JAPAN INTERNATIONAL COOPERATION AGENCY
METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
THE REPUBLIC OF THE PHILIPPINES

STUDY ON WATER SUPPLY AND SEWERAGE MASTER PLAN OF METRO MANILA IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME III SUPPORTING REPORT

FEBRUARY 1996

NIPPON JOGESUIDO SEKKEI CO., LTD.
TOHMATSU & CO.

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SUPPORTING REPORT

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General

Chapter 1.

Introduction

Part I. General

Chapter 1. Introduction

1. Brief History of Manila's Water Supply

Early Sources: 1878 - 1908

In 1743, Don Francisco Carriedo y Peredo, a retired Captain-General, bequeathed 10,000 pesos, which were all he had, to Manila as the nucleus of a fund for a public water supply to the city. The donation, with interest, accumulated enough funds so that in 1878 Don Genaro de Palacios y Guerra began what was called the "Carriedo Waterworks."

Water was taken from the Mariquina River at Santolan and pumped into "El Deposito" (the reservoir) in San Juan, where it flowed by gravity to Manila. This project was completed in 1882 and was capable of supplying 4,000,000 gallons (15,141 m^3) per day. It is generally conceded that this is one of the first properly designed water supply systems constructed in the Orient.

Montalban System: 1909 - 1924

In 1898, the Santolan intake capacity was increased to about 8,000,000 gallons (30,282 m^3) per day. Shortly after this augmentation, water from this source became polluted with the waste from several towns located along the banks of the river above the pumping plant. The new regime decided to construct a gravity system, taking water from the same river above the town of Montalban, where the watershed could be protected from contamination. This project, including the construction of a masonry dam (Wawa Dam) and 24 kilometers of steel pipe leading to San Juan, had a maximum capacity of 23,000,000 gallons (87,620 m^3) per day, was started in 1902 and was completed in 1909.

Establishment of Metropolitan Water District: 1919

Prior to the passage of Act No. 2832 in 1919 creating the Metropolitan Water District (MWD), Manila's water supply was administered by the City authorities. Act No. 2832 provided that the District should comprise all territory within the City of Manila and 14 municipalities in Rizal

Province and made it the duty of the District to "furnish an adequate water supply and sewer service to the inhabitants thereof."

Construction of Novaliches Reservoir: 1925 - 1929

After the completion of the Montalban System, Metro Manila experienced its first water shortage during unusually dry season of 1912. It was necessary that year and during subsequent dry seasons, until the completion of the Novaliches Reservoir in 1929, to augment the supply from the gravity system by operating the old pumping plant at Santolan for from several weeks to two months each year. The combined supply from these sources proved inadequate to meet requirements, quantitatively and qualitatively. The limited supply of contaminated water during the hot season, or at the time of maximum demand, was not only a serious inconvenience to residents but necessitated that they either boil the tap water or purchase water from artesian wells for drinking purposes. Thus, the Novaliches reservoir was planned, and was constructed from March 1925 to June 1929. The reservoir initially had a capacity of 9 billion gallons (34,068,000 m^3), but afterwards, in 1960, its capacity was increased to 12 billion gallons (45,420,000 m^3) by raising up the elevation of the dam and the crest of spillway by 0.95 m.

Angat-Novaliches System and Balara Filter Plant : 1924 - 1944

The Angat River was conceived as a major source for Manila early in 1903. But the initial development of the Angat was done only during the 1920s. Investigations were made of possible sources of supply extending over a period of about five years until its was decided in 1924 to draw water from the Angat River. This system comprises several major components, most of them were constructed during the period of the latter half of 1930s, as follows:

- the Ipo Dam (Old Ipo Dam) and Intake (Nov. 1935 - Dec. 1938)
- the Ipo-Bicti Tunnel (Tunnel No. 1, Mar. 1927 - 1931)
- the Bicti-Novaliches Aqueduct (BNAQ-1, May 1936 - Mar. 1939)
- the Novaliches-Balara Aqueduct (LBAQ-1, completed in 1929)
- the Balara Treatment Plant (Filter Plant No. 1, completed in early 1935)

- the 1st Balara-San Juan Aqueduct (Tunnel 2.5 km and Siphon 3.4 km, 1929)
- the 40-ML Covered Reservoir in San Juan (completed in 1935)

Together with the previously completed Novaliches Reservoir, the Angat-Novaliches System augmented the supply capacity to 50,000,000 gallons (189,265 m^3) per day. At that time, it was thought that the completion of the Angat-Novaliches System assured an ample water supply for Manila and its environs for at least 60 years and justified the abandonment of the obsolete Montalban system as a source of supply. Since then, the Angat source has been the backbone of the present day system.

Post-World War II : 1945 - 1964

The post-war period saw some improvements in the Angat-Novaliches System. More aqueducts were constructed, the Balara Treatment Plant was increased in capacity, more storage reservoirs were constructed in San Juan, and additional distribution mains were laid. One additional minor supply was tapped, the Alat River, where a small diversion dam was constructed (completed in 1962) to deliver the Alat flow into the Novaliches Reservoir through Alat Dam-Sapan Kawayan Aqueduct (completed in 1960). During this time the population of the MWSS service area rose from 913,000 in 1939 to 1.6 million in 1948 and 2.5 million in 1960.

A significant event during the period was the creation in 1955 of the National Waterworks and Sewerage Authority (NAWASA or NWSA) which effected a centralized and consolidated control and supervision of all waterworks and sewerage system in the country.

In 1962, the NWSA concluded an agreement with the National Power Corporation (NPC) to include a water supply component to the construction of the Angat Multi-Purpose Dam. The NWSA's financial contribution at the time ensured water rights to a regulated discharge of 22 m^3/s from the dam which was completed in 1968.

Interim Program: 1964 - 1971

In 1964, the International Bank for Reconstruction and Development (IBRD) funded the foreign portion of a $20.2 million interim improvement program.

The Interim Program, which dominated the Manila water supply picture in the 1960s and which was substantially completed by 1970, made significant increases in the system capacity. The Interim Program was designed to increase the capacity of the water system from 738,134 m^3/d (195 MGD) to 1,495,200 m^3/day (395 MGD). A new, larger tunnel (Tunnel No. 2) was driven from Ipo to Bicti, a third Bicti-Novaliches aqueduct was constructed and treatment units were added at Balara. In the distribution system, a number of pump stations were built, many with associated ground storage reservoirs. However, the project did not include any substantial addition to the reticulation system and by the early 1970s, shortages began to be felt.

Establishment of MWSS: 1971

As the development of the NCR as well as nuclear towns and cities throughout the country had remarkably progressed during the later 1960s, the restructuring of water supply administration came into the subject in order to meet the needs of the times. On June 19, 1971, therefore, the "Act Creating the Metropolitan Waterworks and Sewerage System and Dissolving the National Waterworks and Sewerage Authority and for Other Purposes" was enacted by the Senate and House of Representatives.

Through enactment of this Act, the NWSA was abolished and replaced with three specialized agencies: MWSS would take responsibility over Metro Manila and its contiguous areas, the Local Water Utilities Administration (LWUA) would handle cities and municipalities with populations of 20,000 or more, and the Rural Waterworks Development Corporation (RWDC) which would be concerned with the rural population and the smaller provincial urban communities.

1971-1994

In succeeding years, further increases in the system capacity were effected through the construction of additional facilities including the Bicti-Novaliches Aqueduct No. 4 (BNAQ-4, 1983), the La Mesa Treatment Plant and the treatment units at Balara and several pumping stations. Among them, the La Mesa - Bagbag System should be mentioned specially. It completed its construction in 1983, and the total capacity of treatment was raised up to 3,100,000 m^3/d with Balara WTP.

During the period from 1989 to 1993, another expansion project was executed under the Angat Water Supply Optimization Project (AWSOP). This project was intended as further augmentation of supply capacity of MWSS to 15 m^3/s (1,300,000 m^3/d) by "optimized utilization" of the Angat Reservoir. Under this project, the 5th auxiliary turbine at the Angat Power Plant, another Ipo-Bicti Tunnel (No. 3), the Bicti-Novaliches Aqueduct No. 5 (BNAQ-5) and the 2nd La Mesa Treatment Plant LP-2 (900,000 m^3/d) capacity) were constructed. Under some unavoidable circumstances however, the distribution facilities have not been completed yet. Due to the completion of LP-2, the total capacity of treatment was raised up to 4,000,000 m^3/d.

Chapter 3.

Project Framework

Part I. General

Chapter 3. Project Framework

2. Urban Development Background Data

(1) Present Population of the Study Area

The 1990 census placed the total population of the Study Area at 9.4 million, and was distributed as follows: NCR (six cities and eleven towns) with 7.9 million, while Cavite (one city and five towns) and Rizal Province (fourteen towns) with a population of 457,000 and 983,000, respectively (see Table 2.1).

Growing at 3.27% annually since 1980, the Study Area has increased by 2.6 million people and by about 0.5 million households. The average size of households declined from 5.4 to 5.0 during the last ten years.

The NCR is increasing annually by about 202,000 people or 2.98% within the same period, and is currently estimated at 9.0 million (1995). The localities with the highest rates between 1980 to 1990 are: Las Picas (8.09%), Muntinlupa (7.37%), Taguig (7.11%), Caloocan (5.02%) and Valenzuela (4.83%). Cavite (one city and five municipalities) and Rizal province are increasing by about 13,300 and 42,200 people or 3.49% and 5.87%, respectively, within the same period. The population of Cavite and Rizal in 1995, are estimated at 537 thousand and 1.2 million, respectively. The localities with the highest growth rates between 1980 and 1990 are Bacoor (5.86%) and Imus (4.54%) in Cavite, and Antipolo (11.82%), Cainta (7.95%), Angono (5.67%) and Rodriguez (4.83%) in Rizal Province.

(2) Overview of Population Growth

During the period 1970-1990 the total population of the Study Area had increased by almost 2.1 times and amounted to 9.4 million in 1990. A remarkable increase of nearly 2.3 million was recorded in the decade of 1970-1980, but it might be noticeable that the population growth rate had already shown a tendency to decline: from 4.64% in the 1970-1975 period to 3.23% during 1985-1990. It is clear that the population growth of the NCR had a radical pattern. This point

Table 2.1 Population Distribution by City/Municipality by Selected Year

No.	City/ Municipality	1970	1975	1980	1985	1990	Growth Rate (%)			
							1975/70	1980/75	1985/80	1990/85
	NCR	3,966,695	4,970,006	5,925,884	6,942,191	7,948,392	4.61	3.58	3.22	2.74
1	Manila	1,330,788	1,479,116	1,630,485	1,765,907	1,601,234	2.14	1.97	1.61	-1.94
2	Pasay	206,283	254,999	287,770	331,860	368,366	4.33	2.45	2.89	2.11
3	Quezon	754,452	956,864	1,165,865	1,377,926	1,669,776	4.87	4.03	3.40	3.92
4	Caloocan	274,453	397,201	467,816	543,302	763,415	7.67	3.33	3.04	7.04
5	Mandaluyong	149,407	182,267	205,366	233,843	248,143	4.06	2.42	2.63	1.19
6	Las Pinas	45,732	81,610	136,514	207,770	297,102	12.28	10.84	8.76	7.41
7	Makati	264,918	334,448	372,631	421,367	453,170	4.77	2.19	2.49	1.47
8	Malabon	141,514	174,878	191,001	220,197	280,027	4.32	1.78	2.89	4.92
9	Marikina	113,400	168,453	211,613	259,806	310,227	8.24	4.67	4.19	3.61
10	Muntinlupa	65,057	94,563	136,679	183,693	278,411	7.77	7.65	6.09	8.67
11	Navotas	83,245	97,098	126,146	147,364	187,479	3.13	5.37	3.16	4.93
12	Paranaque	97,214	158,974	208,552	266,740	308,236	10.34	5.58	5.01	2.93
13	Pasig	156,492	209,915	268,570	334,770	397,679	6.05	5.05	4.51	3.50
14	Pateros	25,468	32,821	40,288	48,346	51,409	5.20	4.18	3.71	1.24
15	San Juan	104,559	122,492	130,088	142,443	126,854	3.22	1.21	1.83	-2.29
16	Taguig	55,257	73,702	134,137	166,308	266,637	5.93	12.72	4.39	9.90
17	Valenzuela	98,456	150,605	212,363	290,551	340,227	8.87	7.11	6.47	3.21
	CAVITE	230,689	267,926	324,273	389,775	457,020	3.04	3.89	3.75	3.23
1	Cavite City	75,739	82,456	87,666	96,639	91,641	1.71	1.23	1.97	-1.06
2	Bacoor	48,440	62,225	90,364	116,783	159,685	5.14	7.75	5.26	6.46
3	Imus	43,656	48,566	59,103	71,440	92,125	2.14	4.01	3.86	5.22
4	Kawit	28,437	33,813	39,368	47,250	47,755	3.52	3.09	3.72	0.21
5	Noveleta	10,560	12,141	14,460	17,120	20,409	2.83	3.56	3.43	3.58
6	Rosario	23,817	28,725	33,312	40,543	45,405	3.82	3.01	4.01	2.29
	RIZAL	307,238	414,192	555,473	673,066	982,940	6.16	6.05	3.92	7.87
1	Angono	12,127	17,574	26,511	33,864	46,014	7.70	8.57	5.02	6.32
2	Antipolo	26,508	40,944	68,912	93,242	210,588	9.08	10.97	6.23	17.70
3	Baras	7,166	9,722	11,196	13,321	16,880	6.29	2.86	3.54	4.85
4	Binangonan	52,296	63,215	80,980	93,858	127,561	3.87	5.08	3.00	6.33
5	Cainta	20,714	36,971	59,025	82,749	126,839	12.28	9.81	6.99	8.92
6	Cardona	16,880	21,266	24,503	27,313	32,962	4.73	2.87	2.20	3.83
7	Jala-Jala	8,115	9,276	11,945	13,667	16,318	2.71	5.19	2.73	3.61
8	Morong	18,970	21,058	24,858	26,295	32,165	2.11	3.37	1.13	4.11
9	Pililla	15,052	18,985	23,222	26,887	32,771	4.75	4.11	2.97	4.04
10	Rodriguez	20,882	31,176	41,859	49,856	67,074	8.35	6.07	3.56	6.11
11	San Mateo	29,183	38,955	51,910	61,381	82,310	5.95	5.91	3.41	6.04
12	Tanay	23,247	33,382	40,443	48,121	58,410	7.51	3.91	3.54	3.95
13	Taytay	46,717	58,274	75,328	86,507	112,403	4.52	5.27	2.81	5.38
14	Teresa	9,381	13,394	14,781	16,005	20,645	7.38	1.99	1.60	5.22
	TOTAL	4,504,622	5,652,124	6,805,630	8,005,035	9,388,352	4.61	3.78	3.30	3.24

Source : National Statistics Office (NSO)
Growth rates arranged by the Study Team

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can be traced by a closer look at the highest average annual growth rate of each city/municipality all through the census periods.

Figures 2.1 and 2.2 show the population growths of the country and the Study Area through the census periods.

Figure 2.1
Philippine Population Growth

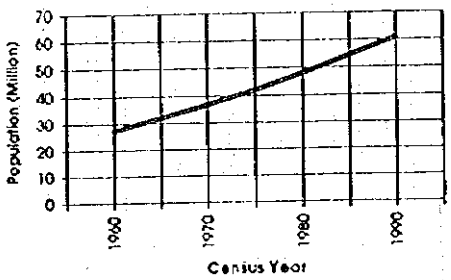
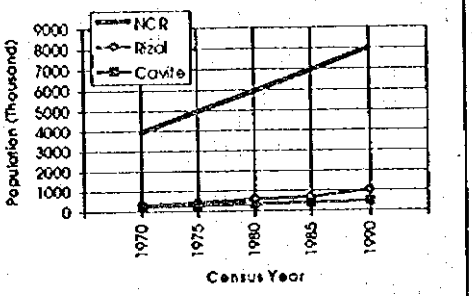


Figure 2.2
Study Area Population Growth



The National Capital Region remains as a growth center and the on-going population growth has already been beyond the boundary of the NCR to the contiguous provinces of Cavite, Rizal and Bulacan.

