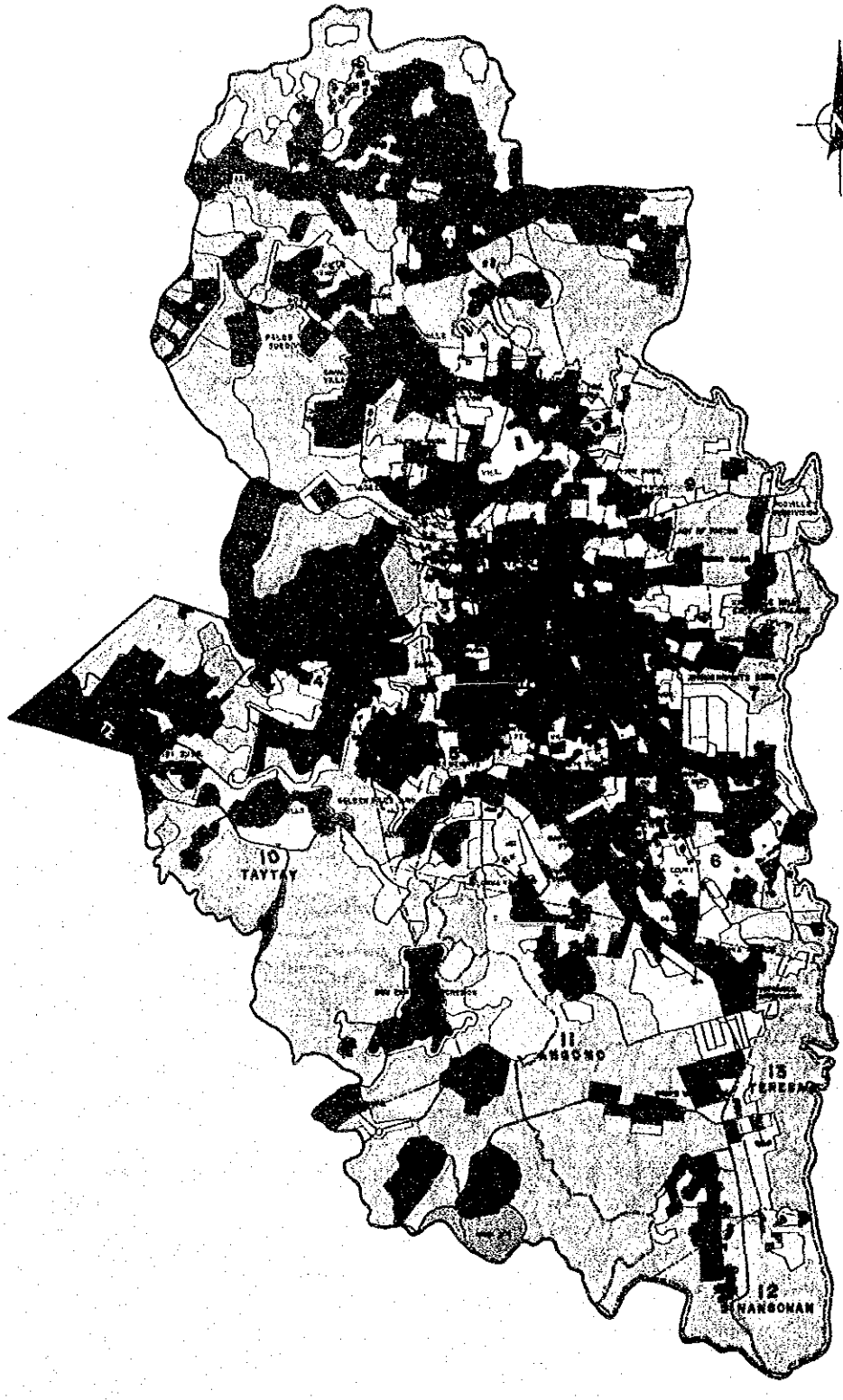
TABLE 6.2.13 WATER DEMAND AND SUPPLY IN THE BASIN

(UNIT: CU.M/DAY)

	ANTIPOLO BASIN						MWSS SERVICE AREA					
	DEMAND	SUPPLY				SHORTAGE	DEMAND	SUPPLY				NET SHORTAGE
YEAR	DAILY AVERAGE	MWSS EX. WELL	PRIVATE WELL	MWSS REHAB.	MWSS AUGMENT.	DAILY AVERAGE	DAILY AVERAGE	MWSS EX. WELL	PRIVATE WELL	MWSS REHAB.	MWSS AUGMENT.	DAILY AVERAGE	DAILY MAXIMUM
1990	19,456	9,809	9,647	--	--	--	--	9,809	2,434	--	--	--	--
1995	23,147	9,809	9,647	2,070	5,810	(4,189)	14,116	9,809	2,434	2,070	5,810	(6,007)	1,051
1996	24,622	9,809	9,647	2,070	5,810	(2,714)	16,763	9,809	3,512	2,070	5,810	(4,439)	3,943
1997	26,096	9,809	9,647	2,070	5,810	(1,240)	19,409	9,809	4,591	2,070	5,810	(2,871)	6,834
1998	27,571	9,809	9,647	2,070	5,810	235	22,056	9,809	5,669	2,070	5,810	(1,303)	9,725
1999	29,045	9,809	9,647	2,070	5,810	1,709	24,702	9,809	6,748	2,070	5,810	265	12,617
2000	30,520	9,809	9,647	2,070	5,810	3,184	27,349	9,809	7,826	2,070	5,810	1,834	15,508
2005	36,749	9,809	9,647	2,070	5,810	9,413	34,773	9,809	8,512	2,070	5,810	8,572	25,958
2010	46,000	9,809	9,647	2,070	5,810	18,664	45,485	9,809	9,647	2,070	5,810	18,149	40,892



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 6.1.1 STRUCTURE PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	



BARANGAY / MUNICIPALITY

1. Bagong Nayon
2. Sta. Cruz
3. De la Paz
4. Beverly Hills
5. San Roque
6. Dalig
7. San Jose
8. San Isidro
9. San Luis
10. Taytay
11. Angono
12. Binangonan
13. Teresa

STUDY AREA
AQUIFER BASIN ZONE
MUNICIPALITY BOUNDARY
BARANGAY BOUNDARY

LEGEND

BUILT-UP AREA
COMMERCIAL AREA
INDUSTRIAL AREA
AGRICULTURAL LAND
FOREST GRASS LAND
OPEN SPACE
OTHERS

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 6.1.2
FUTURE LAND USE MAP, 2010 ANTIPOLO AREA