Problems related to rapid urbanization such as congestion and an acute housing shortage may have contributed to the spillover of some residents of Metro Manila towards neighboring provinces.

(3) Household and Population Density

Occupying 0.7% of the national land, the household and population density of the Study Area (1990), were estimated at 1.85 million and 4,400 persons/sq.m. The country's population density was placed at 202 persons/sq.m.

The population density of the Study Area is distributed as follows: 13,000 person/sq.km. in the NCR, 2,500 person/sq.km. in Cavite, and only 700 person/sq.km. in Rizal. The five most congested areas per square kilometer are Manila (41,600), Pateros (27,800), Makati (24,600), Mandaluyong (22,200) and Pasay (20,900) all located in the National Capital Region. The five

Table 2.2 Study Area Population, Household, Density (1990)

No.	City/ Municipality	Land Area (Ha.)		Population	Household	Density (pers/ha)		Person/ Household
		NSO	Study Team			NSO	Study Team	
	NCR	63,600	61,240	7,948,392	1,569,538	125	130	5.1
1	Manila	3,830	3,850	1,601,234	308,909	418	416	5.2
2	Pasay	1,390	1,760	368,366	73,846	265	209	5.0
3	Quezon	16,620	16,660	1,669,776	332,283	100	100	5.0
4	Caloocan	5,580	5,580	763,415	151,132	137	137	5.1
5	Mandaluyong	2,600	1,120	248,143	49,774	95	222	5.0
6	Las Pinas	4,150	3,270	297,102	57,670	72	91	5.2
7	Makati	2,990	1,840	453,170	89,295	152	246	5.1
8	Malabon	2,340	1,740	280,027	58,367	120	161	4.8
9	Marikina	3,890	2,280	310,227	60,088	80	136	5.2
10	Muntinlupa	4,670	3,970	278,411	53,449	60	70	5.2
11	Navotas	260	1,100	187,479	38,995	721	170	4.8
12	Paranaque	3,830	4,020	308,236	61,128	80	77	5.0
13	Pasig	1,300	3,160	397,679	77,642	306	126	5.1
14	Pateros	1,040	185	51,409	9,808	49	278	5.2
15	San Juan	1,040	620	126,854	24,356	122	205	5.2
16	Taguig	3,370	4,538	266,637	53,153	79	59	5.0
17	Valenzuela	4,700	4,480	340,227	69,643	72	76	4.9
	Reclaimed Land		1,067					
	CAVITE	18,572	18,621	457,020	91,396	25	25	5.0
1	Cavite City	1,183	620	91,641	19,040	77	148	4.8
2	Bacoor	5,240	5,240	159,685	30,928	30	30	5.2
3	Imus	9,701	9,701	92,125	18,648	9	9	4.9
4	Kawit	1,340	1,750	47,755	9,767	36	27	4.9
5	Noveleta	541	390	20,409	4,012	38	52	5.1
6	Rosario	567	920	45,405	9,001	80	49	5.0
	RIZAL	130,383	131,144	982,940	189,712	8	7	5.2
1	Angono	2,600	2,200	46,014	8,941	18	21	5.1
2	Antipolo	30,610	30,610	210,588	40,852	7	7	5.2
3	Baras	2,340	2,340	16,880	3,163	7	7	5.3
4	Binangonan	7,270	7,270	127,561	24,378	18	18	5.2
5	Cainta	1,019	2,190	126,839	24,775	124	58	5.1
6	Cardona	3,120	3,120	32,962	6,264	11	11	5.3
7	Jala-Jala	4,930	4,930	16,318	3,035	3	3	5.4
8	Morong	3,760	3,760	32,165	6,255	9	9	5.1
9	Pililla	7,390	7,390	32,771	6,131	4	4	5.3
10	Rodriguez	31,280	31,280	67,074	12,891	2	2	5.2
11	San Mateo	6,490	6,490	82,310	16,079	13	13	5.1
12	Tanay	24,340	24,340	58,410	11,089	2	2	5.3
13	Taytay	3,374	3,364	112,403	21,881	33	33	5.1
14	Teresa	1,860	1,860	20,645	3,978	11	11	5.2
	TOTAL	212,555	211,005	9,388,352	1,850,646	44	44	5.1

Source : National Statistics Office (NSO)

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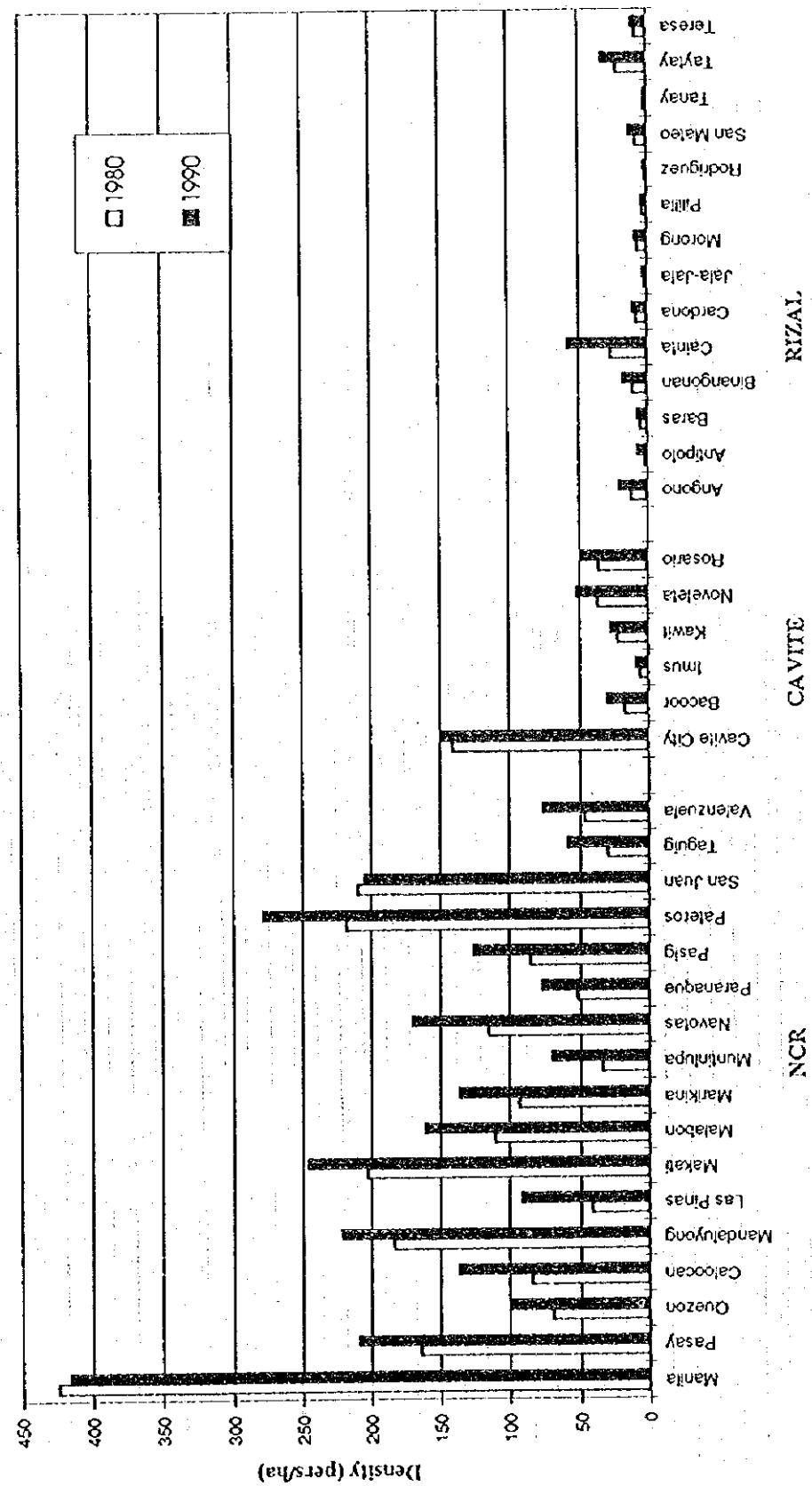

Figure 2.3 Population Density (1980 & 1990)

least densely populated areas are found in the municipalities of Rizal: Rodriguez (200), Tanay (200), Jala-Jala (300), Antipolo (700) and Baras (700). Household, population density and density distribution (1980 and 1990) by cities/ municipalities are shown in Table 2.2 and Figure 2.3, respectively.

(4) Major Proposed Transport Projects

The expressway will provide a higher type of transport facility within the NCR and towards the province of Cavite with the construction of C-5 and the Manila-Cavite expressways, and improve the accessibility of the Ninoy Aquino International Airport from the Coastal Road and South Luzon Expressway. The Manila-Cavite expressway will help alleviate the traffic congestion on the major but narrow roads within its zone of influence and at the same time play an important role in promoting economic development in the area as it will provide a direct linkage between Manila and the Export Processing Zone in Cavite (CEPZ).

Manila-Cavite and C-5 expressway projects and other relevant transport projects regarded as one of the pre-conditions for expressway network planning are shown in Table 2.3 and Figure 2.4.

The Marikina-Infanta Road (on-going) is envisaged to serve as an alternative to the existing route from Metro Manila to Famy and further to Infanta via the Marikina-Famy-Infanta Road. Its improvement/construction will provide better access and movement of goods and services to 9 municipalities covering a total population of 630,000. The project road will traverse large tracts of agricultural lands planted to palay, corn, coconut and other crops. Its construction is expected to enhance the development of the agricultural, forestry, fishery, and mining potentials of Quezon Province. It is also intended to hasten the social, economic, and political integration of the undeveloped eastern section of Quezon Province with Metro Manila. The project road is likewise considered as a major infrastructure support to the on-going and proposed development plans and programs in Quezon Province as embodied in the CALABARZON Industrial Corridor.

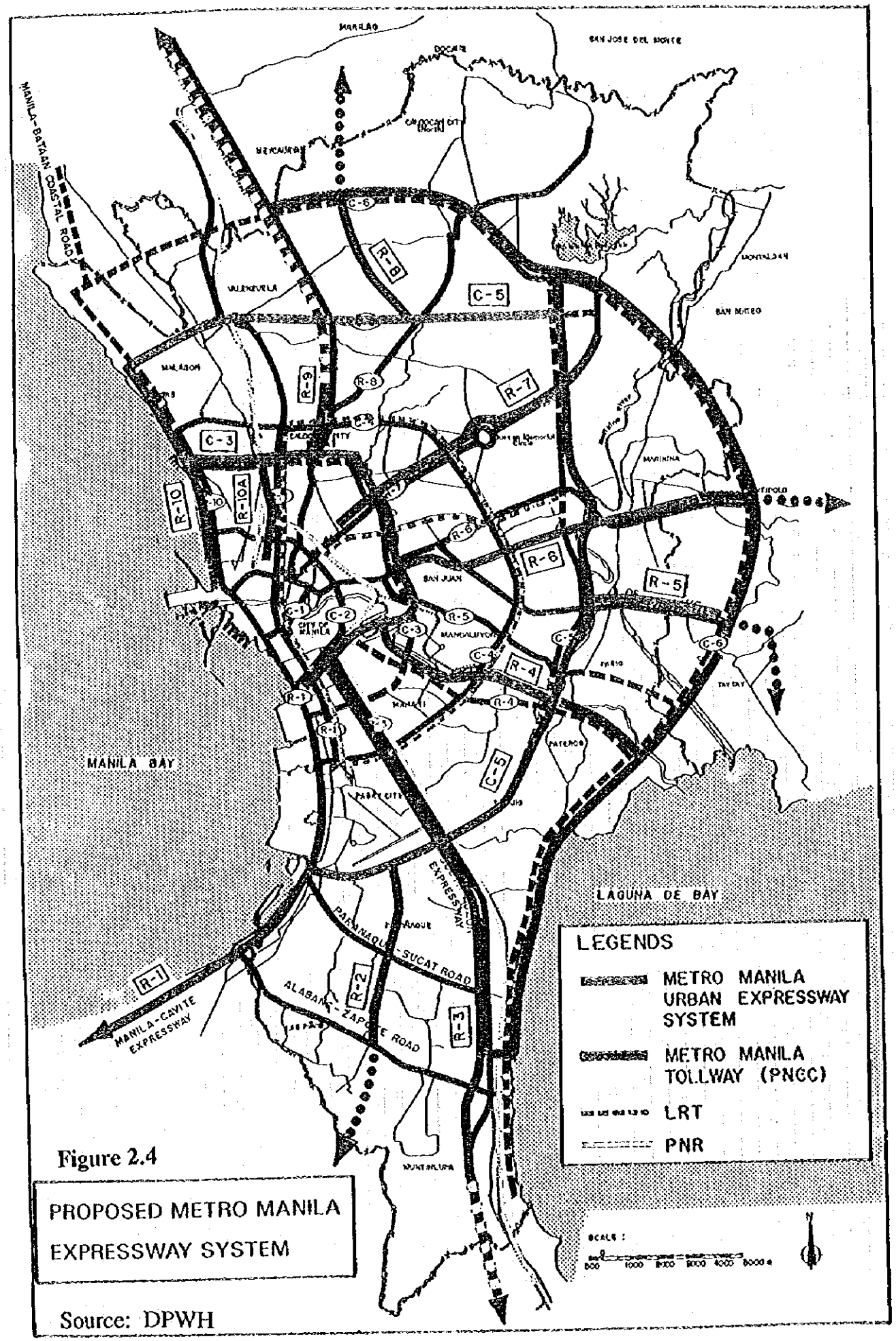

Figure 2.4

PROPOSED METRO MANILA EXPRESSWAY SYSTEM

Source: DPWH

Table 2.3 Planned Road Projects

Projects	Length (Km)	Implementation Schedule
I. METRO MANILA SKYWAY		
1. Construction of elevated expressway along Alabang to Buendia Avenue to Quirino Avenue Section expressway along Alabang to Buendia Avenue to Quirino	18.06	1994-1997
2. Quirino Avenue to Araneta Avenue		
3. Araneta Avenue to A. Bonifacio Avenue	3.44	1997-1998
4. A. Bonifacio Avenue to North Avenue Expressway	5.04	1998-1999
	3.90	1996-1997
II. MANILA-CAVITE AND C-5 EXPRESSWAY		
1. Manila-Cavite Expressway	6.00	1996-1997
2. Operation of R-1 Toll Expressway	6.60	Under constr. by PEA
3. C-5 Expressway from R1 to R3	9.54	1995-1997
III. METRO MANILA EXPRESSWAY RADIAL ROAD (ROUTE-4) Construction of elevated expressway running along the river bank of C-3 to C-5 and later to be extended to C-6	7.22	
IV. METRO MANILA EXPRESSWAY (ROUTE-5) Construction of elevated double-deck type structure along Ortigas Avenue from C-5 to C-6	5.30	
V. METRO MANILA EXPRESSWAY (ROUTE-7) Construction of elevated expressway along Quezon Avenue then at ground level along Commonwealth Avenue to Batasang Pambansa	12.20	
VI. TO THE NORTH Construction of C-5 from U.P. to Letre	19.74	1995-1998
VII. TO THE EAST Construction/improvement of Marikina-Infanta Road	101.40	On-going

2.1 Current Land Use

(1) Classification of Land Use

The land area figures are summarized in Table 2.4 and the land use distribution is shown in Table 2.5.

Table 2.4 Summary of Current Land Use

Region	Built-up Area	Recreation, Park, Sports, Open Space	Agricult.	Forest	Wetland, Others	Total	Percentage Over Total Land Area
NCR	33,932	8,600	5,923	7,771	5,014	61,240	29.02
Cavite	2,640	343	11,027	3,520	1,091	18,621	8.82
Rizal	5,962	1,313	26,195	96,407	1,267	131,144	62.15
Total	42,534	10,256	43,145	107,698	7,372	211,005	100.00
Percentage Over Total Land Area	20.16	4.86	20.45	51.04	3.49	100.00	

Table 2.5 Current Land Use, 1994

	City/ Municipality	Land Area (Ha) Available Data	Land Area (Ha) Study Team	Percent (%)	Built-up Area Res.	%	Commer	%	Indust	%	Instit	%	Open Space	%	Recreat. Parks, Sport	%	Agricult.	%	Forest	%	Wetland	%	Others	%
	Total Land Area incl. Reclamat.	63,600	61,240	100	22,861	37.3	2,925	4.8	3,932	6.4	4,214	6.9	7,438	12.1	1,162	1.9	5,923	9.7	7,771	12.7	2,656	4.3	2,358	3.9
	Total Land Area excl. Reclamat.		60,173	100	22,861	38.0	2,925	4.9	3,932	6.5	4,214	7.0	7,438	12.4	1,162	1.9	5,923	9.8	7,771	12.9	2,656	4.4	1,291	2.1
	Manila	3,830	3,850	100	2,460	63.9	500	13.0	200	5.2	310	8.1	85	2.2	150	3.9	-	0.0	-	0.0	-	0.0	145	3.8
N	Pasay	1,390	1,760	100	740	42.0	170	9.7	40	2.3	570	32.4	73	4.1	100	5.7	50	2.8	8	0.5	-	0.0	9	0.5
	Quezon	16,620	16,660	100	5,990	36.0	640	3.8	800	4.8	1,100	6.6	1,990	11.9	200	1.2	1,340	8.0	4,050	24.3	-	0.0	550	3.3
C	Caloocan	5,580	5,580	100	1,995	35.8	200	3.6	270	4.8	150	2.7	750	13.4	6	0.1	910	16.3	1,250	22.4	-	0.0	49	0.9
	Mandaluyong	2,600	1,120	100	590	52.7	100	8.9	160	14.3	155	13.8	13	1.2	90	8.0	-	0.0	12	1.1	-	0.0	-	0.0
R	Las Pinas	4,150	3,270	100	1,360	41.6	90	2.8	140	4.3	50	1.5	700	21.4	10	0.3	260	8.0	480	14.7	150	4.6	30	0.9
	Makati	2,990	1,840	100	1,100	59.8	330	17.9	150	8.2	120	6.5	15	0.8	110	6.0	-	0.0	-	0.0	-	0.0	15	0.8
	Malabon	2,340	1,740	100	665	38.2	80	4.6	200	11.5	54	3.1	110	6.3	7	0.4	40	2.3	54	3.1	460	26.4	70	4.0
	Marikina	3,890	2,280	100	960	42.1	100	4.4	220	9.6	100	4.4	488	21.4	42	1.8	170	7.5	130	5.7	20	0.9	50	2.2
	Muntinlupa	4,670	3,970	100	1,130	28.5	100	2.5	180	4.5	120	3.0	1,170	29.5	100	2.5	240	6.0	920	23.2	10	0.3	-	0.0
	Navotas	260	1,100	100	340	30.9	40	3.6	70	6.4	30	2.7	80	7.3	3	0.3	6	0.5	5	0.5	461	41.9	65	5.9
	Paranaque	3,830	4,020	100	1,645	40.9	120	3.0	290	7.2	170	4.2	800	19.9	160	4.0	310	7.7	265	6.6	230	5.7	30	0.7
	Pasig	1,390	3,160	100	1,100	34.8	125	4.0	520	16.5	96	3.0	530	16.8	27	0.9	566	17.9	24	0.8	2	0.1	170	5.4
	Pateros	1,040	185	100	105	56.8	10	5.4	2	1.1	17	9.2	10	5.4		0.0	30	16.2	3	1.6	-	0.0	8	4.3
	San Juan	1,040	620	100	441	71.1	60	9.7	15	2.4	67	10.8	30	4.8	7	1.1	-	0.0	-	0.0	-	0.0	-	0.0
	Taguig	3,370	4,538	100	810	17.8	90	2.0	135	3.0	975	21.5	250	5.5	135	3.0	990	21.8	365	8.0	748	16.5	40	0.9
	Valenzuela	4,700	4,480	100	1,430	31.9	170	3.8	540	12.1	130	2.9	344	7.7	15	0.3	1,011	22.6	205	4.6	575	12.8	60	1.3
	Reclaimed Area Manila side		331		Reclaimed Area Laguna de Bay side from Taguig to San Pedro (future) (3000 ha.)																			
	Reclaimed Area Pasay side		491																					
	Reclaimed Area Parnanaque side		245																					
	CAVITE	18,572	18,621	100	2,063	11.1	96	0.5	168	0.9	313	1.7	304	1.6	39	0.2	11,027	59.2	3,520	18.9	875	4.7	216	1.2
	Cavite City	1,183	620	100	275	44.4	32	5.2	3	0.5	196	31.9	21	3.4	5	0.8	-	0.0	10	1.6	70	11.3	6	1.0
	Bacoor	5,240	5,240	100	700	13.4	26	0.5	16	0.3	30	0.6	128	2.4	10	0.2	2,340	44.7	1,580	30.2	290	5.5	120	2.3
	Imus	9,701	9,701	100	530	5.5	15	0.2	4	0.0	36	0.4	105	1.1	1	0.0	7,200	74.2	1,790	18.5	-	0.0	20	0.2
	Kawit	1,340	1,750	100	298	17.0	13	0.7	2	0.1	23	1.3	18	1.0	7	0.4	859	49.1	85	4.9	395	22.6	50	2.9
	Noveleta	541	390	100	80	20.5	6	1.5	1	0.3	10	2.6	10	2.6	14	3.6	130	33.3	19	4.9	110	28.2	10	2.6
	Rosario	567	920	100	180	19.6	4	0.4	142	15.4	16	1.7	22	2.4	2	0.2	498	54.1	36	3.9	10	1.1	10	1.1
	RIZAL	130,383	131,144	100	5,253	4.0	130	0.1	483	0.4	96	0.1	1,253	1.0	60	0.0	26,195	20.0	96,407	73.5	510	0.4	757	0.6
	Angono	2,600	2,200	100	320	14.5	15	0.7	10	0.5	15	0.7	60	2.7	1	0.0	539	24.5	1,120	50.9	60	2.7	60	2.7
	Antipolo	30,610	30,610	100	1,070	3.5	23	0.1	45	0.1	-	0.0	617	2.0	-	0.0	1,970	6.4	26,600	86.9	-	0.0	285	0.9
	Baras	2,340	2,340	100	84	3.6	Included in Residential Area						-	0.0	-	0.0	1,940	82.9	246	10.5	-	0.0	70	3.0
	Binangonan	7,270	7,270	100	630	8.7							-	0.0	-	0.0	450	6.2	6,190	85.1	-	0.0	-	0.0
	Cainta	1,019	2,190	100	890	40.6	50	2.3	200	9.1	32	1.5	390	17.8	50	2.3	348	15.9	180	8.2	-	0.0	50	2.3
	Cardona	3,120	3,120	100	165	5.3							-	0.0	-	0.0	120	3.8	2,835	90.9	-	0.0	-	0.0
	Jala-Jala	4,930	4,930	100	85	1.7	Included in Residential Area						-	0.0	-	0.0	2,450	49.7	2,395	48.6	-	0.0	-	0.0
	Morong	3,760	3,760	100	160	4.3							-	0.0	-	0.0	3,530	93.9	70	1.9	-	0.0	-	0.0
	Pililla	7,390	7,390	100	164	2.2							-	0.0	-	0.0	3,976	53.8	3,250	44.0	-	0.0	-	0.0
	Rodriguez	31,280	31,280	100	335	1.1	12	0.0	8	0.0	15	0.0	52	0.2	3	0.0	750	2.4	30,035	96.0	-	0.0	70	0.2
	San Mateo	6,490	6,490	100	400	6.2	10	0.2	160	2.5	16	0.2	64	1.0	1	0.0	740	11.4	5,077	78.2	-	0.0	22	0.3
	Tanay	24,340	24,340	100	290	1.2	Included in Residential Area						-	0.0	-	0.0	6,570	27.0	17,480	71.8	-	0.0	-	0.0
	Taytay	3,374	3,364	100	560	16.6	20	0.6	60	1.8	18	0.5	70	2.1	5	0.1	1,131	33.6	850	25.3	450	13.4	200	5.9
	Teresa	1,860	1,860	100	100	5.4	Included in Residential Area						-	0.0	-	0.0	1,681	90.4	79	4.2	-	0.0	-	0.0
	TOTAL	3,783	2,820	100	595	21.1	47	1.7	13	0.5	213	7.6	81	2.9	6	0.2	539	19.1	1,130	40.1	130	4.6	66	2.3

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As shown in the tables, built-up areas were classified into residential, commercial, institutional and industrial use. The land use items common to the public and government facilities such as government buildings, educational, cultural, health, welfare, religious, cemetery, military camps, etc., were classified as institutional.

The existing general land use pattern in the Study Area shows the predominance of forest. Forest area which includes forest, bushes and grassland, constitutes about 51% of the total land located mostly in the province of Rizal (Rodriguez, Antipolo, Tanay, Pillila, etc.). Agricultural land covers farm areas comprising 20.4% is the second largest area, while the aggregate area of recreational/park/sport/open space, and wetland/others represent 4.9% and 3.5% respectively of the total. Built-up areas (residential/commercial/industrial/institutional) cover 20.2%, and these are situated mostly in the NCR (79.7%), Cavite (6.2%) and western part of Rizal province (14.1%). 57.3% of the existing urban land is used for residential purposes while a larger number of land are vacant lots owned by private individuals speculating on the ever increasing prices of real estate. Open space consisting of vacant area within the built up area and unoccupied subdivisions which is mixed mostly with grassland covers 12.4% in the NCR, 1.6% in Cavite and 1.0% in Rizal. The wetland category, consisting of water related lands (marine pond, salt bed, swamp, marsh, tidal flat mud and sand) is concentrated mainly in Navotas, Malabon, Parañaque, Las Piñas and Taguig (NCR), Taytay (Rizal), and Cavite City, Bacoor, Kawit and Noveleta (Cavite), and covers 1.9% of the total land area. Others which includes water surface (lake, river and undefined use) use constitutes about 1.6% of the total land area.

The current land use map is shown in Figure 2.5 reclassified into 6 categories: built-up or residential area (divided into 3 sub-categories: high, middle and low density), industrial, agricultural, forest, open space and wetland, for the purpose of the water supply study.

(2) Land Use Trends

The inner morphology of cities and municipalities in the Study Area is marked with a land use trend that is responsive to the economic, social and political climate of the country. The late 1980's and the start of the 1990's indicated a land use trend marked by the following:

- Increased density and size of squatter housing areas in city centers
- Development of medium-scale residential subdivisions for upper-middle income markets even to the periphery (Caloocan South, Quezon City, Muntinlupa in the NCR, and

- Cainta, Antipolo in Rizal), while low-cost housing have moved to provinces outside Metro Manila, such as Cavite, Rizal, Laguna and Bulacan
- The growth of big commercial centers along the EDSA spine and high intensity commercial activities along the major transport routes in the periphery of Metro Manila
- Development of the urban area with high density housing
- Location of new and relocation of existing industries at cheaper sites to the north (Bulacan), east (Rizal) and south (Cavite, Laguna, etc.).

Existing land use is illustrated as shown in Figure 2.5 and described briefly as follows:

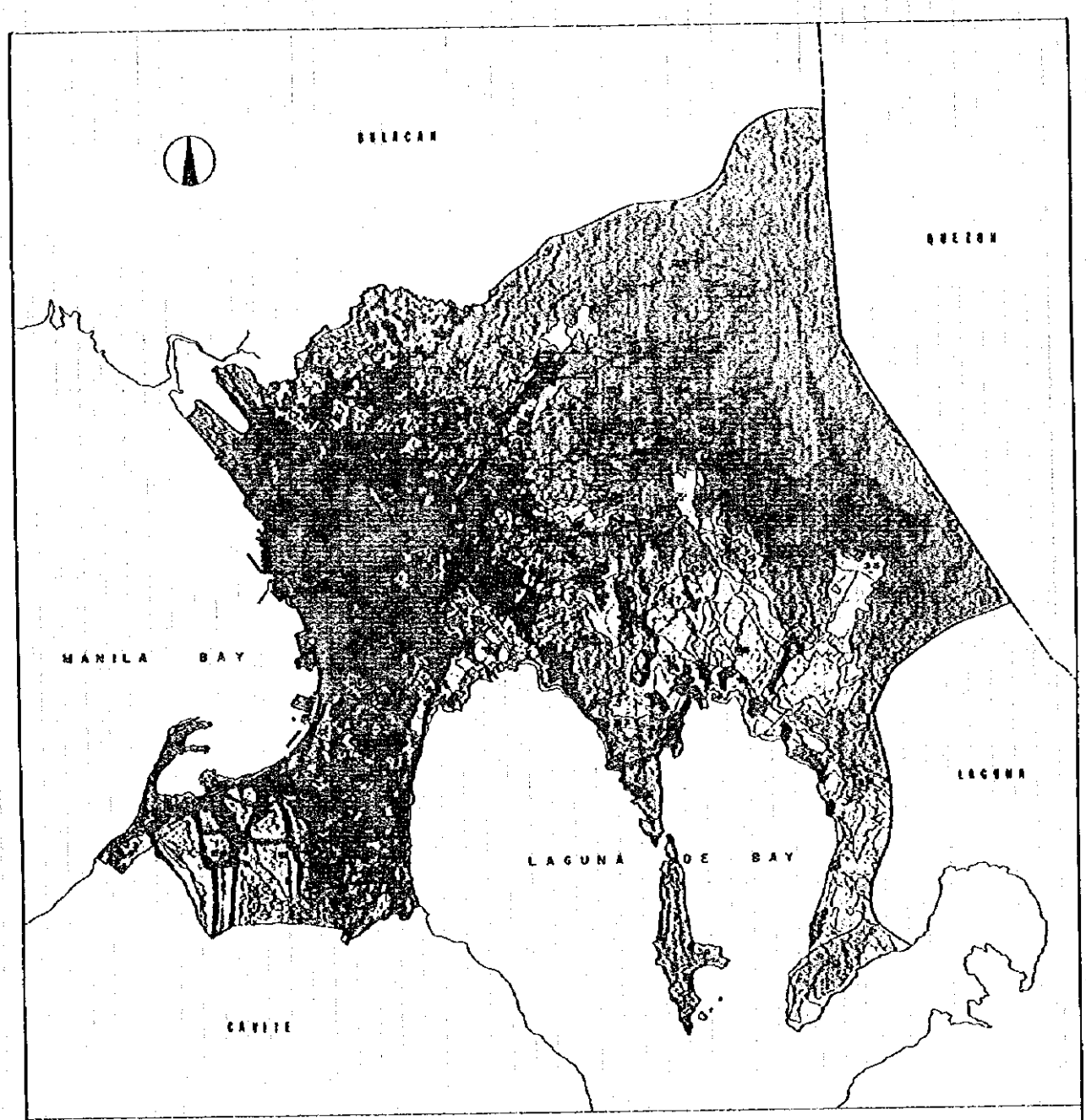
a) Residential Use

Comparable to most dense and mature urban areas, the main use of land in the Study Area is for residential purposes, except the northeastern part of Rizal province which is devoted to watershed and preservation area. Residential use accounts for 14.3% of the total land area, and 38% of the NCR land (excluding the reclaimed area), these include the approximately 300 hectares occupied by slum and squatter communities.

b) Commercial Use

Land utilized for commercial uses comprise 1.5% of the Study Area and 4.9% of the total NCR land. The old commercial districts of the City of Manila, mainly concentrated in Ermita/Malate, Divisoria, Santa Cruz, Binondo, and Tondo have lost their premiership. Their vitality is still strongly supported by the mass market, but because of age, renewing the area to regain its prime position is necessary.