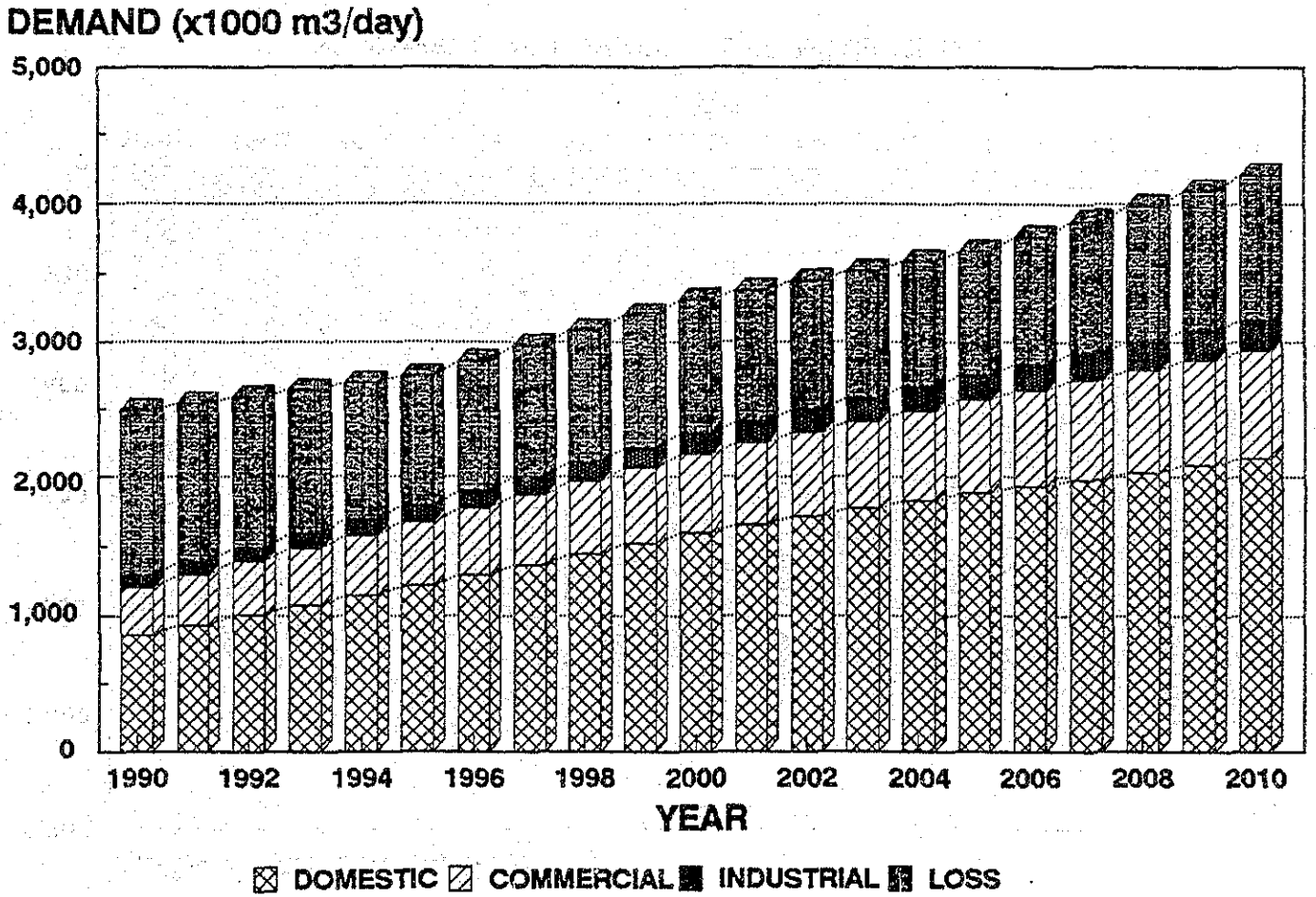


FIGURE 6.2.1 MWSS WATER DEMAND

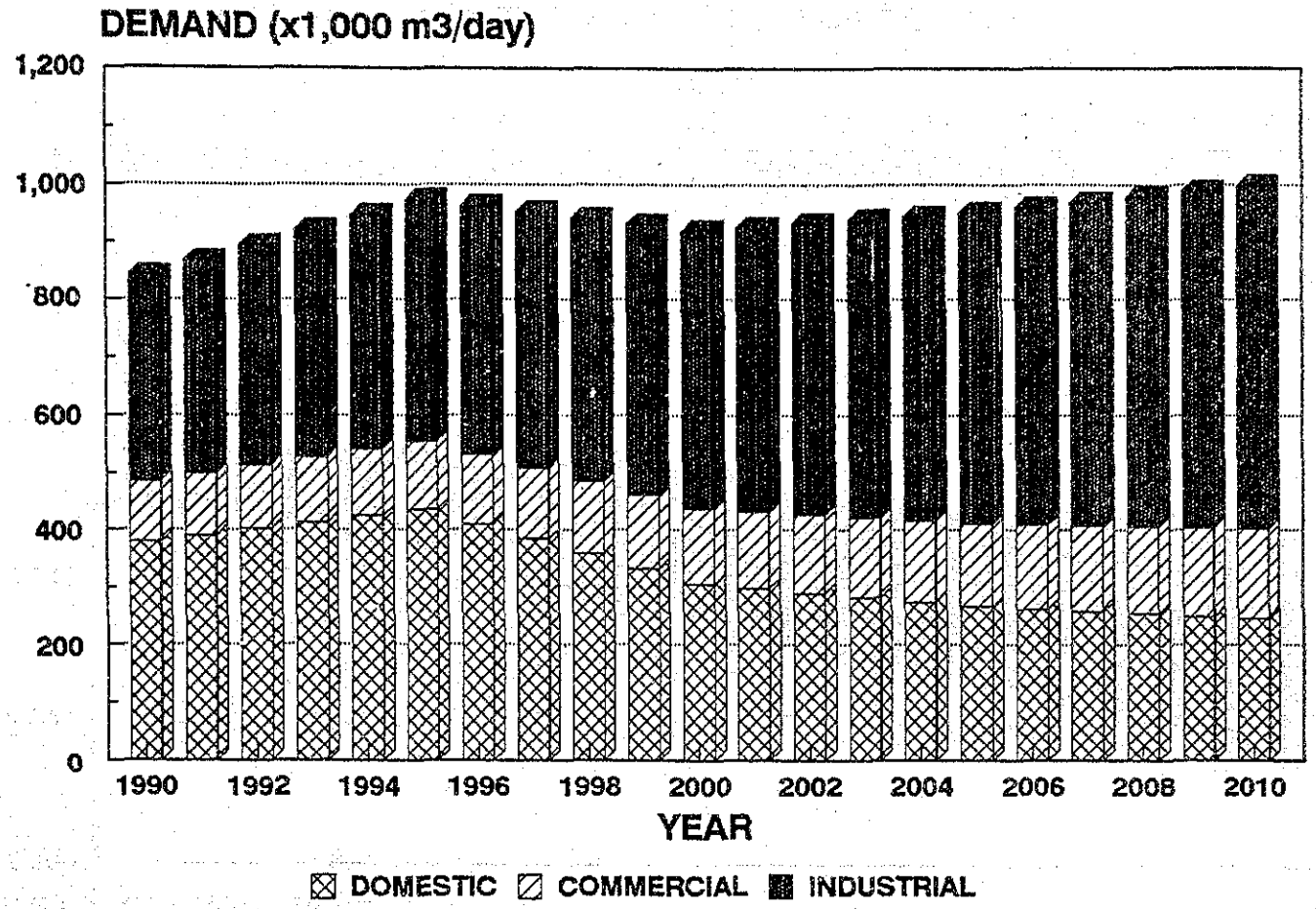


FIGURE 6.2.2 PRIVATE WATER DEMAND

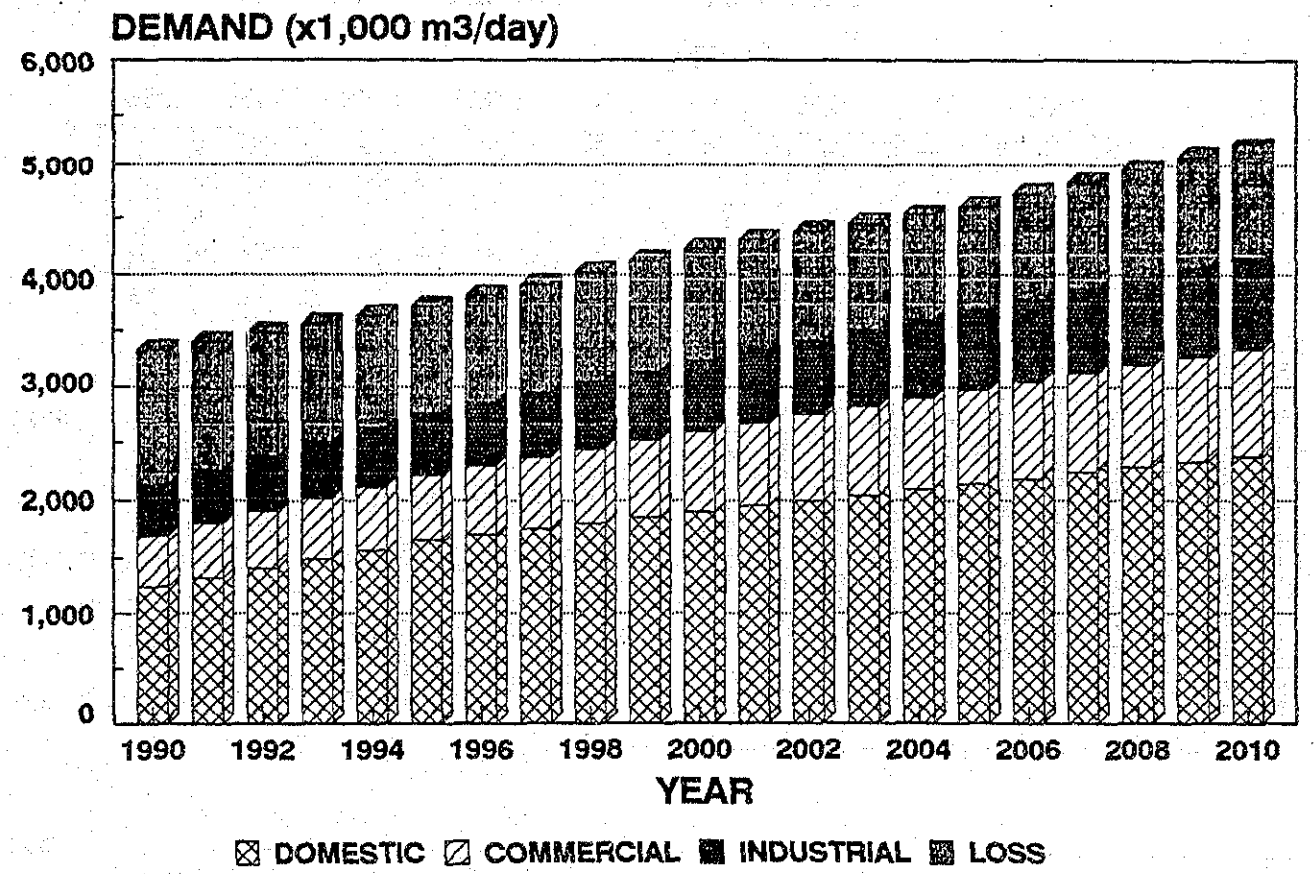


FIGURE 6.2.3 TOTAL WATER DEMAND (MWSS+PRIVATE)