The huge population and the congested traffic conditions of Manila were factors which initiated the dispersal of commercial areas in the 1970's. New commercial activities developed outside the original center. These occurred in and around new regional nodes, first in Cubao and the Balintawak Area in Quezon City, at Makati and at Greenhills in San Juan. New fast-paced developments are seen at the intersections of North Avenue, Ortigas Avenue, and Shaw Boulevard with EDSA and the Ortigas Center in Pasig. Commercial areas in Cavite and Rizal provinces have been developed along the major transport routes.



STUDY ON WATER SUPPLY AND SEWERAGE MASTER PLAN OF METRO MANILA

Figure 2.5 LAND USE MAP 1994

c) Industrial Use

The major areas where industrial facilities are concentrated include the following: along Mac Arthur Highway, Balintawak, North Expressway/Bagbaguin Road, along Pasig River (from Manila Bay to EDSA), along Marikina River (from Pasig River to Aurora Blvd.), Marikina (north area), EDSA/South Superhighway, along South Superhighway (from Sucat to Alabang) and along Ortigas Avenue Extension (from Pasig to Taytay).

d) Institutional Use

Two percent of the total land is occupied by institutional facilities, mostly located in the NCR (7% of NCR total area). Over the years educational institutions, health centers, cultural facilities and military institution were dispersed throughout the Metropolitan Manila Area. The government's policy of decentralization and the lack of government-owned facilities in the area hastened this trend.

e) Open Spaces

Although existing land use allocation studies list 12.4% of the NCR as an open space, these include vacant lands at the periphery which are essentially unserviced and undeveloped lands. Examination on the available data and field survey, shows that the unoccupied subdivision represent about 23% of the total residential/open area land, and 4.3% of the total land.

The present trend of the Study Area indicates a continuous increase of the urban area involving whole the unoccupied subdivisions, agricultural and grassland areas, especially in Quezon City, Parañaque, Las Piñas, Muntinlupa in NCR, Bacoor and Imus in Cavite, and Antipolo, Taytay and Angono in Rizal.

Furthermore, as a result of the widespread sale and conversion of farm lands into housing and industrial purposes many agricultural areas will decrease. With high land prices spawned by the massive urbanization, it is inevitable that the farmers would rather sell their lands to real estate developers, or they themselves would convert these lands into residential, commercial or industrial sites.

2.2 Regional Development Framework

The formulation of the regional plan for the National Capital Region and Region IV are vested in the Metropolitan Manila Authority and the PPDCO of Cavite and Rizal respectively. Recognized by major agencies, the Regional Development Plan for Metro Manila issues the relevant policies. Covering all the six cities and the 11 municipalities, programs and projects are identified to achieve the goals and objectives. Specifically, medium-range plans which are for a period of five years, and the physical growth strategy are formulated for the following:

Medium- Range Plan

- Economic sector. Plans are directed to the informal sector, industry, trade and commerce, tourism and employment.
- Social sector. Plans and programs are geared towards improvement in housing, livelihood, health, nutrition and family planning, social welfare, education, labor and manpower, environmental management and peace and order.
- Physical development. The programs are mainly infrastructure related and cover transport, traffic engineering and management, water supply and sewerage, flood control and drainage, communications and energy.
- Development strategies are geared towards providing the perspective for long-term planning. Efforts are directed to the following goals:
- Alleviation of poverty,
- Generation of productive employment,
- Creation of desirable environment,
- Enhancement in the delivery of urban services, and
- Strengthening the institutional capability.

Physical Growth Strategy

a. Preservation areas (where urban development must not be allowed): Novaliches and Marikina watersheds, Navotas, and in portions of municipalities along the Laguna Lake area.

b. Urban consolidation zones (where planned development should be pursued, less pollutive industries may be allowed): outside the boarders of Muntinlupa, Las Piñas, Pateros, Taguig, Caloocan (North) and Valenzuela.

c. Main built-up areas, include portions of Manila, Pasay, Quezon City, Caloocan, San Juan, Mandaluyong and Makati, require the following:

- Does not allow for the expansion of facilities for higher education,
- Bans both new and expansion of heavy industries,
- Encourages the rehabilitation of blighted areas, and the upgrade of urban services,
- Requires for the implementation of the idle land tax, land use planning and update of zoning ordinance and the closure of open dumpsites.

In Laguna Lake areas, required are the regulation of pollution control and coastal preservation which is towards preparing the lake as source of water for Metro Manila.

2.3 Urban Development

(1) Urbanization Trend

Population and its distribution largely determine the extent of urbanization, thus a close look into population trends in the Study Area from 1970 to 1990 was undertaken in the previous Section.

Annual growth rates of Metro Manila decreased from 4.61% to 2.74% while outside the NCR (Cavite and Rizal) increased from 4.86% to 6.3%. As regards to density, the NCR is the most densely populated area; however, the growth of the inner core (inside EDSA) is declining, while the outer area of the metropolis, presently, with a moderate density is increasing rapidly due to the availability of low-priced land.

Another factor to consider in urbanization is the land use. Based on the existing land use and previous studies, the past trend of urbanization is described as follows:

- Urbanization extends not only to the entire Metro Manila area but outside Metro Manila as well, such as Meycauyan (north), Cainta and Antipolo (east) and Alabang, Imus, San Pedro (south).
- Population has been spreading towards the outer areas rapidly, while it has started to decrease in the inner areas.
- Employment in many of the inner areas, except some major growth centers, has been declining together with population. Strong concentration is observed in areas along EDSA.
- Commercial land use spread mostly to the south and east, in proportion to urbanization. During the last 15 years, big commercial complexes (especially along EDSA) were constructed.
- Most of the industrial development occurred in the mid-1980's as a result of MMA's land use policies and the rapid distribution of population, leaving no more room for further developments in the NCR.

(2) Urban Structure

The development of Metro Manila can be traced from the center of the City of Manila. As the years passed, Manila evolved into a major urban center. Other urban centers that have been developed through the years include Cubao, Makati and Ortigas.

Metro Manila's present population of 8 million has carried the rapid growth of urbanization beyond EDSA. Areas such as Novaliches, Marikina, Pasig and Alabang are growing as major suburban centers. In the 1980's, the pressure of urbanization was put aside Metro Manila, such that a strong link was established with the following areas: Meycauyan, Antipolo and Cavite.

Therefore, the present urban structure of Metro Manila and the Study Area may be described as a radial-satellite pattern, with the City of Manila, Makati and Cubao/Ortigas in the center, as represented in Figure 2.6 and outlined below.

As commonly observed in large urban areas which are only served by roads, the growth of a strong urban center is limited due to constrained accessibilities. In the case of Metro Manila, the traditional Central Business District (CBD) in Manila seems to have reached more or less its saturation level around 1980, while other sub-urban centers have grown rapidly, especially along EDSA which has large transport capacity. Especially, some urban centers developed at the strong initiative of the private sector such as Makati, Ortigas, Cubao, etc., contribute to the development of an adequate hierarchical urban system greatly.

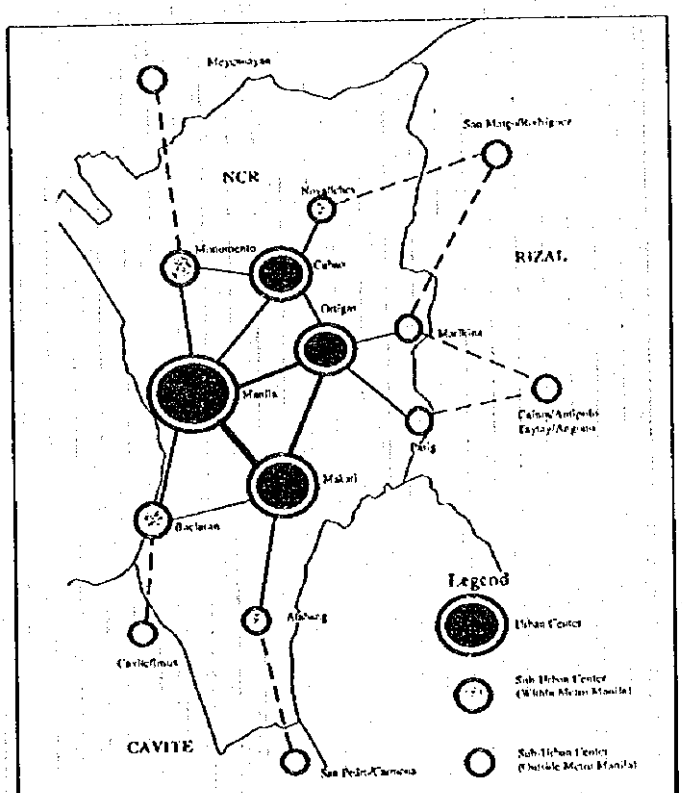


Figure 2.6 Present Urban Structure

Along with major transport corridors, suburban centers have further developed and linked with those in Metro Manila. As the actual urban areas of Metro Manila extend beyond its administrative boundary, the adjoining areas in Cavite, Rizal, Bulacan and Laguna, have been getting integrated with the metropolitan system.

(3) Planned Developments

Among various planned developments, the major ones are:

a. Conversion Plan of Military Camps in Metro Manila;
b. Laguna de Bay Reclamation Project;
c. Manila-Cavite Coastal Road and Reclamation Project (Boulevard 2000);
d. Alabang Stock Farm and New Bilibid Prison;
e. Lunsod Silangan Development Plan;
f. Rizal Industrial Estate;
g. Socialized Housing in Manggahan Floodways;
h. Subic Bay Freeport.

At present, these projects are still in the study stage and have no definite implementation plans. However, as the target year of this Study is 2015, it is relevant to look into the outline of these projects.

a) Conversion of Military Camps in Metro Manila

The Metro Manila military camps located within the developed urban sections of the region are among the areas presently under-utilized. Located at strategic sections of the region, they offer fresh and varied opportunities for development.

The redevelopment of Fort Bonifacio and Villamor Air Base, which are located in a prime urban areas, will have significant impact on the urban system of Metro Manila when it is properly developed. The total land area proposed for development in Fort Bonifacio is 745 hectares. Villamor Air Base presently occupies a gross area of 264 hectares including 135 hectares of Villamor Golf and Country Club.

b) Laguna de Bay Reclamation Project

The project aims to develop 3,000 ha. of reclamation areas along the coast of Laguna de Bay, stretching from Taguig in the north to San Pedro in the south, in a comprehensive and integrated manner along a New Town Concept, offering a "countermagnet" or sub-regional center for the orderly expansion and spill over the growth of Metro Manila. The entire project area is composed of four islands with the following landuse allocation: residential, institutional, industrial, commercial (shopping), commercial (recreation), parks and playgrounds.

The project study (master development planning) was completed under the Public Estates Authority. At present, there is no concrete implementation commitment.

c) Manila-Cavite Coastal Road and Reclamation Project

This project intends to develop approximately 990 ha. of reclaimed area, including 30 ha. of CCP Complex portion and some 400 ha. of existing reclaimed areas, along the Manila-Cavite Coastal Road for self-sufficient urban sector or mini-metropolis. Proposed land uses would include economic activities, government services, educational opportunities, recreational facilities, and residential sites.

The project study was made in May 1988 under the Public Estates Authority (PEA). At present, the reclamation project is integrated with the construction of the Manila-Cavite Coastal Road and being undertaken by PEA.

d) Alabang Stock Farm and New Bilibid Prison

The Alabang Stock Farm and New Bilibid Prison are located in Muntinlupa, at the north and south areas, respectively.

The Alabang Stock Farm intends to develop about 244 ha. of grassland for housing, institutional and commercial uses, while the New Bilibid Prison area consisting of about 405 ha. may be converted into a mixed-use development area. Presently, however, there is no definite development plan yet for the Bilibid Prison area.

Furthermore, intensive residential development mixed with fragmented commercial/industrial development is being undertaken by private developers all over the municipality (on conversion process into a city), which is expected to be fully populated by the year 2015.

e) Lunsod Silangan Development Plan

Lunsod Silangan, a proposed satellite city under the Human Settlements Development Corporation, is located east of Metro Manila and covers a total area of 180,724 ha. It includes the municipalities of Antipolo, Tanay, Baras, Rodriguez all in Rizal; Quezon, Infanta and Real all in Quezon, and Santa Maria in Laguna. Land inventory of Lunsod Silangan indicate the following allocation:

Watershed Areas	108,220 ha.
Resettlement Areas	
(Teresa, Rodriguez, Baras, Infanta-Famy)	14,571 ha.
Forest Reserves	1,386 ha.
Planning Modules	52,372 ha.
Unclassified	3,814 ha.
Total	180,723 ha.

At present, there is no Master Plan which covers the entire Lunsod Silangan townsite reservation.

f) Rizal Industrial Estate

The industrial area shall be planned as a major activity center in Lunsod Silangan and occupies a site within easy access from the Marikina-Infanta Highway. The site is proposed to absorb a number of non-polluting industries and generate the main sources of employment for the town's residents.

g) Socialized Housing in Manggahan Floodways

The MARILAQUE Commission Secretariat in coordination with the National Housing Authority and association heads of the Manggahan Floodway, evaluated and prepared a masterlist of household heads for lot entitlement following the directive of the President. Data processing is on-going.

The above three proposed projects (e, f, and g) are priority project areas included in the MARILAQUE Project.

h) Subic Bay Freeport

The Master Plan for the Subic Bay Freeport Zone (SBFZ) is to be developed through grant from the World Bank. According to Subic Bay Metropolitan Authority the Subic Bay Freeport which is emerging as a hub for commerce and industry in the Philippines and the Asia-Pacific Region, will be the newly-industrialized zone by the year 2000. This project site is located outside the Study Area, approximately 120 km away from Manila, but cited here due to its importance in the development strategy of the region.

The major proposed developments are summarized in Table 2.6.

Table 2.6 Major Planned Development Projects

Project Name	Location	Area (ha.)	Proposed Development	Estimated Population Increase (2000-2015)	Remarks
Fort Bonifacio Development Project	Taguig	745	High value and medium-rise residential development, commercial areas, 18-hole golf course	30,000 ~ 50,000	Redevelopment of military camp area
Villamor Air Base	Pasay City	135	High value residential development, community facilities, 27-hole golf course	10,000	Redevelopment of military camp area
Manila-Cavite Coastal Road and Reclamation Project	Manila Bay Coastal Area from Pasay to Bacoor	430 (existing) 990 (proposed)	Semi-metropolis: government facilities, institutional, residential, commercial and recreational facilities	100,000	Mini-metropolis of Metro Manila Land reclamation is going on
Laguna de Bay Reclamation Project	Laguna de Bay Coastal Area from Taguig to San Pedro	3,000	Residential, commercial, institutional, industrial and recreational	50,000 (200,000)	Sub-regional center of Metro Manila Mini-metropolis of Metro Manila
Alabang Stock Farm	Muntinlupa (north)	244	Residential, institutional	15,000 17,000	
New Bilibid Prison	Muntinlupa (south center)	405	Mixed-use	?	There is no definite development plan
Lunsod Silangan Development Plan	Antipolo, Tanay, Baras, Rodriguez in Rizal; Infanta, Quezon and Real in Quezon; Santa Maria in Laguna	180.724	Proposed satellite city	2,819,463	Priority project areas included in the MARILAQUE Project
Rizal Industrial Estate	Tanay	326	New industrial estate	?	
Socialized Housing in Manggahan Floodways	Manggahan Floodways	?	Socialized housing	Under evaluation	
Subic Bay Freeport	Subic	No data	Commercial, industrial use	?	Outside the study area

Part I General

Chapter 3. Project Framework

3. Outlying Regions (Future Expansion Area)

The outlying regions comprise the provinces of Cavite, Laguna, Rizal and Bulacan, areas contiguous to the NCR. The strategic location of these regions makes them very important in the attainment of national goals.

Laguna and the south of Cavite, together with Rizal and Bulacan are rapidly growing as the future urban centers. Therefore, emphasis should be given to these regions as the expansion areas of the NCR, as they will serve as the new industrial and growing urban centers.

Spatial development of Cavite, Laguna, and Bulacan, just like its economic development, is strongly affected by the presence of the NCR.

The area within some 50 km radius of Metro Manila, is considered as a region where various activities are interrelated by way of the economy of Metro Manila. The further suburbanization around Metro Manila and expansion of its areas of influence should take into account the development of the outlying regions as well.

The general description and population data of Rizal and a part of the Cavite province were presented in the previous reports (P/R(1), IT/R and P/R(2)). However, because of their urban strategic location and since they could be affected by the development activities in NCR, a brief description and population projection figures are also given for the provinces of Laguna and Bulacan, as shown below:

3.1 Bulacan Area

In addition to the service area of the MWSS (NCR, Rizal, and part of Cavite), background information on the Province of Bulacan is included in the Study Area, as the province is adjacent to Metro Manila, and it is also the principal source of water supply for Metro Manila and its suburbs.

Although current and projected population figures for the whole province are provided, only 6 of the municipalities which are contiguous and source of water for the MWSS service area are briefly described below:

(1) Brief Profile of the Municipalities of Bulacan Area

a) Angat

The municipality of Angat is the third largest in terms of land area which mostly is relatively uneven and cultivated with upland rice and corn. Inland fishing along the Angat river is the main occupation of the people. It is also the main source of gravel and sand for the construction industry.

Agricultural production may not expand in the long run due to topographical constraints. But the municipality foresees commercialization of the poultry and livestock industries.

The 1990 census show that there are 6,612 households with 34,494 individuals in Angat. Angat is one of the sparsely populated areas in Bulacan with a population density of only 5 persons per hectare.

b) Marilao

The municipality of Marilao is the second smallest in Bulacan, being only 2,400 hectares. The present agricultural land area is about 1,250 hectares.

Marilao is only 20 kilometers from Manila and most of the industries were established before 1980. These industries include textile factories, food processing plants, chemical and paper making. Cottage industries also flourished along with the big industrial plants. These industries were the main source of employment in the area.

The rapid expansion of Metro Manila has transformed Marilao from an agricultural municipality into an urban one. Most lands are being used for residential purposes. As of 1990, Marilao has 56,361 residents in 11,428 households. The annual population growth rate is 5.28%, the highest in the Bulacan area.

c) Meycauayan

One of the highly developed municipalities and only 15 kilometers from Manila is the town of Meycauayan. The total municipal land area covers 2,790 hectares.

The main industries in the municipality are involved in leather, tanning, textile, farming, fishing, and jewelry fabrication. The poultry industry is also well-developed. Meycauayan has the second highest number of manufacturing firms in the province.

With the growing number of industrial firms in Meycauayan, environmental degradation through pollution is becoming a serious problem.

Meycauayan is the second highest municipality in the Bulacan area in terms of population. As of 1990, the census survey showed that there are approximately 123,982 residents in the municipality. The annual growth rate is 4.21%, the third highest in the Bulacan area.

d) Norzagaray

With a population of 33,485 (1990), Norzagaray remains the most sparsely populated area with only 1 person per hectare.

Industries found within Norzagaray are cement factories, aggregate plants, marble works, and lime processing plants.

Most of the resource-based heavy industries are situated in Norzagaray due to its existing rich natural resources. Records show that four (4) large companies extract limestone from quarries in Norzagaray.

e) Obando

Obando has the least land area in the province of Bulacan. It covers only 1,366 hectares.

A fishing industry survey of the province indicated that a considerable segment of the provincial population still depends on municipal/sustenance fishing as a primary source of income. The residents of the municipality of Obando depend on fishing as one important source of employment.

Another important provincial industry and the second source of income is the manufacture of metals. One hundred establishments engaged in metal industry are situated in the province, one of which is the Quality Aluminum Products Corporation (Obando), one of the biggest scrap metal manufacturer. Another industry is the processing of salt from sea water.

Obando is the second most densely populated municipality of Bulacan. Its population as of 1990 is placed at 46,346 with a population density of 34 persons per hectare.

f) San Jose del Monte

The municipality of San Jose del Monte has a total land area of 8,500 hectares. The predominant soil types in the area are the Novaliches clay loam and the Quingua silt loam. The land in the area is characterized as steep, very severely to excessively eroded or shallow for cultivation. It is more suited to pasture (cattles, hogs, etc.). It has been reported that irrigated area is below 1% of the total land area.

San Jose del Monte has been pinpointed as a suitable site for an industrial estate primarily catering to small cottage and medium industries, specifically food and garment manufacturing. Reports showed that there are several manufacturing firms and commercial establishments in the area.

The rapid increase in population from 18,704 in 1975 to 58,791 in 1979 was largely due to the relocation of squatters from Metro Manila to Sapang Palay.

The 1990 population statistics are placed at 142,047 residents, thus making it the most populated among the six municipalities of the Bulacan area.

(2) Population of Bulacan Area

a) Present Population

The municipalities of Bulacan Area (Angat, Marilao, Meycauayan, Norzagaray, Obando, and San Jose del Monte)) covers 13.8% of the total Bulacan provincial land area.

The 1990 Census of Population and Housing placed the total population of the six municipalities at 436,715 which is almost the same figure as Cavite's population in the same year. Among the

six, the bulk of the population was concentrated in San Jose del Monte (142,047) and Meycauayan (123,982). Both municipalities are located adjacent to the NCR.

The average population density of the area is estimated at 9 persons per hectare, and increased from only 1 person per hectare in Norzagaray to 44 persons per hectare in Meycauayan.

Present population and population projection by selected years, household and density are given in Table 3.1.

b) Future Population

The population projections up to year 2015 are based on NSO census data and estimated by the Study Team. The results are shown in Table 3.2 and Figure 3.1, containing population figures from 1980 to 2015 (every 5 years) and their respective growth rates.

The total population in Bulacan area is projected to increase from a 1990 level of 437,000 to 562,000 by the year 2000 and 708,000 by the year 2015. However, the annual growth rate will decrease gradually.

Comparing the population projection of Bulacan (6 municipalities) with those of Cavite and Rizal given in the previous reports, the forecast annual growth rate of the Bulacan area is higher than the Rizal province and lower than the Cavite area. However, just like in Cavite and Rizal, the most populated areas are concentrated in those municipalities which are adjacent to the NCR, as reflected in Figure 3.1.

TABLE 3.1 POPULATION, NUMBER OF HOUSEHOLD AND DENSITY BY MUNICIPALITY (BULACAN AREA)

NO	MUNICIPALITY	AREA (ha)	POPULATION			HOUSEHOLD (1990)		DENSITY (per/ha)		
			1990 (Census)	2000	2015	Hhold	p/hhold	1990	2000	2015
1	Angat	6,900	34,494	43,940	55,885	6,612	5.2	5	6	8
2	Balagtas	2,800	42,658	54,766	69,797	8,099	6.8	15	20	25
3	Baliuag	4,505	89,719	107,961	122,599	17,091	6.3	20	24	27
4	Bocaue	3,085	67,243	82,776	100,472	13,193	6.3	22	27	33
5	Bulacan	7,299	48,770	60,036	72,871	9,641	6.2	7	8	10
6	Bustos	4,750	34,965	40,658	46,162	6,644	6.1	7	9	10
7	Calumpit	4,470	59,042	67,515	75,298	10,825	6.2	13	15	17
8	Doña Trinidad	93,200	8,614	10,604	12,871	1,748	6.1	1	1	1
9	Guiguinto	2,498	44,532	57,116	72,685	8,642	6.6	18	23	29
10	Hagonoy	8,266	90,212	101,440	110,964	16,869	6.0	11	12	13
11	Malolos	8,836	125,178	140,065	152,303	24,225	5.8	14	16	17
12	Marilao	2,400	56,361	75,045	98,069	11,428	4.9	23	31	41
13	Meycauayan	2,790	123,982	159,700	199,753	24,955	5.0	44	57	72
14	Norzagaray	27,600	33,485	42,571	53,327	6,343	5.28	1	2	2
15	Obando	1,366	46,346	56,216	70,315	9,179	5.1	34	41	51
16	Pandi	3,290	32,648	39,487	46,944	6,345	6.2	10	12	14
17	Paombong	6,173	32,052	37,603	43,140	5,915	6.4	5	6	7
18	Plaridel	4,350	52,954	63,608	75,062	9,955	6.4	12	15	17
19	Pulilan	2,910	48,199	58,697	70,406	9,049	6.5	17	20	24
20	San Ildefonso	16,000	59,598	68,826	77,564	10,992	6.3	4	4	5
21	S. J. del Monte	8,500	142,047	184,126	230,306	26,489	5.4	17	22	27
22	San Miguel	24,100	91,124	106,485	121,621	16,705	6.4	4	5	5
23	San Rafael	9,800	49,528	60,434	72,597	9,467	6.4	5	7	7
24	Sta. Maria	7,880	91,468	117,774	150,543	17,479	6.7	12	19	19
	TOTAL	263,768	1,507,209	1,837,469	2,201,553	287,890	144.6	321	402	481

Source: Population of 1990: NSO
2000 and 2015 projected by the Study Team based on NSO population projection data.

TABLE 3.2
POPULATION PROJECTION AND GROWTH RATE OF MUNICIPALITIES CONTIGUOUS TO THE NCR BY SELECTED YEARS

NO	MUNICIPALITY	1980	1985	1990 (Census)	1995	2000	2005	2010	2015
1	Angat	25,006	29,316	34,494	39,027	43,940	48,752	52,520	55,885
2	Marilao	35,298	43,571	56,361	66,007	75,045	83,060	90,053	98,069
3	Meycauayan	84,124	100,890	123,982	144,008	159,700	174,514	187,723	199,753
4	Norzagaray	26,202	29,960	33,485	38,070	42,571	46,589	50,115	53,327
5	Obando	39,877	44,279	46,346	50,174	56,216	61,431	66,080	70,315
6	S. J. del Monte	91,324	111,652	142,047	166,035	184,126	201,206	216,436	230,305
	TOTAL	301,831	359,668	436,715	503,321	561,598	615,552	662,927	707,654

		GROWTH RATE (%)						
NO	MUNICIPALITY	1985/80	1990/85	1995/90	2000/95	2005/00	2010/05	2015/10
1	Angat	3.23	3.31	2.50	2.40	2.10	1.50	1.25
2	Marilao	4.30	5.28	3.21	2.60	2.05	1.63	1.72
3	Meycauayan	3.70	4.21	3.04	2.09	1.79	1.47	1.25
4	Norzagaray	2.72	2.25	2.60	2.26	1.62	1.47	1.25
5	Obando	2.12	0.92	1.60	2.30	1.79	1.47	1.25
6	S. J. del Monte	4.10	4.93	3.17	2.10	1.79	1.47	1.25
	TOTAL	3.57	3.96	2.88	2.22	1.85	1.49	1.31

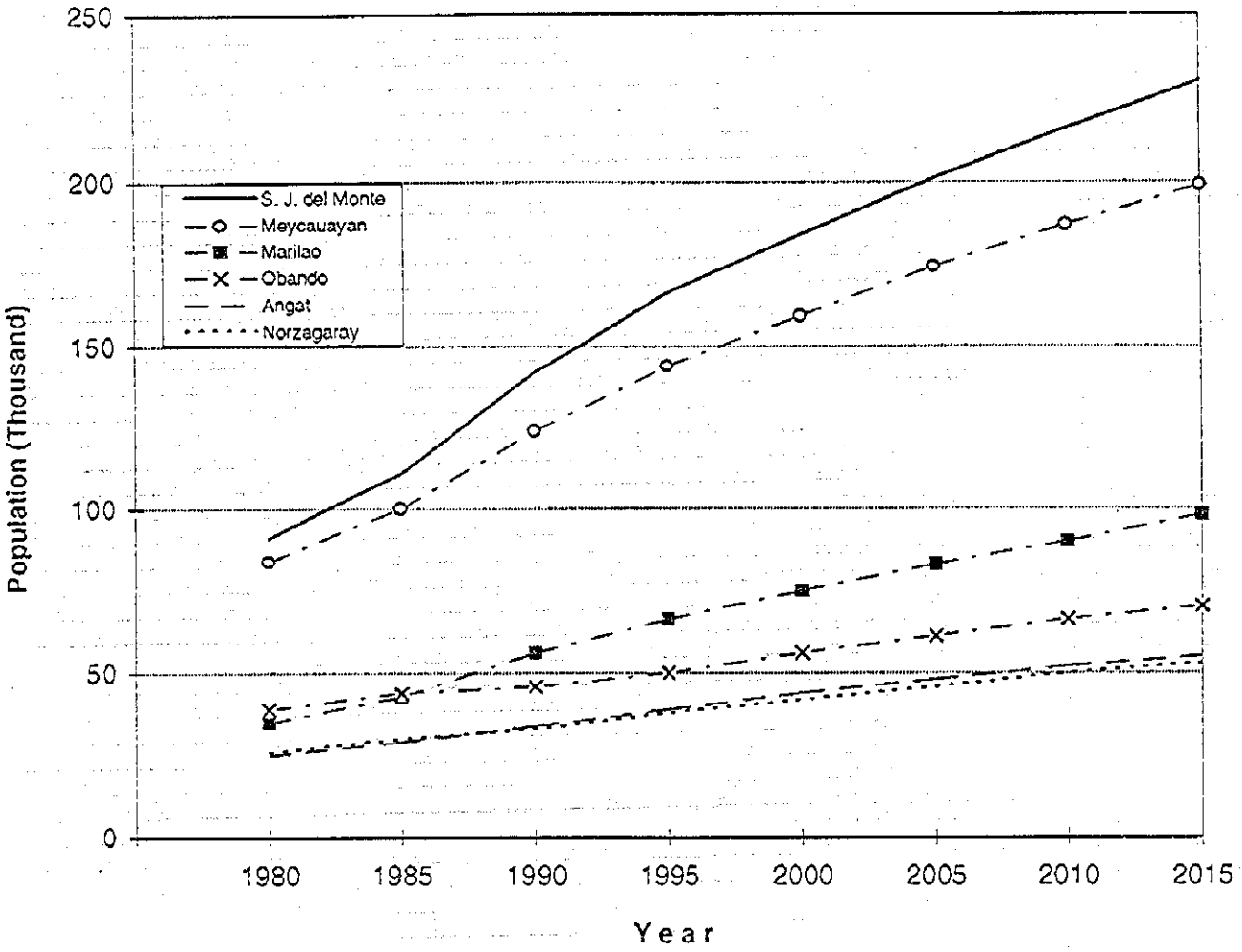


Figure 3.1 Estimated Population of the Municipalities of Bulacan

Filename:bulcan.xls

3.2 Laguna Province

(1) Population of Laguna

The population of Laguna has been growing faster than the national population, accelerating from 3.35% per annum in the 1970's to 3.48% per annum in the 1990's as shown below. This largely reflects increase in migration from Metro Manila and rural areas such as Bicol and the Visayas.

The localities with the highest rates between 1980 to 1990 are: San Pedro (7.70%), Biñan (4.86%), Santa Rosa (3.95%), Cabuyao (3.76%), Calamba (3.65%), and Los Baños (2.94%). The total population of these municipalities reached 692,397 in 1990, accounting for 50.5% of the total provincial population in the same year. By the year 2015 the total population of these localities is estimated to be 2.6 times the 1990 population, at about 1,791,000.

Table 3.1 shows the projected population of Laguna.

The future potential urban centers (fastest growing municipalities) are located along the south super highway where major developments are expected to shape the future development in the Greater Capital Region.

Based on the population studies and urbanization trend toward the south corridor, the fastest growing municipalities are as follows:

San Pedro, Cabuyao, Santa Rosa, Calamba, Biñan (municipalities located along the South Super Highway), and Los Baños

Another factor contributing to the rapid development of these areas is the establishment of industrial sites by the private sector and the location of tourist spots.