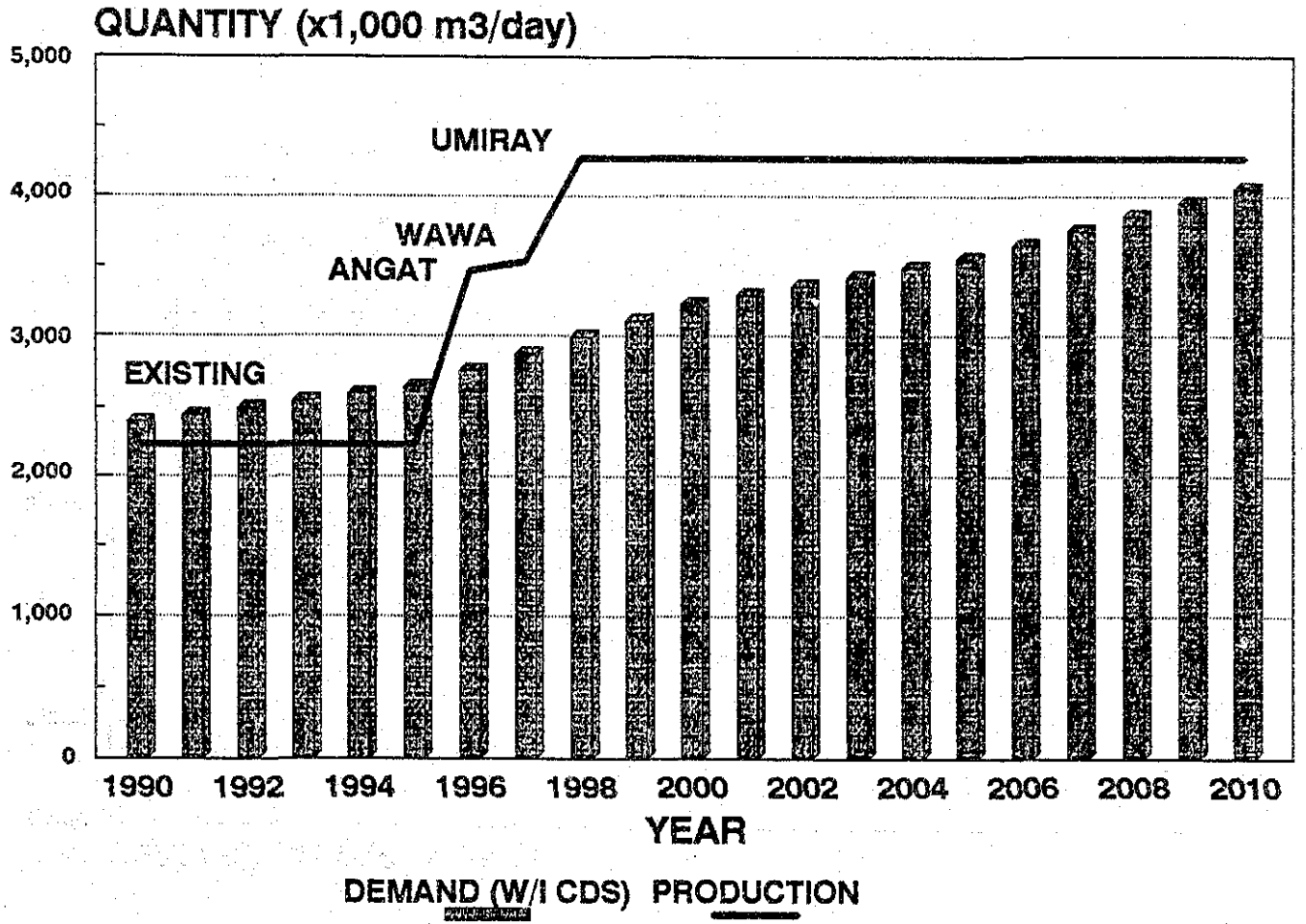


FIGURE 6.2.4 DEMAND VS. SUPPLY CAPACITY

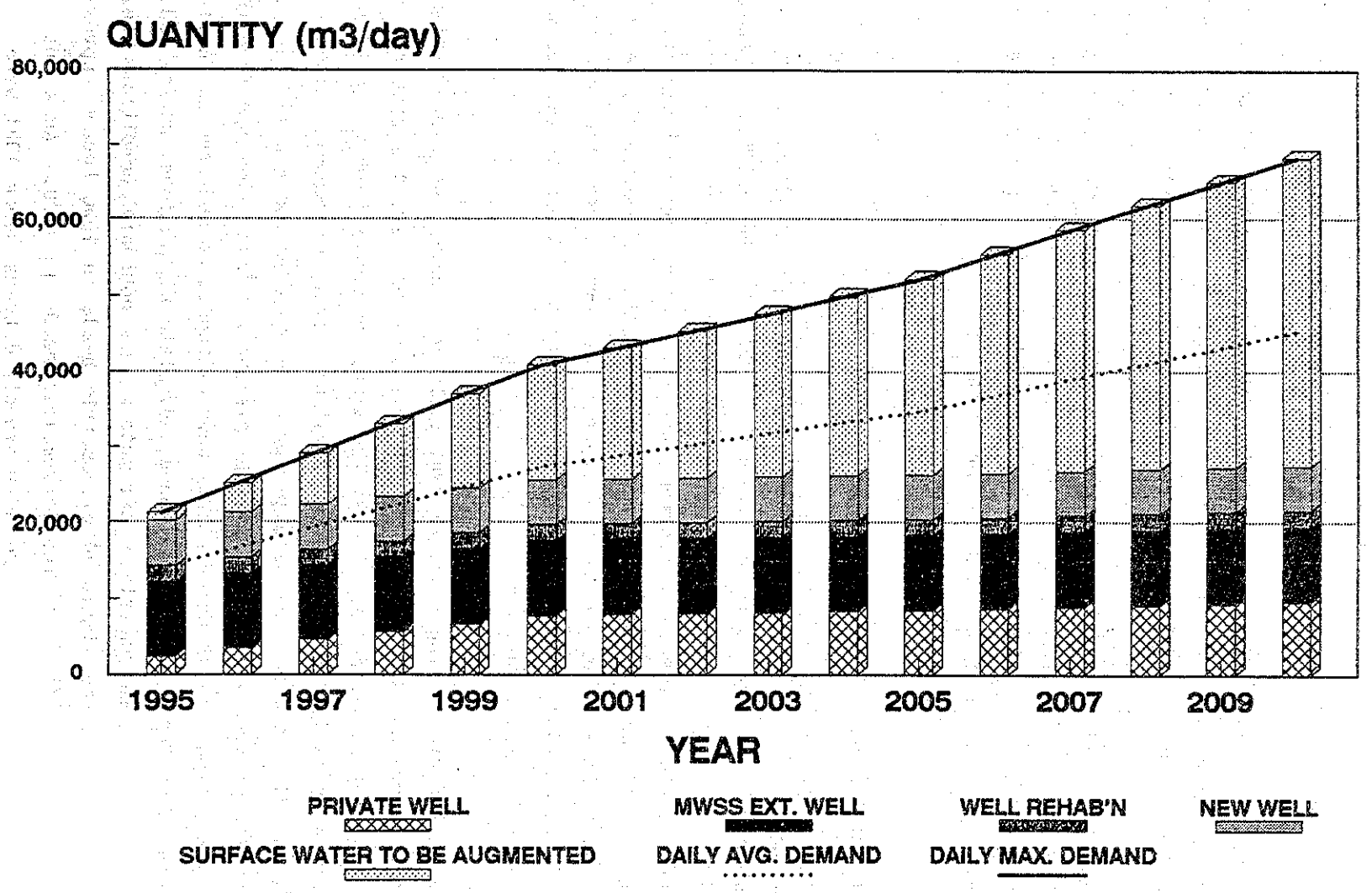


FIGURE 6.2.5 DEMAND VS. SUPPLY CAPACITY
(WITHIN MWSS SERVICE AREA IN ANTIPOLO)

CHAPTER 7 EVALUATION OF GROUNDWATER RESOURCES

7.1 GROUNDWATER MODELING

Groundwater modeling and computer simulation were carried out to evaluate the groundwater resources in Metro Manila. The computer models used for the study are the quasi three-dimensional groundwater flow model (Q3P model) and the two-dimensional solute transport and dispersion model (MOC model). The Q3P model was applied to both the Antipolo and Metro Manila groundwater basins to quantify the groundwater resources (Figure 7.1.1). The MOC model was applied to the Las Piñas area to reveal the mechanism of saline water intrusion.

7.2 ANTIPOLO GROUNDWATER BASIN MODEL

The Q3P model was applied to the confined aquifer system formed by Member III of the Guadalupe Formation (Gs) in the Antipolo Plateau (Figure 7.2.1). The model used a finite-element grid with lengths of 8.5km in the north-south direction and 4.0km in the east-west direction. The size of each rectangular element is 250mx250m. Based on the results of the field studies and hydrogeological interpretations, the geohydrologic parameters of each element and boundary conditions at the perimeters of the model were specified.

The calibration of the model was initially carried out by using 10 time-steps throughout the 10-year period from 1981 to 1990. The recharge to the aquifer is assumed to be only the direct recharge from precipitation previously estimated from the water balance study. Groundwater discharge data in the modeled area were prepared, by coordinates and time-steps, from the groundwater use survey. The piezometric heads obtained from the 30-year, steady-state calculations were extrapolated and used as initial groundwater heads in 1981 for non-steady-state simulations. During model calibration, some uncertain parameters and boundary conditions were modified until the simulated piezometric heads in 1990 became approximately equal to the measured piezometric heads in 1990. As a result, the general trends in change of piezometric heads since 1981 were reasonably simulated, e.g., the maximum drawdown of 16.4m which is the result of the increment in discharge (from 11,419 CMD to 19,456 CMD)

during the 10-year period.

In order to design an optimal pumpage plan for the basin, the Antipolo groundwater flow model, calibrated as mentioned, simulated future piezometric heads up to year-2010. Obtained from the 62-year water balance computations, the recharge value of 418.8 mm/yr (or 28,183 CMD) corresponding to a 5-year drought probability was used as the future recharge. The following three (3) cases were prepared for the simulation of future piezometric heads, with the assumption that the discharge of existing private wells shall be the same as that for 1990 and no new private wells are constructed.

Case A: The discharge of MWSS wells in 1990 will continue up to 2010.

Case B: New MWSS wells (discharge rate = 830 CMD per well) will be constructed.

Case C: The existing ten (10) MWSS wells will be augmented by 207 CMD per well by well rehabilitation, and new MWSS wells will be constructed.

For Cases B and C, the criteria for locating new wells are:

i. New wells should be located where the simulated piezometric heights of Case A in 2010 are more than 30m because the drawdown of new wells are assumed to be 21m from the static level.

ii. Existing pumping grids should be avoided for the location of new wells.

iii. The combined total discharge of existing and new wells should not exceed the recharge to the basin.

iv. The simulated piezometric heights at the sites of new wells should be more than 21m using the new discharge up to the year 2010.

In Case A, the simulated piezometric heads will decline even though the discharge is the same as that in 1990. A maximum drawdown of 52.4m is expected for the period 1991 to 2010.

The results show that for Case B as many as ten (10) wells can be constructed. For Case C, seven (7) new wells can be constructed and an augmentation of 2,070 CMD can be realized by rehabilitation of the existing wells. In Case C, the total discharge is 27,334 CMD, which is smaller than the recharge value that is equivalent to a drought with a return period of 5 years.

The optimal plan for groundwater development in the Antipolo basin therefore calls for the rehabilitation of 10 existing MWSS wells and the construction of seven new wells. Figure 7.2.2 shows the discharge distribution for Case C. Figure 7.2.3 shows simulated piezometric changes. The simulated piezometric heads in 1990 and 2010 are shown in Figures 7.2.4 and 7.2.5, respectively. It is noted, however, that the optimal groundwater pumpage is limited so that the water demands after 1998 cannot be supplied by the groundwater in the basin.

7.3 METRO MANILA GROUNDWATER BASIN MODEL

The Q3P model was applied to the Guadalupe confined aquifer system in the Metro Manila groundwater basin (see Figure 7.1.1). The finite-element grid used in the model has respective lengths of 48.3km and 37.8km in the north-south and east-west directions. The size of each rectangular element is 1380m by 1350m. Geohydrologic parameters and boundary conditions were assigned based on results of field studies and hydrogeological interpretations, and then modified/identified throughout calibration of the model.

The calibration of the model was done in the same manner as that for the Antipolo Groundwater Basin Model. The modeled domain was divided into a direct recharge area and a leakage recharge area based on the pattern of the measured piezometric surface. Groundwater discharge data were prepared, by coordinates and time-steps, from the results of the groundwater use survey. The measured piezometric heads in 1981 were employed as initial piezometric heads for the simulations. The boundary condi-

tions and some uncertain parameters, such as leakance and storage coefficient, were modified throughout the calibration of the model until the simulated piezometric heads for 1990 were approximately equal to the measured piezometric heads in that year. As a result, the recovery of the piezometric heads in the central part of Metro Manila, as well as their decline in the outskirts, were reasonably simulated.

Future piezometric heads were predicted using the calibrated model.

Five (5) future groundwater pumpage scenarios were made:

Scenario 1: Future pumpage based on Scenario 1 of the water demand projections. (See Table 6.2.11 and Figures 7.3.1 and 7.3.2.)

Scenario 2: Future pumpage based on Scenario 2 of the water demand projections. (See Table 6.2.11 and Figures 7.3.1 and 7.3.2.)

Scenario 3: Future pumpage based on Scenario 3 of the water demand projections. (See Table 6.2.11 and Figures 7.3.1 and 7.3.3.)

Scenario 4: Future pumpage based on Scenario 4 of the water demand projections. (See Table 6.2.11 and Figures 7.3.1 and 7.3.3.)

Scenario 5: Discharge in 1990 continues up to 2010.