The industrial estates are:

Canlubang Industrial Estate (7,000 ha)

Ayala-Laguna Industrial Estate (340 ha)

Science Park in Cabuyao (120 ha)

Table 3.1 Population of Laguna

City/ Municipality	1970	1980	1990	2000	2015	Growth Rate 1980/1970	1990/1980	2000/1990	2015/2000
Alaminos	16,649	20,615	27,412	36,839	57,395	2.16	2.89	3.00	3.00
Bay	16,881	22,960	32,535	43,724	68,121	3.12	3.55	3.00	3.00
Binan	58,290	83,684	134,553	208,957	376,319	3.68	4.86	4.50	4.00
Cabuyao	32,117	46,286	66,975	94,475	147,189	3.72	3.76	3.50	3.00
Calamba	82,714	121,175	173,453	244,673	381,192	3.89	3.65	3.50	3.00
Calauan	19,747	25,259	32,736	41,905	56,398	2.49	2.63	2.50	2.00
Cavinti	10,462	13,222	15,131	18,445	23,060	2.37	1.36	2.00	1.50
Famy	4,651	5,241	7,928	10,149	13,659	1.20	4.23	2.50	2.00
Kalayaan	6,957	10,247	13,118	17,629	25,533	3.95	2.50	3.00	2.50
Liliw	14,638	17,436	21,911	27,505	37,019	1.76	2.31	2.30	2.00
Los Baños	32,167	49,555	66,211	88,932	133,631	4.42	2.94	3.00	3.00
Luisiana	11,494	12,199	14,241	16,527	20,663	0.60	1.56	1.50	1.50
Lumban	13,289	17,360	19,773	22,499	26,121	2.71	1.31	1.30	1.00
Mabitac	6,377	8,543	11,444	14,938	20,104	2.97	2.97	2.70	2.00
Magdalena	7,650	10,433	13,450	17,217	23,172	3.15	2.57	2.50	2.00
Majayjay	12,316	13,699	15,875	18,424	21,389	1.07	1.49	1.50	1.00
Nagcarlan	25,057	30,637	37,696	46,404	62,453	2.03	2.10	2.10	2.00
Paete	11,601	16,383	20,579	25,086	33,762	3.51	2.31	2.00	2.00
Pagsanjan	14,556	19,489	25,024	30,804	41,459	2.96	2.53	2.10	2.00
Pakil	7,229	9,048	13,438	18,060	28,136	2.27	4.03	3.00	3.00
Pangil	8,118	10,519	15,212	20,444	31,851	2.62	3.76	3.00	3.00
Pila	15,551	20,962	27,467	33,812	45,506	3.03	2.74	2.10	2.00
Rizal	6,539	7,510	9,501	11,582	15,587	1.39	2.38	2.00	2.00
San Pablo City	105,517	131,655	161,630	197,026	265,171	2.24	2.07	2.00	2.00
San Pedro	32,991	74,556	156,486	267,301	517,302	8.49	7.70	5.50	4.50
Santa Cruz	47,114	60,620	76,603	95,226	128,161	2.55	2.37	2.20	2.00
Santa Maria	12,575	15,744	20,525	26,274	35,361	2.27	2.69	2.50	2.00
Santa Rosa	41,335	64,325	94,719	137,534	230,418	4.62	3.95	3.80	3.50
Siniloan	12,413	17,220	22,759	29,997	43,445	3.33	2.83	2.80	2.50
Victoria	12,741	16,522	21,847	28,240	40,900	2.63	2.83	2.60	2.50
TOTAL	699,736	973,104	1,370,232	1,890,678	2,955,477	3.35	3.48	3.27	3.02

Source: 1970, 1980 and 1990 (NSO population and census data)
2000 and 2015 projected by the Study Team
Fastest growing municipalities

The government policy is to establish industrial locations away from Metro Manila, and to convert these locations into full urban communities by supporting the development of small industrial districts, housing, urban infrastructure, and services in health and education.

Major tourist sites in the province include Laguna de Bay itself, the seven lakes of San Pablo, rapids and falls of Pagsanjan, hot springs in Los Baños and Calamba, and handicrafts in Pacte.

The ultimate image of Cavite and Laguna, together with Rizal, may be a huge "agro-industrial park" characterized by a large urban area centering on Metro Manila embracing business and service activites supported by high-grade social services and urban amenities encompasing a rich rural environment containing several industrial hubs surrounded by productive agricultural and forest areas.

Part II

Water Supply

Chapter 1.

Review of Current Operation

Part II Water Supply

Chapter 1. Review of Current Operations

1. Raw Water Source

1.1 Surface Water

1.1.1 Angat River

For its water source, MWSS relies mainly on the Angat River. Presently MWSS draws an annual average of 22 m^3/s (1,900 mld) raw water from the Angat Reservoir through the Auxiliary units of the Hydroelectric Power Plant. The contribution of the intervening watershed upstream of the diversion at Ipo Dam, enables a total constant diversion of 28.5 m^3/s (2,460 mld) for the raw water supply of Metro Manila. The raw water diversion at Ipo Dam represents 97 % of the present total water production of MWSS.

The 22 m^3/s Water Right was granted to MWSS for Metropolitan Manila domestic use in October 1962 by virtue of Memorandum of Agreement entered into by and between NAPOCOR and NWSA. This permit was subsequently confirmed by NWRB in Resolution No. 02-0389, on March 13, 1989, which was deemed necessary in connection with the forthcoming World Bank Mission regarding the on-going rehabilitation and expansion projects of MWSS at that time, to wit:

RESOLUTION NO. 02-0389

Resolved, as it is hereby resolved, to confirm MWSS Water Permit in the amount of 22 m3/s (500 mgd) from the Angat Reservoir.

Under the Angat Water Supply Optimization Project (AWSOP) scheme, an additional 15 m^3/s (1,300 mld) discharge was estimated to be available to MWSS by "the optimized usage" of reservoir releases, i.e., multiple use (power generation-irrigation-water supply) of water release with priority given to water supply.

The resolution by the Board of the NWRB to grant the MWSS an additional 15 m^3/s was adopted during the Meeting on 2 January 1988. However, it has two restrictions, viz.:

1) up to the maximum of 15 m^3/s

2) out of the unutilized grant intended for irrigation

Amendment to NWRB Resolution No. 03-0188

The Board on motion duly moved and seconded, unanimously amended Resolution No. 03-0188 adopted during the National Water Resources Board 12th Meeting on 2 January 1988 by deleting the phrase "during the interim period before the full implementation of the Manila Water Supply III Project". The resolution should read as follows:

RESOLUTION NO. 03-0188

Resolved, as it is hereby resolved, to grant the MWSS an additional allocation out of the unutilized grant intended for irrigation up to the maximum of 15 m^3/s from the Angat Reservoir.

The resolution by the NWRB is legally effective. However, further process is required in order to get a water permit for the additional 15 m^3/s. Because, although the water supply to Metro Manila takes precedence over the other purposes, it should be necessary to secure the concurrence of the NIA and NAPOCOR regarding the increased withdrawal for water supply.

And this will be realized only by modifying the present "operation rule curves" for the Angat Dam operation to satisfy the requirement of MWSS as much as possible, and at the same time to minimize negative effect for the use of irrigation and power generation.

Not much progress has been made to resolve this issue of additional allocation since 1988. During the meeting of Joint Operation and Maintenance Committee (JOMC) chaired by Mr. Cipriano C. Ferraril (PAGASA) which was held on 14 October 1994, the Hydrology Sub-Committee group was directed to meet with MWSS key officials and other concerned agencies so as to review and reinforce the justification for the Sub-Committee's recommendations to the JOMC. There has been no progress regarding this issue. This problem should be resolved soon together with the program of maximizing the use of water to be brought from Umiray River into

Angat Reservoir. Hopefully, the final settlement should be made just before the commencement of construction work of the diversion tunnel in the Umiray-Angat Transbasin Project (UATP).

The additional 15 m^3/s water right has been in placed following the conditions attached but MWSS has not been able to benefit from it due to the abnormalities of regional climatic conditions and the irregular withdrawals of water from the hydroelectric plants. The actual withdrawal of MWSS after commissioning the Auxiliary Turbine No. 5 under AWSOP from December 1992 to December 1994 is shown in Table 1.1. According to this table, the minimum 2.26 to the maximum 12.25 m^3/s of "AWSOP water" has been taken during this period.

At any rate, the Angat Reservoir is practically at its marginal productivity, considering the annual inflow and the available storage capacity. Since UATP has been formulated to augment supply capacity of the system with minimal negative environmental impact, it has been proposed that three low weirs (run-off-the-river diversion weirs) will be constructed for water intake instead of a high dam to impound the run-off from the Umiray watershed.

There is no significant climatic difference between Angat basin and the proposed watershed of Umiray basin, precipitation patterns of the two basins are similar except that the rainy season of the Umiray basin is extended up to February of the coming year. This means that the run-off of Angat watershed remains high due to the extended rainy season in the area.

Considering above-mentioned conditions and meteorological characteristics, the operation of the Angat Reservoir would be "tightrope walking" especially during an unusually severe and long-period of drought.

Such a dam, according to a well-planned comprehensive operation of the two dams, can supply necessary amount of water to the Angat Dam in a drought period.

Table 1.1 Actual Water Released from Angat Reservoir for MWSS

Year	Month	Released as Existing Water Right 22 m^3/s (1987-1992 Ave. m^3/s)	Water Released through Aux. Turbine #5 (m^3/s)	Water Released for the Month (m^3/s)
1992	Dec.	25.49	3.58	29.07
1993	Jan.	25.90	4.76	30.66
	Feb.	26.58	7.76	34.34
	Mar.	26.41	2.26	28.67
	Apr.	26.49	4.24	30.73
	May	25.38	3.77	29.15
	Jun.	18.40	0.00	18.4
	Jul.	16.45	0.00	16.45
	Aug.	13.72	0.00	13.72
	Sept.	18.48	0.00	18.48
	Oct.	18.49	4.67	23.16
	Nov.	22.28	0.00	21.44
	Dec.	25.49	12.25	37.74
Total		264.07	39.71	
Ave.		22.00	3.31	

* Main Turbine Operation for only 22 days due to water level below 180.00 m.
** No Main Turbine Operation due to reservoir water level below 180.00 m.
*** Main Turbine Operation for only 7 days due to reservoir water level below 180.00 m and preventive maintenance of the elector- mechanical equipment.

1994	Jan.	25.90	3.78	29.68
	Feb.	26.58	3.01	29.59
	Mar.	26.41	2.63	29.04
	Apr.	26.49	2.72	29.21
	May	25.38	8.69	34.07*
	Jun.	18.40	9.37	27.77**
	Jul.	16.45	4.22	20.67
	Aug.	13.72	10.56	24.28
	Sept.	18.48	7.79	26.27
	Oct.	18.49	9.38	27.87
	Nov.	22.28	0.00	20.10
	Dec.	25.49	2.32	27.81
Total		264.07	64.47	
Ave.		22.00	5.37	

* Main Turbine Operation for only 27 days due to ZERO NIA requirement.
** Main Turbine Operation for only 17 days due to ZERO NIA requirement.

1.2 Groundwater

In addition to surface water supplied Central Distribution System (CDS), MWSS manages groundwater supply systems which supply water to the areas not connected to CDS. There are 258 MWSS-owned deepwells within the MWSS Service Area (MSA), of which 113 wells are active while 142 wells are inactive or abandoned. Three wells are for "stand-by" (as of June 1993).

Annual production of groundwater (together with surface water production) in the last ten years are tabulated in Table 1.2 while the status of MWSS deepwells is shown in Table 1.3. Average daily water supply by the groundwater is approximately 70 to 90 mld.

The present total supply from private groundwater sources in the MWSS service area is 840,700 mld. Table 1.4 presents the breakdown, by use, of water supplied from private wells.

Table 1.2 Annual Production of Groundwater and Surface Water

Year	Groundwater (million m^3/year)		Surface Water (million m^3/year)		Total Production (million m^3/year)	
1984	25.6	(3.8%)	642.2	(96.2%)	667.8	(100.0%)
1985	29.5	(3.7%)	757.4	(96.3%)	786.8	(100.0%)
1986	30.4	(3.4%)	874.1	(98.6%)	904.5	(100.0%)
1987	27.9	(3.2%)	834.8	(96.8%)	862.6	(100.0%)
1988	29.5	(3.4%)	849.3	(96.6%)	878.8	(100.0%)
1989	29.0	(3.3%)	859.1	(96.7%)	888.1	(100.0%)
1990	33.3	(3.7%)	875.8	(96.3%)	909.1	(100.0%)
1991	33.9	(4.2%)	779.6	(95.8%)	813.4	(100.0%)
1992	28.0	(3.3%)	823.4	(96.7%)	851.4	(100.0%)
1993	25.7	(2.6%)	973.0	(97.4%)	998.7	(100.0%)
1994	26.7	(2.6%)	1,009.6	(97.4%)	1,036.1	(100.0%)

A study on the groundwater development in Metro Manila was conducted by JICA during the period from August 1990 to March 1992. According to the recommendation of the study, MWSS is now implementing rehabilitation of inactive wells, and also developing some wells in the MSA not connected to Central Distribution System (CDS).

In addition to MWSS-run wells, there has been reported some 3,000 privately-owned wells in the MSA. Over exploitation of groundwater mainly for industrial use alongside the coastal area causes saline water intrusion into the acquifer. A considerable amount of this abstraction should

be replaced by MWSS water in due course. The annual abstraction estimated is shown in Table 1.4.

Table 1.3 Present Status of MWSS Deepwells (as of March, 1995)

	Active	Inactive	Stand-by	Abandoned	Total
NCR:					
Caloocan	-	2	-	1	3
Las Piñas	1	3	-	4	8
Mandaluyong	-	-	-	3	3
Makati	18	16	3	1	38
Malabon	3	3	-	3	9
Manila	-	-	-	3	3
Muntinlupa	7	-	-	-	7
Navotas	1	8	-	-	9
Parañaque	4	3	-	3	10
Pasay	3	1	-	1	5
Pasig	2	1	-	2	5
Pateros	-	-	-	2	2
Quezon City	19	-	-	7	26
San Juan	-	-	-	-	0
Valenzuela	3	4	-	1	8
Cavite:					
Bacoor	8	-	-	2	10
Cavite City	12	-	-	10	22
Imus	2	-	-	3	5
Kawit	5	2	-	-	7
Noveleta	9	-	-	-	9
Rosario	2	1	-	-	3
Rizal:					
Antipolo	16	-	-	1	17
Cainta	5	2	-	2	9
Marikina	-	13	-	2	15
Rodriguez	4	-	-	2	6
San Mateo	5	-	-	3	8
Taguig	3	1	-	3	7
Taytay	7	-	-	1	8
Total	139	60	3	60	262

Table 1.4 Use of Water from Private Wells, 1991 (mld)

Description	Domestic	Commercial	Industrial	Total
NCR	266.9	93.3	280.7	640.9
Cavite	46.9	5.2	5.9	58.0
Rizal	65.2	8.3	68.3	141.8
Total	379.0	106.8	354.9	840.7

1.3 Other Water Sources

1.3.1 Marikina River Basin

The Marikina River Basin is one of the nine alternative sources in the pre-feasibility and feasibility studies of MWSP III conducted in 1978 and 1979. The lower reaches of the Marikina River had been the source of the Carriedo Waterworks from 1882 to 1909. In 1909, the Montalban System took the place of the Carriedo Waterworks (due to increasing water pollution caused by domestic waste discharge above the Santolan pumping plant), taking water from the same river above Montalban (now Rodriguez). After 30 years, however, this system was abandoned due to the completion of Angat-Novaliches System in 1939.

Recently, the Marikina River came around as an alternative source again, as shown in the feasibility study for the Manila North-East Water Supply Project (MNEWSP), for immediate and future improvement of water supplies for the municipalities of Rodriguez, San Mateo and Marikina located north-east of Manila. The study includes the possible reactivation of the Wawa Dam which was built in 1909 as part of the original water supply system for Manila.