The results are summarized as follows:

Scenario 1: (Refer to Figures 7.3.4 and 7.3.6.) Piezometric heads in 2010 shall rise at the southern part of Quezon City and Metro Manila (Parañaque, Las Piñas and Bacoor). A maximum rise of 20m of piezometric head is predicted at the coastal area of Las Piñas because of decrement in pumpage. However, piezometric heads will go down at the northern and southwestern parts of Metro Manila. Significant drawdowns such as 83m in north Valenzuela, 57m in Cavite and 37m in Pasig are predicted. Piezo-

1991 to 2000, then stabilize after 2000. A constant decline shall be seen in Pasig for the period 1991 to 2010. Piezometric heads in Las Piñas for the period 1991 to 2000 shall rise but will go down gradually after 2005.

Scenario 2: (Refer to Figures 7.3.4 and 7.3.6.) From year-1991 onward, the piezometric heads shall go down 59m north of Valenzuela and 33m in Cavite. Piezometric heads will decline in most of Metro Manila for the period 1991 to 2000, then stabilize or slightly recover after 2001.

Scenario 3: (Refer to Figures 7.3.5 and 7.3.7.) Piezometric heads in 2010 shall be higher than those in 1990 for north Valenzuela and Cavite; respectively, 50m and 29m for the years 2010 and 1990. Recovery of piezometric heads shall occur in almost all areas of Metro Manila for the period 2001 to 2005 due to decreasing pumpage.

Scenario 4: (Refer to Figures 7.3.5 and 7.3.7.) This is the scenario where the maximum groundwater discharge can be found. The discharge shall increase for the periods 1991 to 2000 and 2005 to 2010. The drawdowns of piezometric heads are estimated at 90m in north Valenzuela and 56m in Cavite. Piezometric heads in most of Metro Manila shall show significant declines until the year-2000, afterwhich the declines become gradual or stable.

Scenario 5: Piezometric heads in 2010 relative to piezometric heads in 1990 shall recover at a maximum of 10.7m at the central part of Metro Manila. Decline of piezometric heads shall be seen at the northern, eastern (along Marikina River), and southern to southwestern parts of Metro Manila. The maximum drawdowns are predicted at 21.7m at the northern part of Quezon City and 16.9m in Rosario that is at the southwestern part of Metro Manila.

Simulation results show that the maximum drawdown of 50m will occur even in Scenario 3 where the discharge is the smallest among the future groundwater use plans. This may cause severe saline water intrusion and may damage even inland areas.

7.4 SALINE WATER INTRUSION MODEL

The MOC model was employed to analyze the saline water intrusion mechanism in the Las Piñas area--one of the areas most affected by saline water intrusion in Metro Manila (Figure 7.4.1). A vertical two-dimensional model was made based on a hydrogeological section from the shoreline towards inland. The model is 4km in length, 300m in depth and 200m in width. Each cell is 100m long, 15m thick and 200m wide. The geohydrologic parameters of each aquifer unit were specified based on the results of well loggings, pumping tests and core analysis conducted in the JICA test wells in Las Piñas. The boundary conditions were specified from the results of hydrogeological analyses (Figure 7.4.2).

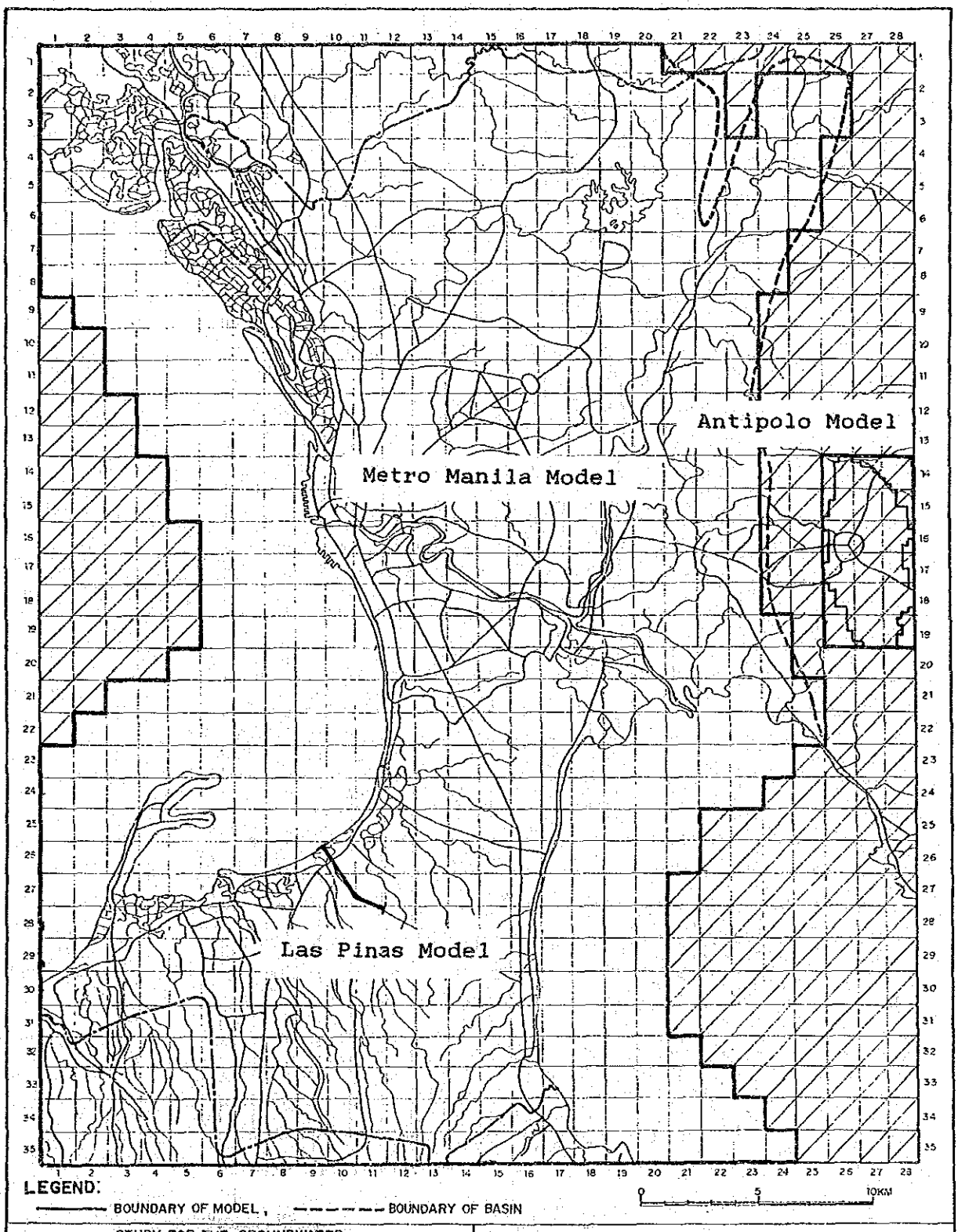
Steady-state simulation was initially carried out for model identification. This was done by checking geohydrologic parameters and boundary conditions through comparison of simulated and measured piezometric heads. Direct recharge from rainfall was applied to the uppermost cells of the model. Pumpage data obtained from the groundwater use survey were also used, considering well locations and screen positions. Except in the uppermost cells, initial piezometric heads were taken as 0. The results show good agreement of values of simulated piezometric heads and observed heads, accomplished without modifying any hydrogeologic parameters.

After fixing the groundwater flow, the solute transport model was calibrated to compute the chloride concentrations. From the facies of each aquifer unit, transport parameters were estimated. The origins of saline water were assumed to be at Manila Bay and the alluvial lowlands where marine ponds are located. Several sets of parameters were employed in the model to compare the movements of saline water. For this comparison, the location of the source was also varied.

The results of simulation using the solute transport model show that saline water originated from the Manila Bay and marine ponds; it then moved and dispersed inland towards piezometric head depressions created by heavy pumpage (Figures 7.4.3 and 7.4.4). Also, the simulated distribution of chloride concentration shows good agreement with the observed distribution of the same. And further, not only was it Manila Bay which played a significant role in the occurence of saline water in the area,

but also the marine ponds and rivers where saltwater is present. It is predicted that if the center of the piezometric head depression, which is presently located at the central part of the model, moves more inland as a result of groundwater abstraction by new wells, the direction of saline water intrusion shall subsequently be towards inland. Deeper aquifers located below -300m, where no saline water exists at present, could become contaminated. Further lowering of piezometric heads should be avoided.

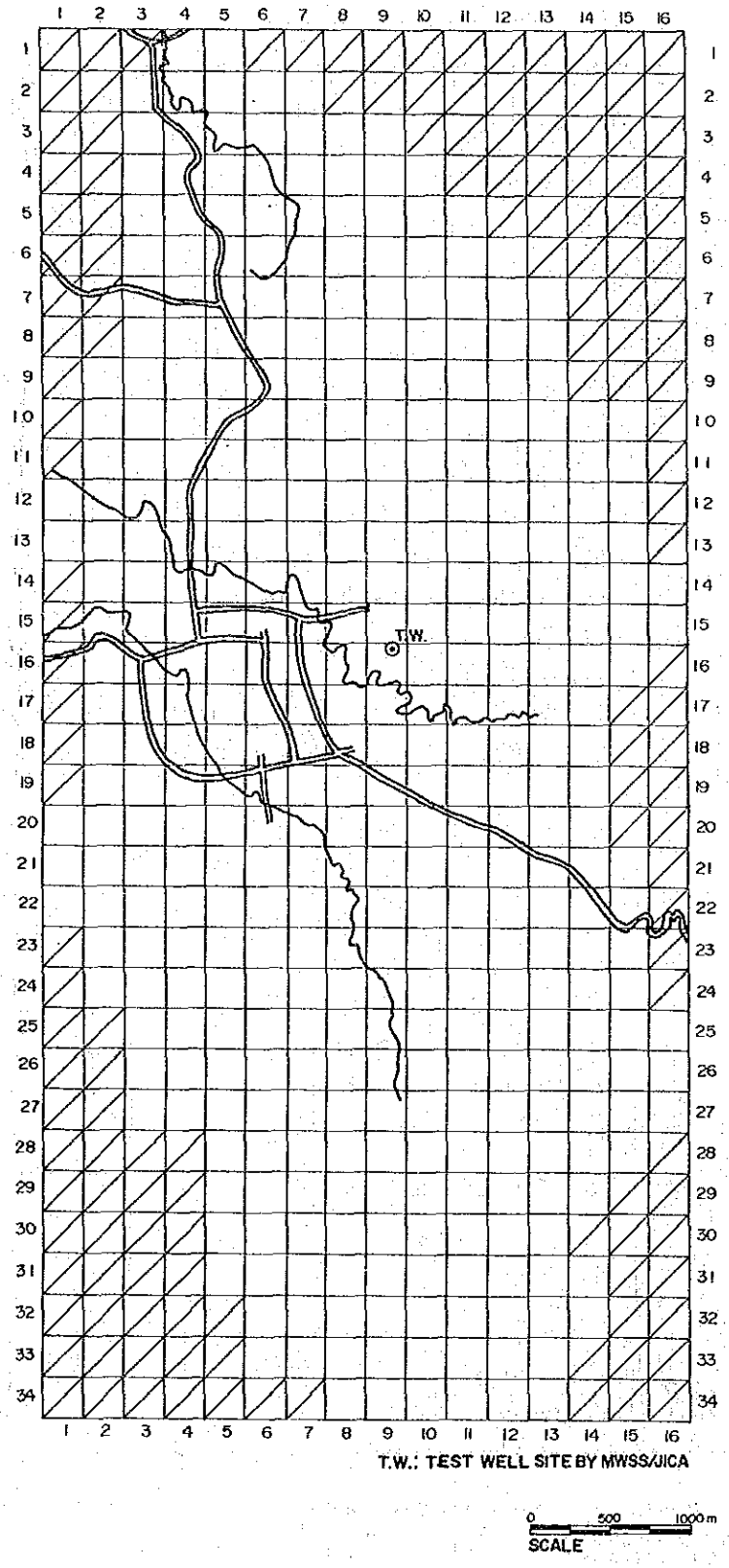
The mechanics of saline water intrusion just discussed should be considered in the assessment, development and management of groundwater resources in the area. Location of new wells, well depths and pumpage should be carefully evaluated to arrest the further spread of saline water.



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 7.1.1 FINITE-ELEMENT GRID USED TO MODEL METRO MANILA BASIN



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 7.2.1
FINITE-ELEMENT GRID USED TO MODEL ANTIPOLO BASIN

ATP Q MAP (m^3/d)

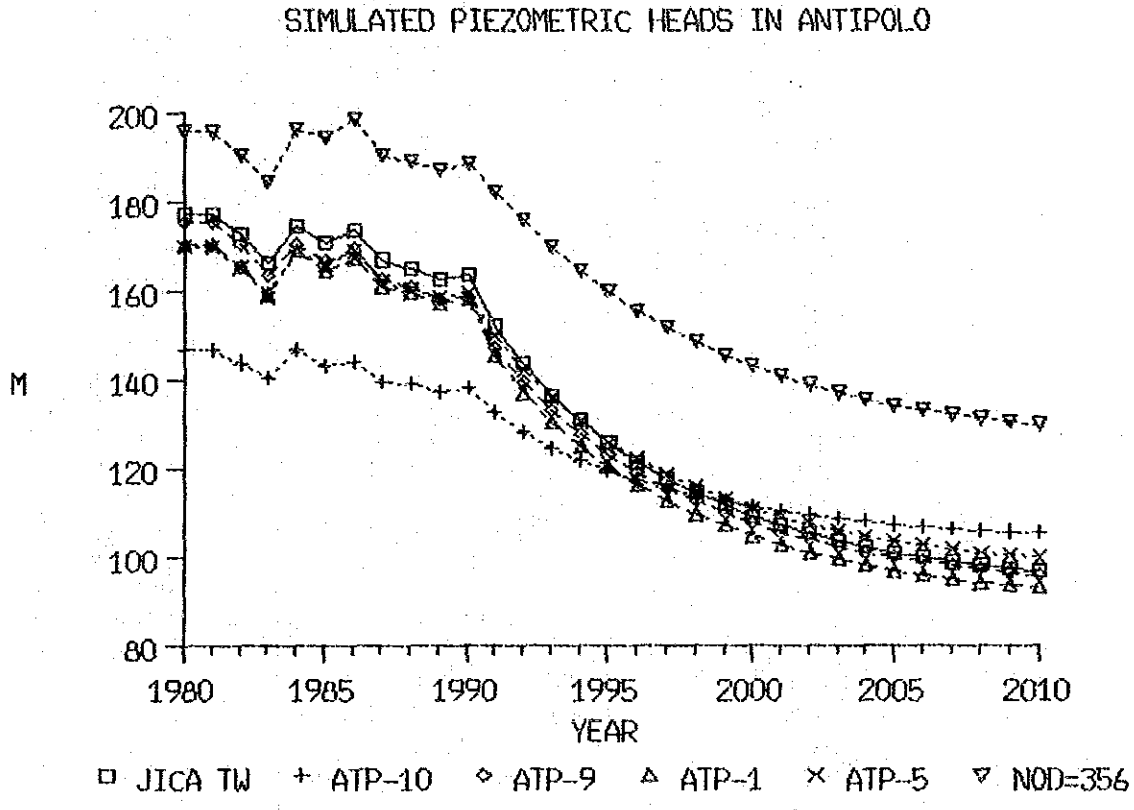
YEAR: 1991

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
19999.9999.	9999.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	1
29999.9999.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	2
39999.9999.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	3
49999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	9999.	9999.	4
59999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	9999.	5
69999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	9999.	6
79999.9999.	0.	0.	0.	681.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	7
89999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.	9999.	8
99999.	0.	0.	0.	0.	0.	0.	0.	454.	0.	0.	0.	9999.	9999.	9999.	9999.	9
109999.	0.	0.	0.	500.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	10
119999.	0.	0.	0.	0.	0.	27.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	11
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	12
13	0.	0.	1778.	0.	0.	0.	0.	830.	0.	0.	0.	0.	0.	0.	9999.	13
149999.	27.	0.	0.	0.	0.	830.	1907.	1765.	0.	0.	0.	0.	0.	0.	0.	14
159999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	15
169999.	1125.	0.	0.	0.	1490.	0.	0.	0.	0.	0.	0.	0.	0.	9999.		16
179999.	0.	0.	1577.	0.	830.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.		17
189999.	0.	6.	1636.	0.	1088.	830.	0.	0.	0.	0.	0.	0.	9999.	9999.		18
199999.	0.	0.	716.	0.	0.	0.	584.	0.	0.	1444.	0.	0.	0.	9999.	9999.	19
20	0.	0.	0.	0.	0.	36.	1132.	830.	0.	252.	0.	1363.	0.	0.	9999.	9999.	20
21	0.	0.	0.	0.	0.	0.	302.	830.	0.	99.	0.	0.	0.	0.	9999.	21
22	0.	0.	0.	0.	0.	648.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	22
239999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	23
249999.	0.	0.	0.	0.	0.	0.	0.	533.	0.	0.	0.	0.	0.	0.	9999.	24
259999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	25
269999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	26
279999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	27
289999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	5.	45.	0.	0.	0.	9999.			28
299999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.			29
309999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.			30
319999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	1134.	0.	0.	9999.	9999.				31
329999.9999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.					32
339999.9999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.				33
349999.9999.9999.9999.9999.9999.9999.	0.	0.	0.	0.	0.	0.	0.	0.	9999.	9999.	9999.					34
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	

TOTAL Q IN MODELED AREA = 27334.m^3/d

□ : Location of New MWSS Wells

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.2.2 OPTIMAL DISCHARGE PLAN IN ANTIPOLO BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY	



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.2.3 SIMULATED PIEZOMETRIC HEADS (DISCHARGE FROM 1991 TO 2010 = OPTIMAL PLAN)
JAPAN INTERNATIONAL COOPERATION AGENCY	