In the conclusion of this study, top priority was given to an alternative scheme which recommended as supply source a combination of feeding by the Balara Treatment Plant (for Marikina) and development of the Marikina groundwater aquifer (for Rodriguez and San Mateo), due to the urgency of the project and the amount of construction cost.

Reactivation of the existing Wawa Dam was considered not feasible, due to its insufficient yield (because the existing Wawa Dam is a sort of 'intake dam' and its average yield is only 57 mld) and contamination of water by undesirable discharge of wastewater from pig farms located along the upstream tributary (Bosoboso River) of the dam.

Fortunately, MNEWSP has no water treatment plants or appurtenant components. It is comprised of distribution pipelines and some deepwells (for Rodriguez and San Mateo). Considering that the construction period for MWSP III requires at least eight years (even for its 1st Phase), improvement of the water supply in Rodriguez and San Mateo by developing groundwater supply system is necessary. When the MWSP III is realized, water supply in this

project area will be replaced with Kaliwa System, and all the distribution pipelines provided by MNEWSP will be useful, just as they are without any changes.

1.3.2 Taal Lake

Taal Lake is located about 50 km south of Manila. The lake drains through the Pansipit river into Balayan Bay, about 8 km to the southwest. The only available data to evaluate the potential yield of Taal Lake are the Pansipit River records which reflect the variations of the net natural lake inflow with a certain delay owing to the retention capacity of the lake. According to the result of the former study, the estimated yield of Taal Lake is some 12 to 14 cms.

As to the environmental considerations, Taal Lake occupies a deep caldera of the most active volcano next to Mayon Volcano in Albay. Since 1572, Taal Volcano has had 33 recorded eruptions. Its most violent eruptions occurred in 1749, 1754, 1911 and 1965. The 1911 eruption devastated most of area of the surrounding the volcano and spewed ashes as far as Manila. The 1965 eruption killed 150 people, injured more than 800, and displaced almost 65,000 people. As one of the six most active volcanoes, Taal has been under regular monitoring and surveillance. Considering this, as well as the preservation of natural scenic beauty, Taal Lake was discounted as future water supply source.

1.3.3 Pampanga River

Since the Pinatubo eruption, the Pampanga River suffers from 'lahar' (mud flows). Considering the enormous amount of spewed lahar, it will affect the flow of the Pampanga River for a long time. For this reason, the Pampanga River will be excluded as a future water source to supply Metro Manila.

Part II Water Supply

Chapter 1. Review of Current Opterations

2. Present Water Supply Condition

The present system pressures in the respective service areas of La Mesa and Balara Plants are inadequate. Some places suffer not only from low pressure but from intermittent water supply. Table 2.1 presents, by city/municipality, the MWSS service area's geographical features and water supply condition by category, as shown below:

Condition
(1) No water in daytime
(2) Intermittent/Low pressure
(3) Low pressure: 0 ~ 5 psi (0 ~ 0.35 kg/cm^2)
(4) Moderate pressure: 6 ~ 15 psi (0.4 ~ 1.06 kg/cm^2)
(5) High pressure: 16 up psi (1.13 up kg/cm^2).

Results of a water pressure survey conducted by MWSS in September 1994 show that water supply is good in Marikina (except northern portion) and Pasig. The water pressures in these areas have not been reduced because the main pipes are relatively new.

Table 2.1 Service Area Geographical Features and Water Supply Conditions

City/Municipality	Geographical Features	Water Supply Condition
Manila	The western portion facing Manila Bay is all built up and is almost flat with elevations ranging from 2 to 3 m. Sampaloc, the residential portion adjacent San Juan and Quezon City, is on a gently sloping hill with a peak elevation of 15 m.	Condition (1) not experienced. Conditions (2) and (5) areas are few. Large portions of the city are Conditions (3) and (4) areas. Algeciras, Tondo, Ermita and Espiritu pump stations are located in this city.
Pasay	The city lies south of Manila, is almost built up and is relatively flat with elevations ranging from 2 to 4 m. Located in its south portion is the Ninoy Aquino Int'l. Airport with elevations varying from 3 to 24 m. South of the airport and adjacent with Paranaque is a residential part which lies on a gently sloping hill with peak elevation of 12 m	The north portion covers Condition (3) areas while the south portion covers Condition (2) areas. The Pasay Pump Station is located in this city.

Table 2.1 Service Area Geographical Features and Water Supply Conditions (cont'd)

City/Municipality	Geographical Features	Water Supply Condition
Quezon	The city can be subdivided into the south, the central and the north portions. The south portion is adjacent to and as built up as the city of Manila, has elevations between 5 and 60 m mostly ranging from 30 to 40 m. The central portion is a developing residential area. The north portion covers the sparsely populated mountainous areas north of Novaliches Reservoir.	Condition (1) areas are few. Condition (2) areas are found north and south of Balara and south of Bagbag. The central portion is composed mostly of Conditions (4) and (5) areas while the south and north portions cover mostly Condition (3) areas. The Bagbag Reservoir and the San Juan, Cubao, Balara and D.Tuazon pump stations are located in this city.
Caloocan	The south portion is adjacent to the city of Manila and is becoming a built up area. The area is a mixture of industrial and residential areas with elevations ranging from 3 to 25 m.	A small Condition (1) area lies at the north and middle of the city separating Condition (5) area in the west from Condition (3) area in the east. Caloocan Pump Station is within this city.
Mandaluyong	The city is bounded in the west by the city of Manila and in the south by Makati and is becoming built up. The eastern portion bounded by Pasig has many factories. The elevations vary from 3 to 40m but mostly below 30 m..	Condition (1) area covers the center of the city, while Condition (3) areas occupy the rest.
Las Pinas	This municipality is adjacent to the province of Cavite and is generally becoming built up. Its elevation ranges from 2 to 40 m, rising toward the inland areas. Most of the areas are relatively flat with elevations not higher than 20 m.	MWSS supplied areas are mostly along the coast of Manila Bay and are all Condition (2) types.
Makati	The area is built up and includes an industrial portion. Ground elevations varies from 3 to 30 m but mostly less than 10 m. On the east side is a gently sloping hill.	Condition (3) areas are predominant. Conditions (2) & (5) types can be found, also Condition (4) areas, along main roads. Makati Pump Station is located in this area.
Malabon	Marine ponds stretch alongside built up areas in the west portion where elevation ranges from 2 to 4 m. The east portion is a mixture of residential and industrial areas with elevations varying from 10 to 20 m.	The municipality is composed partly by Condition (1) and partly by Condition (3) areas.

Table 2.1 Service Area Geographical Features and Water Supply Conditions (cont'd)

City/Municipality	Geographical Features	Water Supply Condition
Marikina	The municipality is bounded in the east by Rizal province and has elevations ranging from 10 to 40 m, but mostly lower than 20 m. Development of small residential areas toward Antipolo is on-going.	The north portion covers Condition (2) areas. Other portions are composed of Conditions (4) & (5) types with relatively good water supply condition.
Muntinlupa	The portion bounded by Laguna de Bay in the east and by South Superhighway in the west is a residential strip with elevations varying from 2 to 20 m. In the portion west of the superhighway, where development of residential estates is in progress, the elevations range from 25 to 70 m.	by groundwater (no CDS system is avialable).
Navotas	The area is long and narrow extending from north to south alongside Manila Bay and has elevations ranging only from 2 to 3 m. Salt beds and marine ponds can be found in the north portion while permanent and temporary houses are present at the south portion.	Only Condition (3) is experienced in the municipality.
Paranaque	Paranaque extends from Manila Bay towards the interior areas. The elevations vary from 2 to 30 m, mostly lower than 20 m. Large area is being reclaimed in Manila Bay.	The municipality covers mostly Condition (2) areas with some type (3) portions along the coast of Manila Bay.
Pasig	The east side is bounded by Rizal province and the center is traversed by Marikina River. West of the river is a mixture of residential and industrial areas with elevations ranging from 10 to 40 m. Development of residential areas is on-going east of the river towards Cainta. Elevation of this east portion is less than 10 m.	Water supply condition is good. Condition (3) areas occupy portions adjacent to Rizal province. The center and the rest of the area is occupied by Conditions (4) & (5) areas.
Pateros	Except for the eastern part, all areas are becoming built up. Elevation is less than 5 m.	Conditions (4), (3) and (2) are experienced along the main roads, in the east portion, and in the west portion , respectively.
San Juan	The area is on a gently sloping hill with elevations ranging from 2 to 25 m. All portions are becoming built up.	The central portion has Condition (2), while the remaining portion of equal size has Condition (3).

Table 2.1 Service Area Geographical Features and Water Supply Conditions(cont'd)

City/Municipality	Geographical Features	Water Supply Condition
Taguig	The north portion, with elevations from 4 to 30 m, has built up areas along the hill slopes. The hilly central portion is less developed. The southern portion, with elevations from 2 to 30 m, has Greater Manila Food Terminal Market surrounded by residential houses. The eastern portion alongside Laguna de Bay has elevations less than 2 m and has many residences along the roads.	Most areas have Condition (2). Some areas in the northern portion experience Condition (3), (4) & (5). Fort Bonifacio pump station is located in this municipality.
Valenzuela	The municipality is bounded by Bulacan province in the north and by Malabon in the south. Portions in the Malabon side are mixtures of residential and industrial areas with elevations varying from less than 2 to 30 m. In the northeast portion, marine ponds and roadside residences exist, while in the hilly northeast portion, where elevations range from 10 to 30 m, residential areas are being developed.	Portions along the main roads have Condition (4). The rest of the municipality has Condition (3) and partly Condition (1).

Water supply is relatively good in wide areas in Quezon City, Caloocan, and Manila. Still, many areas receive water intermittently. The reasons for this include the throttling and closing of valves and the need for pipe network extensions. Valves are throttled to reduce leakage and prevent breakage in old pipelines, while valves are closed for rationing purposes when water becomes insufficient.

Because of inadequate water pressure, many consumers forcibly withdraw water from the system by installing pumps at their premises. Others draw water directly from the watermains. These practices create a vacuum in the mains increasing the possibility of drawing polluted water from outside the pipe. Improving the water pressure within the system thus becomes imperative.

The rehabilitation of old pipelines, together with sufficient pipe network expansion are therefore very important activities to reduce leakages and increase the supply of water within the system.

Part II Water Supply

Chapter 1 Review of Current Operations

3. Water Quality Standards

Table 3.1 Standard Value for Bacteriological Quality

	Source and mode of supply	Bacteria	Standard value (No./100ml)
a	All drinking-water supplies under all circumstances (Level I, II, III, Bottled water and Emergency Water Supplies	E. Coli or Thermotolerant (Fecal) coliform bacteria	0
b.	Treated water entering the distribution system	E. Coli or Thermotolerant (fecal) coli-form bacteria	0
c.	Treated water in the distribution system	E. Coli or Thermotolerant (fecal) coli-form bacteria Total Coliforms	0 must not be detectable in any 100ml sample. In case of large quantities where sufficient samples are examined, it must not be present in 95% of samples taken throughout any 12-month period

Table 3.2 Standard Values for Biological Organism

Constituent	Permissible limit
Total count/ml	10

Table 3.3 Standard Values for Physical and Chemical Quality (Health Significance)

A. Inorganic Constituents

Constituent	Maximum Level (mg/l)
Antimony	0.005
Arsenic	0.01
Barium	0.7
Boron	0.3
Cadmium	0.003
Chromium	0.05
Cyanide	0.07
Fluoride	1.0
Lead	0.01
Mercury (total)	0.001
Nitrate as NO3-	50
Nitrite as NO2-	3
Selenium	0.01

B. Organic Constituents (Pesticides)

Constituent	Maximum Level (µg/l)
Aldrin & Dieldrin	0.03
Chlordane	0.2
DDT	2
Endrin	0.2
Heptachlor and Heptachlor epoxide	0.03
Lindane	2
Methoxychlor	20
Petroleum oils & grease	nil
Toxyphane	5
2,4-D	30
2,4,5-T	9

Table 3.4 Standard Values for Physical and Chemical Quality:Aesthetic Quality

Constituents Maximum or Characteristic	Level (mg/l)
Taste	Unobjectionable
Odor	Unobjectionable
Color	5 TCU
Turbidity	5 NTU
Aluminum	0.2
Chloride	250
Copper	1
Hardness	300 (as $CacC_3$)*
Hydrogen Sulfide	0.05
Iron	1
Manganese	0.5
pH	6.5 - 8.5
Sodium	200*
Sulfate	250
Total Dissolved Solids	500
Zinc	5*

Table 3.5 Standard Values for Disinfectants and Disinfectant By-Products

	Constituents	Maximum Level (mg/l)
a.	Disinfectant	
	Chlorine (residual)	0.2 - 0.5
b.	Disinfectant By-products	
	Bromate	0.025
	Chlorite	0.2
	2,4,6 trichlorophenol	0.2
	Formaldehyde	0.9
	Phenolic substances	0.001
	Bromoform	0.1
	Dibromochloromethene	0.1
	Bromodichloromethene	0.06
	Chloroform	0.2

* : Secondary standards : compliance with the standard and analysis are not obligatory.
References : WHO guidelines for DWQ, 1984 ; Revision of WHO guidelines for DWQ, 1993

Table 3.6 Chemical of No Health Significance at Concentrations Normally Found in Drinking Water

Asbestos Silver Tin	In accordance with the findings of WHO, the Department of Health does not prescribe any standard values for these compounds since they are not hazardous to human health at concentrations normally found in drinking-water.

Table 3.7 Standard Values for Radiological Constituents

Constituents	Activity Level (Bq/l)
gross alpha activity	0.1
gross beta activity	1

Part II Water Supply

Chapter 1. Review of Current Operations

4. Ongoing and Planned Projects

4.1 IBRD Projects

4.1.1 Angat Water Supply Optimization Project (AWSOP)

The project plans to provide an additional average of 15.0 m^3/s of water, from 22.0 m^3/s to 37 m^3/s, diverted from Angat River. The additional water supply will generate 140,000 new service connections, and serve an equivalent population of 1.1 million. MWSS had initially intended to expand its production capacity by undertaking the MWSP III project, comprising construction of a dam on the Kaliwa River, water treatment facilities, and transmission mains. However, budgetary constraints prompted it to postpone that project and to look for a lower cost solution to improve water supply services. The AWSOP was conceptualized to fill in the gap between the commissioning of MWSP II and MWSP III, that is an interim water supply project that is both low in investment cost and is implementable within a short period of time. Total cost is cofinanced by the IBRD, the ADB, and the OECF at P8,811 billion.

The major components of the project which are in three project stages, include the following:

AWSOP I (1989-1992)

- Additional auxiliary hydroelectric plant (completed).
- Construction of one intake structure at Ipo (completed).
- Construction of one 6.1 km long tunnel from Ipo to Bicti (completed).

AWSOP II (1993-1994)

- Construction of one 16 km long aqueduct No. 5 with a 3.6 m diameter from Bicti to the La Mesa Reservoir (completed).
- Construction of the La Mesa Water Treatment Plant No. 2 with a capacity of 900 mld (completed).

AWSOP III

- Construction of an additional distribution network (110 km of primary lines, 178 km of secondary lines, and 360,000 service connections), including treated water reservoir/pumping stations (ongoing).
- Construction of a La Mesa by-pass aqueduct (ongoing)

4.2 ADB Projects

4.2.1 Umiray-Angat Transbasin Project (UATP)

The project is envisioned to utilize the available reservoir storage capacity of Angat reservoir by the increased inflow of at least 9 m^3/sec of water from the Umiray River transbasin diverted flow; to expand its services to the presently unserved population in Metro Manila; and to provide a higher level of satisfaction for the present customers. Implementation has been committed since 1991 and is scheduled to be completed in 1998. However, the loan is currently suspended by ADB recommendation due to the high potential of the NRW level.

Major components include the following:

First Phase

- Preparation of feasibility study was conducted from January, 1991 to May, 1992 to determine the technical, economic and financial viability of diverting flow of Umiray River to Angat Reservoir.