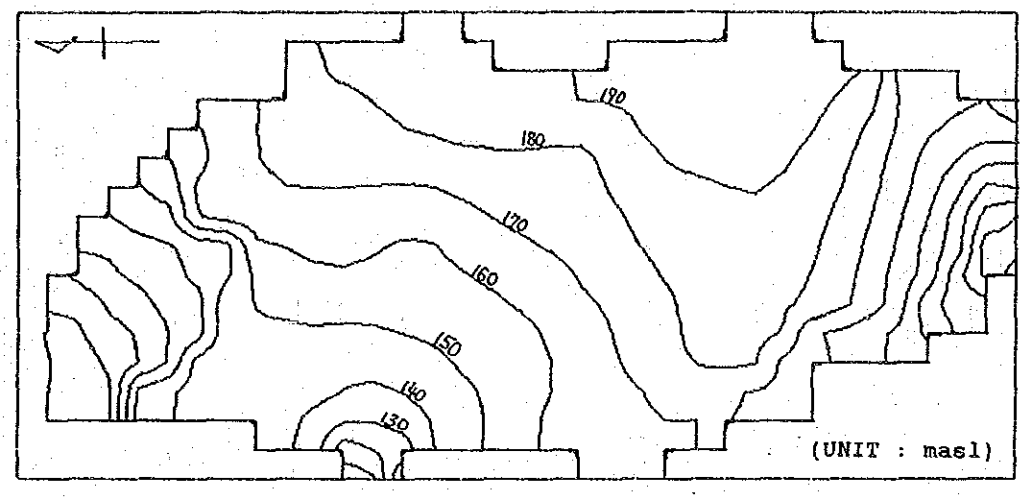


FIGURE 7.2.4(1) SIMULATED PIEZOMETRIC HEADS IN 1990

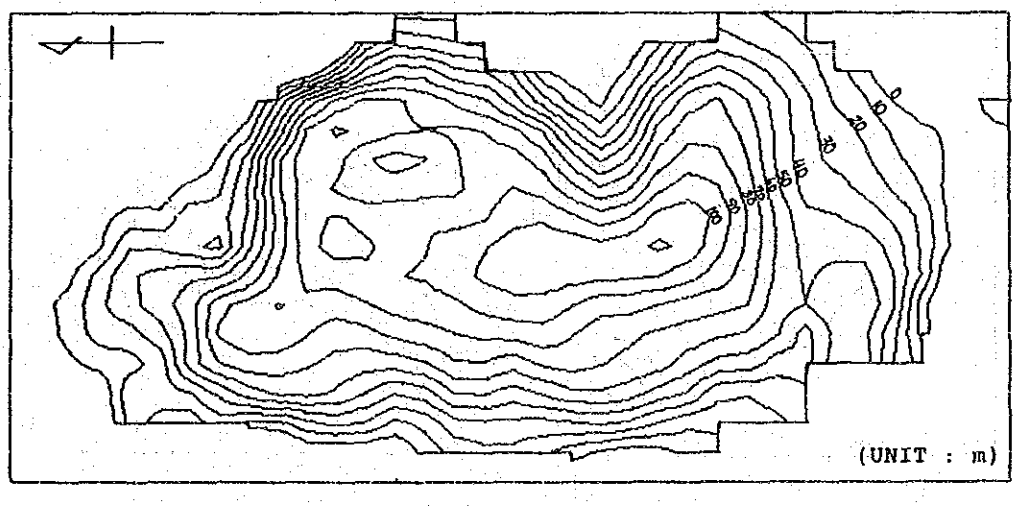


FIGURE 7.2.4(2)
SIMULATED PIEZOMETRIC HEIGHTS FROM BOTTOM OF THE AQUIFER IN 1990

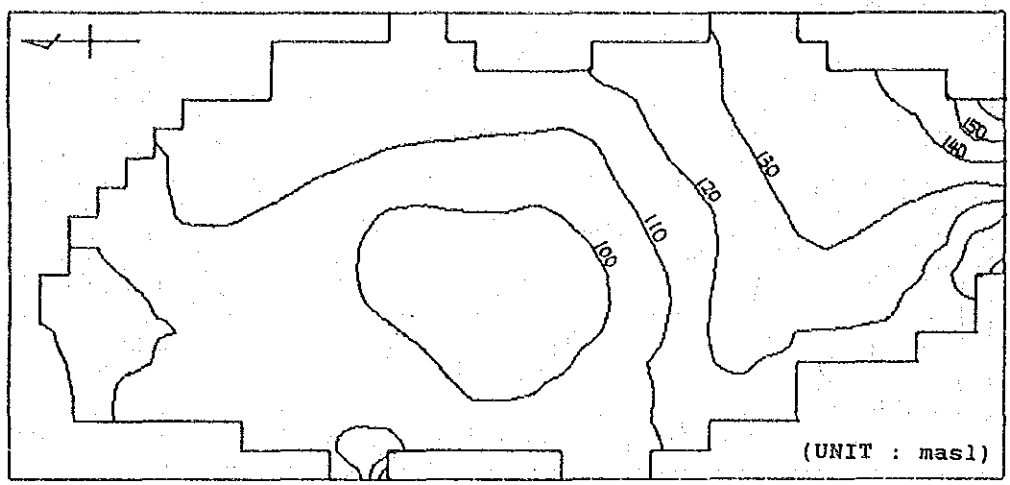


FIGURE 7.2.5(1) SIMULATED PIEZOMETRIC HEADS IN 2010
(DISCHARGE FROM 1991 TO 2010 = OPTIMAL PLAN)

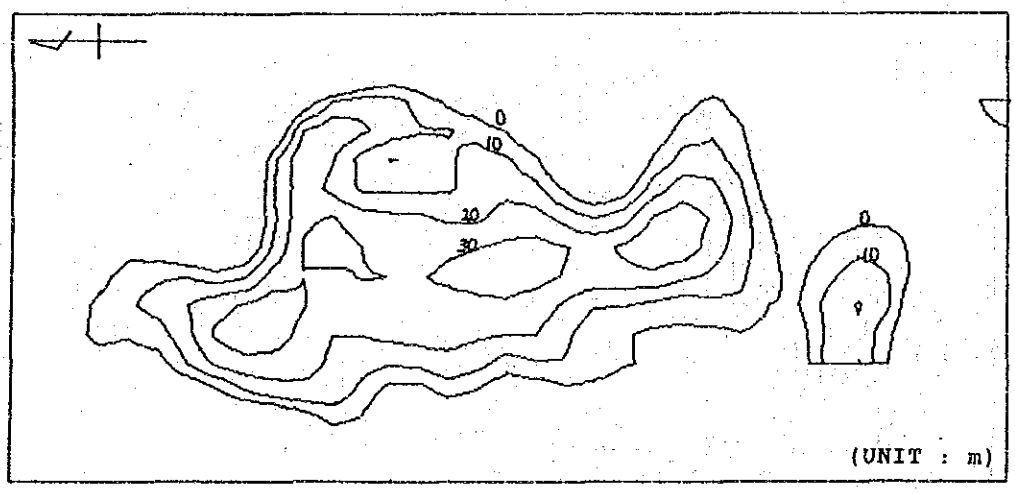
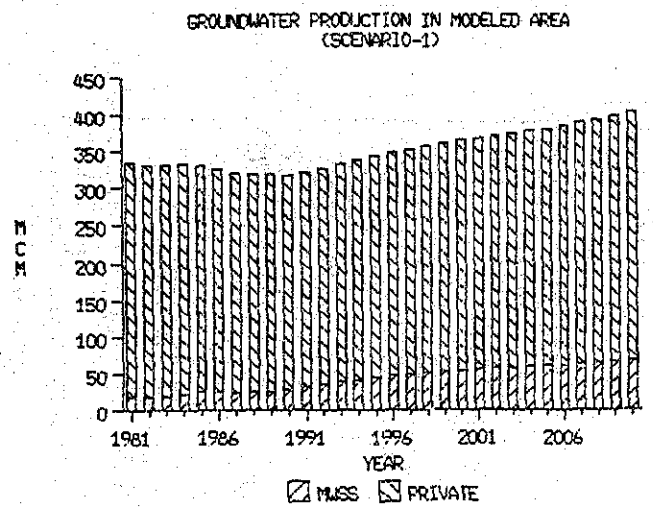
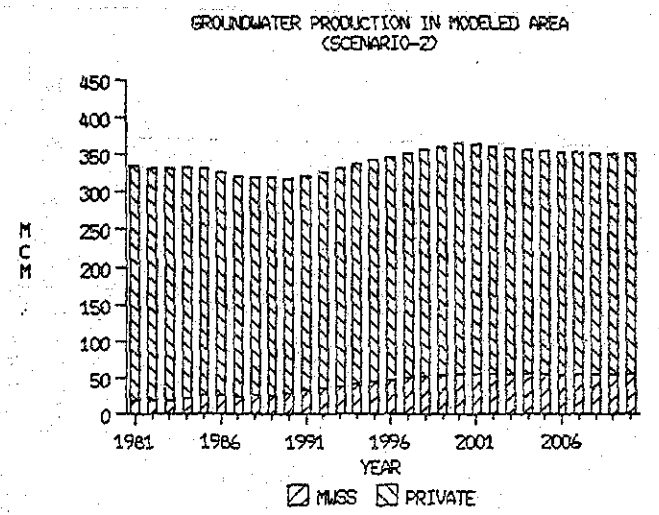
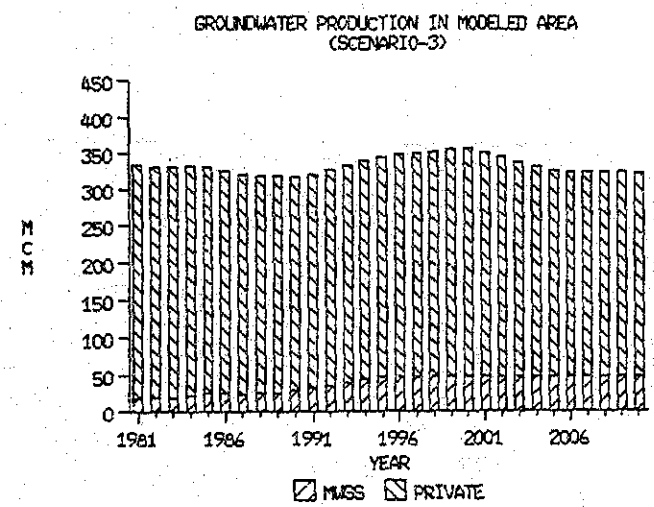


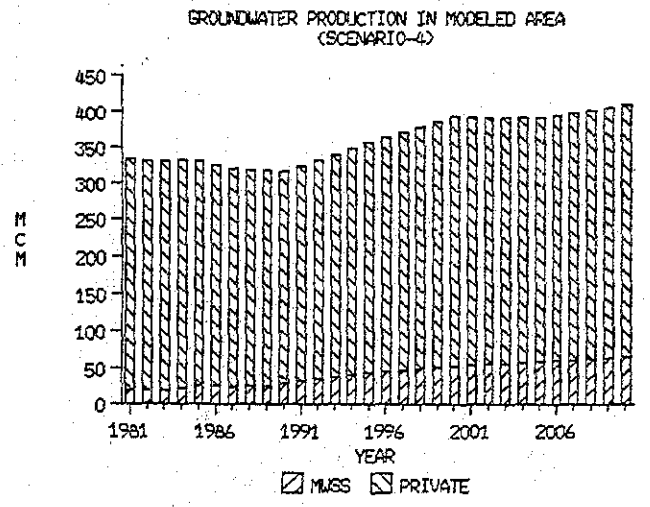
FIGURE 7.2.5(2)
SIMULATED PIEZOMETRIC HEIGHTS FROM BOTTOM OF THE AQUIFER IN 2010
(DISCHARGE FROM 1991 TO 2010 = OPTIMAL PLAN)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	JAPAN INTERNATIONAL COOPERATION AGENCY

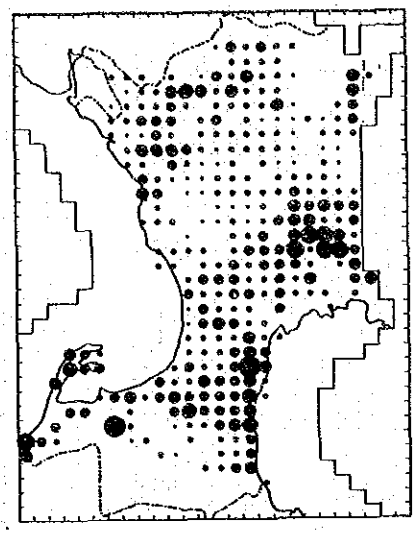




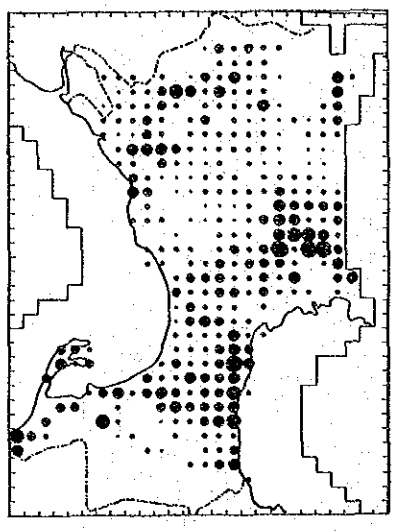




STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA JAPAN INTERNATIONAL COOPERATION AGENCY	FIGURE 7.3.1 GROUNDWATER PRODUCTION OF EACH SCENARIO

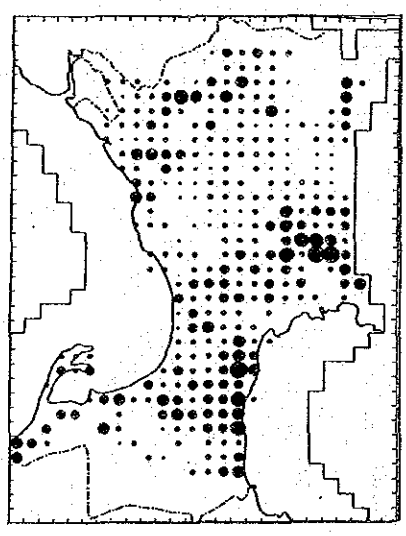


a) Scenario 1

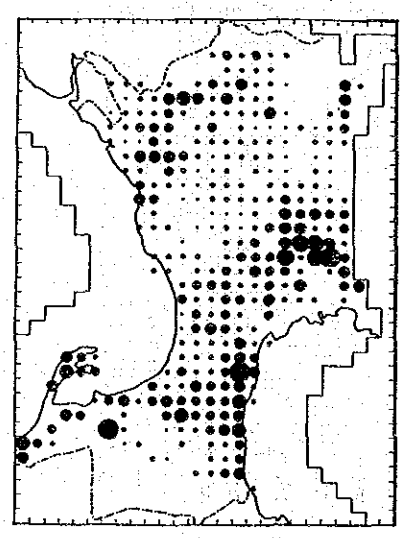


b) Scenario 2

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA JAPAN INTERNATIONAL COOPERATION AGENCY	FIGURE 7.3.2 DISCHARGE DISTRIBUTION IN 2010 (SCENARIO 1, SCENARIO 2)

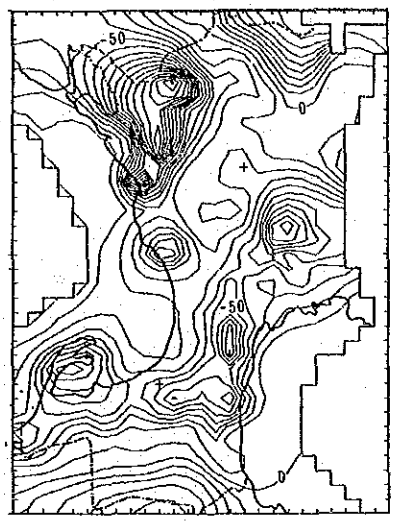


a) Scenario 3

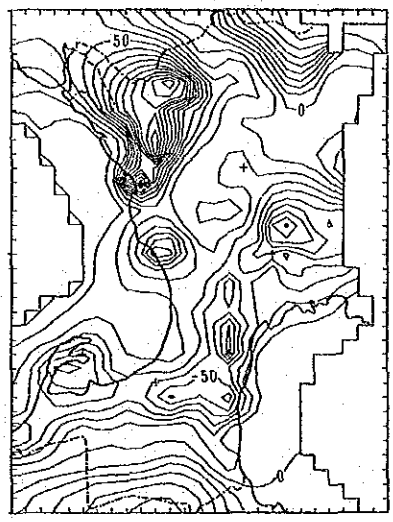


b) Scenario 4

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA JAPAN INTERNATIONAL COOPERATION AGENCY	FIGURE 7.3.3 DISCHARGE DISTRIBUTION IN 2010 (SCENARIO 3, SCENARIO 4)

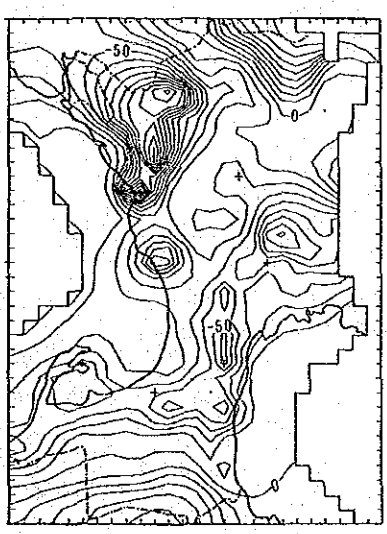


a) Scenario 1
(Contour Interval: 10m, Unit: masl)

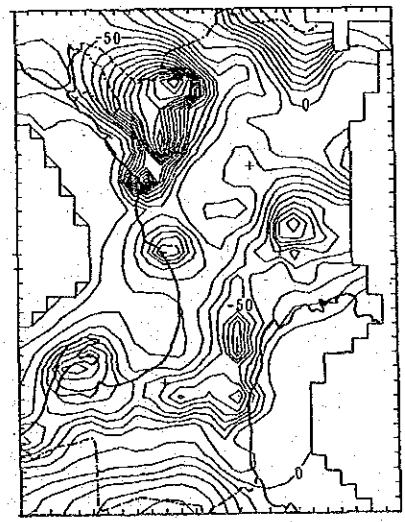


b) Scenario 2
(Contour Interval: 10m, Unit: masl)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.3.4 DISCHARGE DISTRIBUTION IN 2010 (SCENARIO 1, SCENARIO 2)
JAPAN INTERNATIONAL COOPERATION AGENCY	

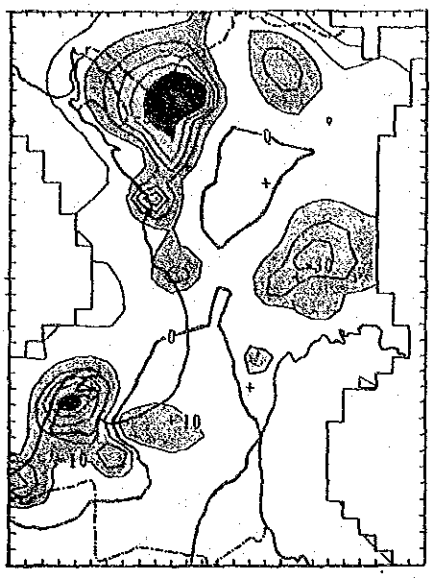


a) Scenario 3
(Contour Interval: 10m, Unit: masl)



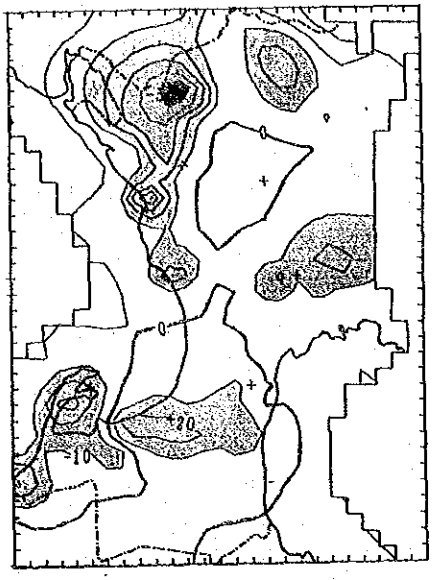
b) Scenario 4
(Contour Interval: 10m, Unit: masl)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.3.5 DISCHARGE DISTRIBUTION IN 2010 (SCENARIO 3, SCENARIO 4)
JAPAN INTERNATIONAL COOPERATION AGENCY	



a) Scenario 1

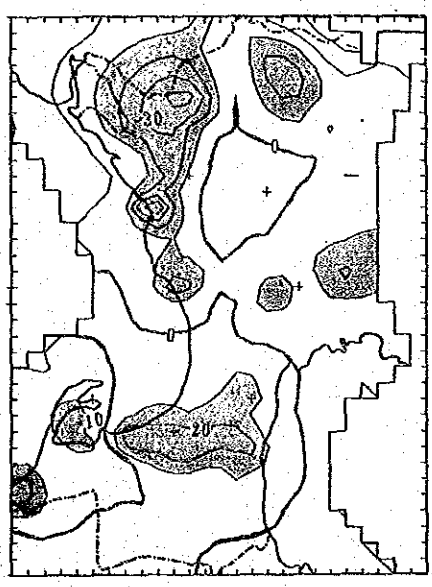
(Contour Interval: 10m, Unit: m)



b) Scenario 2

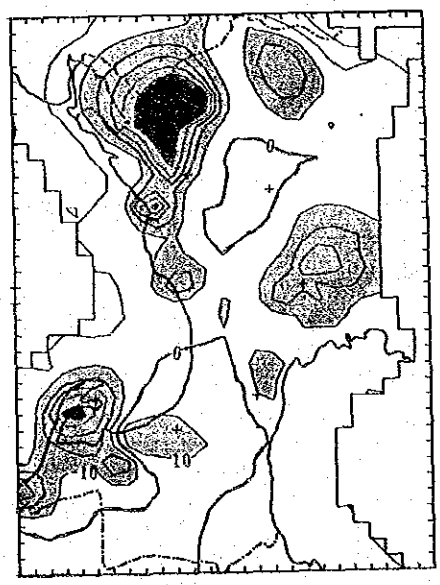
(Contour Interval: 10m, Unit: m)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.3.6
JAPAN INTERNATIONAL COOPERATION AGENCY	SIMULATED PIEZOMETRIC CHANGES FROM 1991 TO 2010 (SCENARIO 1, SCENARIO 2)



a) Scenario 3

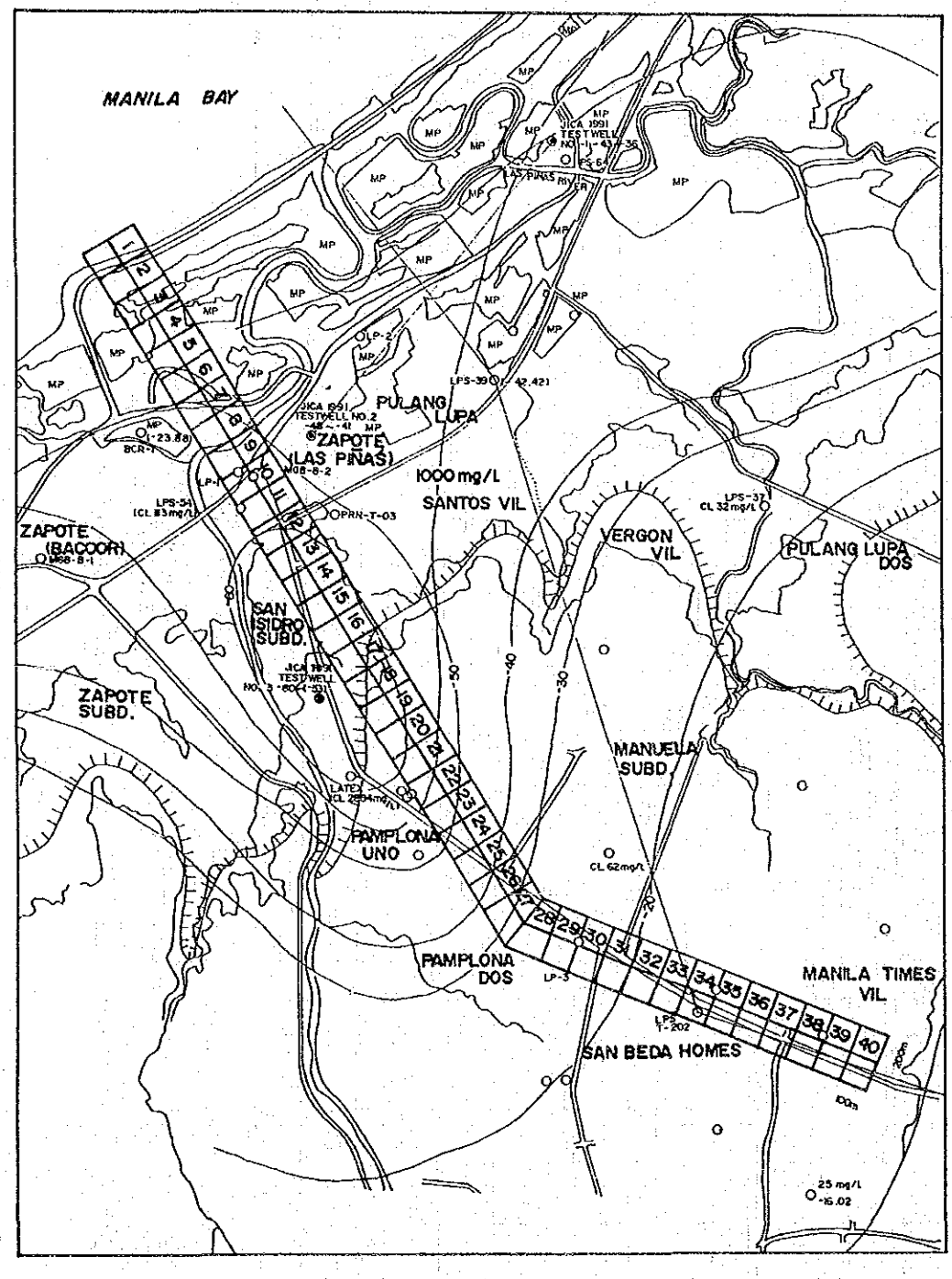
(Contour Interval: 10m, Unit: m)



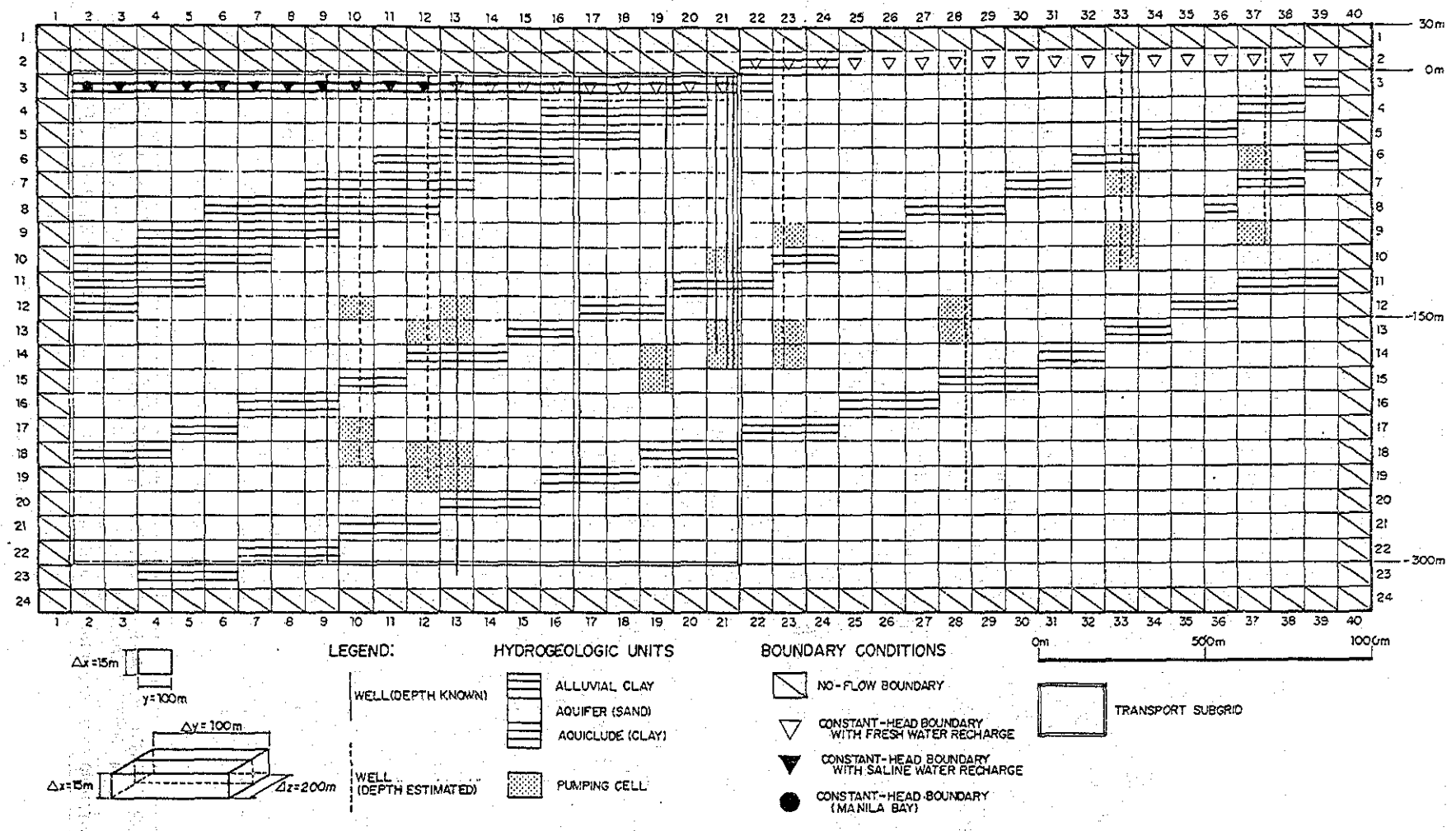
b) Scenario 4

(Contour Interval: 10m, Unit: m)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.3.7
JAPAN INTERNATIONAL COOPERATION AGENCY	SIMULATED PIEZOMETRIC CHANGES FROM 1991 TO 2010 (SCENARIO 3, SCENARIO 4)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 7.4.1 LOCATION OF VERTICAL TWO-DIMENSIONAL MODEL FOR SALTWATER INTRUSION ANALYSIS
JAPAN INTERNATIONAL COOPERATION AGENCY	



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

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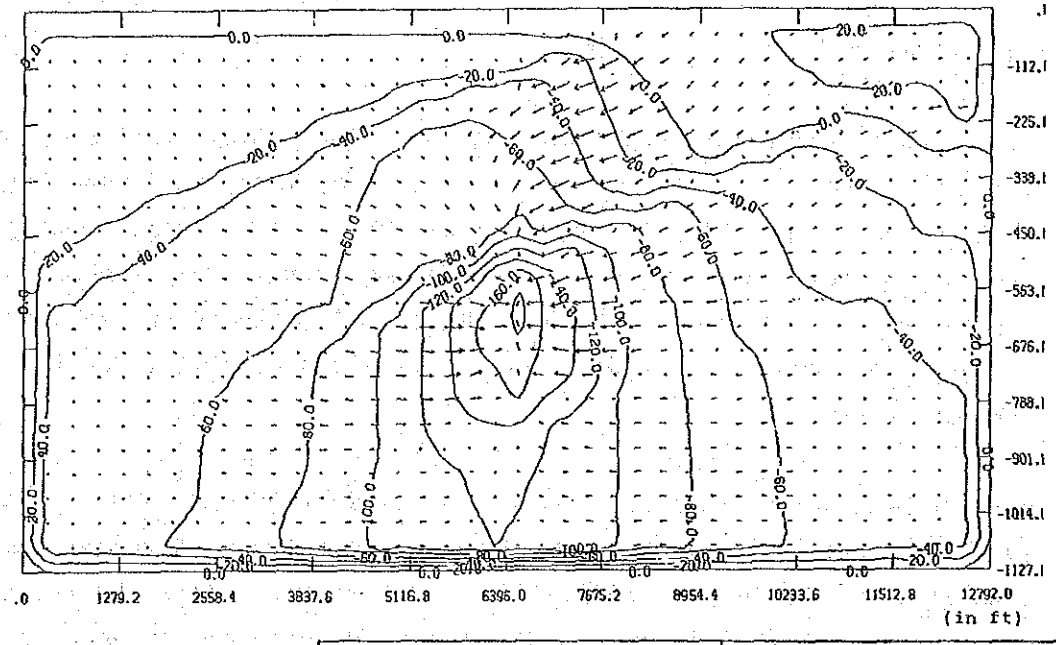
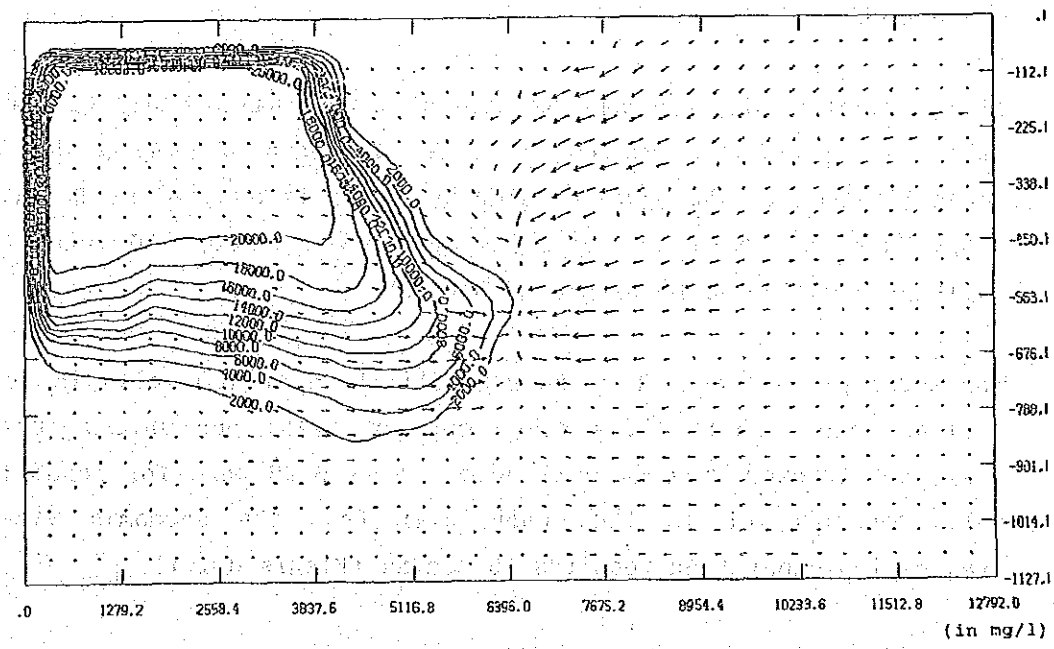
FIGURE 7.4.2
VERTICAL TWO-DIMENSIONAL GRID FOR THE SOLUTE TRANSPORT AND DISPERSION MODEL IN LAS PIÑAS



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA JAPAN INTERNATIONAL COOPERATION AGENCY	FIGURE 7.4.3 SIMULATED PIEZOMETRIC HEADS IN STEADY-STATE CONDITION



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA JAPAN INTERNATIONAL COOPERATION AGENCY	FIGURE 7.4.4 COMPUTED CHLORIDE CONCENTRATION AFTER 10 YEARS SIMULATION