Second phase

- Preparation of detailed engineering design was conducted from January, 1993 to February, 1994.

Third phase

- Construction of :
  - Access road
  - Main diversion dam

- Water treatment plant

- Power transmission line

- Mini hydroelectric plant

4.2.2 AWSOP Telemetry/Scada Component

This work is a part of the AWSOP component. Project area covers Metro Manila, Rizal, Bulacan, and Cavite, all within the jurisdiction of the MWSS service area.

The objective of the project is to provide the information and data necessary to enable more effective management, control, and planning of the facilities of MWSS. The project cost is estimated to be ₱391 M. Bidding and award procedures were completed in December, 1994.

Project components include the following:

- Construction of a central control facility to house the Telemetry/SCADA equipment and computers and the staff. The facility will be equipped with an uninterruptible power supply (UPS), a battery bank, a backup diesel generator and mimic board.

- Construction of gauging points in the MWSS distribution mains and monitoring points in the MWSS facilities, including installation of remote terminal units with built-in radio, communication, equipment and transducers.

- Construction of communication system that will enable the central control facility to communicate with the gauging and monitoring points.

- Computer Aided Design equipment for the use of engineering.

4.2.3 Manila South Water Distribution Project (MSWDP)

The objective is to provide adequate potable water supply to the southern portion of the MWSS service area and will cover the municipalities of Paranaque, Las Pinas in Metro Manila and Bacoor in Cavite Province. The project will involve the construction of distribution systems in the project area which will be interconnected to the central distribution system being improved under the Angat Optimization Project (AWSOP). The total water supply for the project area is

expected to reach about 400 mld, including the 100 mld of water existing before the project. Cost is estimated at 1.696 million pesos.

Major components include the following:

- Construction of two clear water reservoirs.
- Construction of three pumping stations, Taguig/Las Pinas, Las Pinas and Muntinlupa.
- Construction of about 52.3 km of transmission mains and about 220 km of secondary and tertiary pipes.
- Installation of additional 99,058 house service connections and about 300 faucets.
- Acquisition of land/right of way of approximately 2 hectares.

4.2.4 Metro Manila Water Distribution Project (MMWDP)

The project was implemented from 1986 to 1993, to expand the water distribution facilities principally on subdivisions, pockets of infilling developments, the urban sites and other areas presently served with ground water but are showing sign of overextraction or saline intrusion. The project involved the extension of the MWSS water supply facilities subject to the limits imposed by the system capacity. It focused on distributing available water from existing and recently completed capacity (MWSP II included) to areas that can be economically reached by the Central Distribution System, (including areas not previously covered by the design of the MWSP II) and Secondary Distribution System areas. Total project cost is estimated to be P1,473 M with 800,000 people as beneficiary.

Major components include the following:

- Construction of 280 km distribution network, including primary, secondary and tertiary lines.
- subdivision connections to MWSS central distribution system
- additional household service connections

4.2.5 Manila Water Supply Rehabilitation Project II (MWSRP II)

Prior to MWSRP II, MWSRP I was implemented from 1984 to 1992, to upgrade the water supply system in 56 pre-selected zones (8,872 hectares) of the MWSS service area at an estimated cost of P1,832 M. It aimed to reduce the NRW to an acceptable level, replace 150 kms tertiary lines, install 280 public faucets, construct 50 kms of new tertiary lines, replace 108,000 house service connection and relocate 12,000 water meters.

The second phase of the rehabilitation project, MWSRP II, covers the upgrading of the remaining 52(51) zones (9,061 hectares, outside project area of MWSRP I) and 7(5) housing subdivisions which have high non-revenue water. The project was scheduled to be completed within five year period (1988 to 1992) at an estimated cost of P1,675 million to benefit 2.7 million people. With the project, rehabilitated facilities will be properly maintained and operated such that in the future, deficiencies are corrected in a more effective manner. Health risks due to contaminated water from leakages will be reduced.

Major components consist of the following:

- Rehabilitation of water supply facilities in the project area, including installation of new meters, replacement of meters, valves, and hydrants, relocation of meters, legalization of illegal house service connection, testing of meters, leak repair
- Operation modernization - procurement of equipment, instruments, vehicles, tools, and other supplies to support and modernize operation and maintenance of MWSS.
- Institutional strengthening - provision of local training, staffing and procurement of office equipment, automatic telephone exchange, computers and associated facilities to facilitate customer service.
- Public information campaign

4.2.6 Manila North East Water Supply Project (MNEWSP)

A feasibility study was made in 1992 covering the areas of Rodriguez (formerly Montalban), San Mateo, and Marikina located northeast of Manila to benefit 476,000 people by 2005. The sources of water are surface water through high regulating dam and ground water. The volume of supply is 300,000 mld with the project cost estimated at P3,085 million.

Major component includes the following:

- Construction of a regulating dam with a storage capacity of 53 million m^3
- Construction of a water treatment plant with a capacity of 304,000 mld
- Construction of 12 kms transmission line
- Construction of four pumping stations
- Construction of a clear water reservoir
- Construction of 48,514 km distribution lines
- Construction of eight deep wells
- Rehabilitation of nine wells

4.3 JICA Projects

4.3.1 The Project for the Rehabilitation of the Balara Water Treatment Plant

The Balara Water Treatment Plant is one of the two huge plants in Metro Manila, treating an average of 1,350 mld of water that is supplied to more than six million residents of the area.. The treatment plant has two plant systems namely, Plant No. 1 and Plant No. 2 which were constructed in 1935 and 1958, respectively with a combined design production capacity of 1,600 mld. The present water supply has dropped due to the deterioration of the facilities/equipment which are old or antiquated. Difficulties are encountered in operating the plants efficiently.

The objectives of the Project are: 1) to recover the current design capacity of the existing treatment process and equipment, 2) to assure the rapidly increasing population of Metro Manila of high quality potable water supply, 3) to improve the efficiency of the existing plants.

Major component includes the following:

- Installation of mechanical and electrical facilities/equipment
- Installation of instrumentation system
- Minor civil works.

4.3.2 Mini-Project Type Technical Cooperation on the Non-Revenue Water Reduction Project in Metropolitan Manila

The Non-Revenue Water problem of MWSS has become more difficult than originally anticipated when the large-scale rehabilitation programs commenced in the mid-1980s. Over the last decade, the level of NRW was recorded as being much higher than that of Revenue Water, i.e., 65% and 35%, respectively. There has been some improvement in the distribution of Revenue Water in the past few years as a result of massive rehabilitation works. However, many reasons account for the continued increase of NRW at such an alarming rate. These are: 1) deterioration of old transmission/distribution lines; 2) undetected leaks along the secondary and tertiary mains; 3) significant pressure increase in areas formerly with low pressure lines; 4) social and industrial factors, such as rampant tampering of water meter, illegal service connections, etc.

The project aims are shown below:

- Maintaining information of the distribution pipe lines
- Controlling leaks through maintenance
- Identifying and quantifying the existing major factors or determinants that cause substantial NRW

4.4 Local Fund Projects

4.4.1 Fringe Area Water Supply Project (FAWSP)

A feasibility study and detailed engineering design was conducted from 1989 to 1993 to provide potable water supply to isolated areas in the fringes of the MWSS service areas, as well as pockets within the Central Distribution System yet unserved and which are not included in the current water supply improvement program of MWSS. The project originally covers those isolated or fringe areas of MWSS service area as Las Pinas, Marikina, Taguig, Valenzuela, Caloocan City B, Quezon City, Antipolo, Montalban, San Mateo, Taytay, Bacoor, Imus, Kawit, Noveleta, Rosario and Cavite City. However, due to the implementation of the Angat Water Supply Project, and other major MWSS projects, the project coverage was reduced to Antipolo, Montalban, San Mateo, Taytay, Bacoor, Imus, Kawit, Noveleta, Rosario and Cavite City. The supply capacity of the project is estimated at about 68 mld for 452,000 people by 1995 and 73

mld for an additional 421,000 people by year 2005. Groundwater will be the main source of water in the majority of the project areas.

Major components include the following:

- Preparation of feasibility study and master plan for providing potable water supply of MWSS service area and other areas within Central System.
- Construction of deep wells, pumping stations.
- Expansion of distribution networks.
- Rehabilitation of existing deep wells.

4.4.2 Locally Funded Project (LFP)

The projects are short-term and small packages of water and sewerage works which arise out of or necessitated by the normal course of operation of the system. It involves the construction of minor water mains extension projects, public faucets and other miscellaneous works not covered by ongoing foreign assisted projects. This is a continuing program being implemented every year. The total cost is estimated to be ₱2,830.14 million.

Major components include the following:

- Construction of minor watermains extension projects, public faucets and other short-term miscellaneous projects.
- Rehabilitation of water distribution system of various subdivisions already turned-over to the System.
- Rehabilitation of MWSS deep wells.

4.5 BOT Scheme Projects

4.5.1 Cavite Water Supply Project (CWSP)

The project is envisioned to provide an additional 300 mld, which is probably increased to 600 mld, of water to 0.8 million people in the municipalities of Cavite (Imus, Kawit, Noveleta, Rosario and Cavite city) and portion of southern part of MWSS service area to include

Paranaque, Las Pinas, Taguig, Muntinlupa, and Bacoor. Raw water source will be taken in using existing NIA's pumps at the Laguna Lake. It will use the surplus irrigation water to be provided by NIA as part of the irrigation scheme under the Second Laguna de Bay Irrigation Project. The water from the pumping station at Putatan, Muntinlupa will be diverted to a water treatment facility to be constructed near the area under this scheme. Implementation is scheduled from 1996 to 2001 through a BOT scheme.

Major component includes the following:

- Construction of raw water intake structure and a 300 mld (or 600 mld) water treatment plant including treatment of sludge from water treatment process.
- Construction of a 35 mld treated water reservoir.
- Construction of a distribution system consisting of a booster pumping station, 150 kms of transmission mains, secondary and tertiary distribution network, and 75,000 additional house service connection.
- Water Quality Management and provision of facilities for survey and analysis of industrial wastewater and lake water samples.

4.5.2 Manila Water Supply Project III (MWSP III)

In 1984, the project planned to provide a long-term water supply to Metro Manila for the next decade. The project is a multipurpose development project designed to tap Kaliwa River Basin as a water source for Metro Manila and to generate incidental power for Luzon Power Network. Implementation of the project is scheduled from 1998 to 2006 at an estimated cost of P25,000 million to benefit five million people. The project has been temporarily deferred due to the project cost constraints. Only the diversion tunnel for the proposed dam was completed in 1983. Acquisition of the necessary right of ways and relocation of affected residents is still ongoing.

Major component includes the following:

- Construction of access roads and camphouses.
- Construction of headworks of 113 m high concrete faced rockfill dam, tunnels and aqueducts of 13.6 km length and 3 m dia., and power plant

- Construction of a water treatment plant with a total treatment capacity of 1,900 mld at Pantay.
- Construction of distribution system, including water way from the above treatment plant to Cogeo reservoir, treated water reservoir at Cogeo, pumping station at La Mesa, and mainlines, secondary, and tertiary distribution lines and services connections.

4.5.3 Metro Manila Ground Water Distribution Project (MMGWDP)

The project was initiated under the JICA assistance in 1990, to expand water supply by means of ground water development to where the CDS was not extended; i.e.; the Metro Manila pocket area, Rizal Province, and part of Cavite. It also includes the development and implementation of groundwater management program for the MWSS service area. The beneficiaries of the project are some 220,000 people (direct) and another 4,000,000 people (indirect).

Major component includes the following:

- Rehabilitation of 100 existing MWSS wells throughout the MWSS service area
- Construction of seven new deepwell pumping stations and six elevated water tanks in Antipolo.
- Construction of 50 monitoring wells around the MWSS service area.
- Conduct of a detailed hydrogeologic survey or study in Rizal Province through groundwater exploration and test well drilling exploration.

4.6 Other Projects

4.6.1 Rizal Province Water Supply Improvement Project (RPWSIP)

The objectives are to improve and construct waterworks systems in all the nine municipalities of Rizal Province, to wit: Angono, Baras, Cardona, Jala-Jala, Morong, Pililla, Tanay, Taytay, and Teresa, by utilizing groundwater and Laguna de Bay as sources. The project was mandated in 1988 by Batas Pambansa 799, directing MWSS to hasten the integration of the waterworks and sewerage systems in the nine municipalities of Rizal Province into its service area, under a French Government Aid.

Sources of water to be utilized for these project areas will be groundwater for the municipalities of Cardona, Teresa, Baras, Motong, Jala-Jala, Pililla and Tanay and Laguna de Bay for Angono and Taytay. Upon completion of the project, it will supply about 47.5 mld potable water from the Laguna Lake source and 20.338 mld by ground water source. The provision of adequate and potable water to the project area will result in tremendous boost in both commerce and industry, thus uplifting the standard of living of the people as a result of increased opportunities and increases in local government revenues. The total beneficiaries of the project estimated at P1,123 million is approximately 340,000 people.

Major components include the following:

Angono and Taytay

- Intake from Laguna de Bay
- Water Treatment Plant
- Sludge Pumping Station
- Treated water pumping station
- Treated water reservoir
- Distribution pipes

Cardona, Teresa, Baras, Jala-Jala & Morong

- Two units deep wells
- Elevated water tank
- Distribution pipes

Pililla and Tanay

- Nine units deep wells
- Elevated water tank

4.6.2 NRW Reducing Project

NRW Task Force

In order to prepare for the possible water crisis and to monitor and coordinate all activities in reducing NRW, the NRW Task Force, headed by Mr. Rolando E. Roca, the Manager of the Planning and Programming Dept., was established in January 1995. The Task Force directly monitors and coordinates 34 (+2) NRW related projects and programs at MWSS and reports the progress of the NRW activities directly to the Administrator. Formerly, activities on NRW related projects and programs were reported to the Administrator through Department and Division Managers, DA's and SDA. The Task Force has developed the action plan in January 1995, to address NRW and development of supply sources as shown in Table 6.1.

The reduction of NRW requires some legislative and Presidential/Executive actions in addition to the massive internal efforts to be performed by MWSS. The following summarizes Legislative and Presidential/Executive actions proposed by the NRW Task Force:

Recommendations for Legislative Actions by the Task Force

- Amendment of Anti-Pilferage Law
- Increase of MWSS capitalization from P8 to P16 Billion
- Tax exemption for MWSS
- Exemption from COMELEC Ban on bidding, award and implementation of NRW and expansion projects
- Authority for MWSS Board and Administrator to reorganize MWSS following the NPC Model as a guide
- Amendment of Lina Law, authorizes MWSS to eject squatters within its ROW and property
- Exemption from RA 6768 (Salary & Standardization Law)
- Exemption from Attrition Law
- Authorization for MWSS to write-off bad accounts receivable 10 years and older

Table 4.1 Action Plan for NRW

Issues and Concerns	Proposed Solutions
High water losses and pilferage	Immediate passage of Anti-Pilferage Bill Fast track procedures for awards of NRW projects Additional MWSS capitalization for capital projects Partial privatization of MWSS (covered by existing laws and will not require Presidential/Legislative action)
Lack of statutory penalty for illegal use of MWSS water	Immediate passage of Anti-Pilferage Bill
Delay in implementation of NRW and expansion projects	Additional MWSS capitalization Exemption from local excavation and traffic permit Exemption from COMELEC Ban on bidding and awards of NRW projects and hiring/transfer of employees Tax exemption for MWSS from importation of equipment and materials Use of international shopping procedures for APM I Project Exemption from Lina Law, to allow MWSS to temporarily relocate squatters within MWSS property and eject squatters on MWSS right-of-way and property
Insufficient borrowing capacity to improve existing system	Additional MWSS capitalization Exempt MWSS from CSC QS requirements
Loss of skills and manpower to the private sector	Reorganization of MWSS
Increase of MWSS allocation for the Angat Reservoir	Reallocation of Angat water use to favor water supply for Metro Manila which has a higher economic value compared to irrigation water

Source: MWSS Action Plan to Address NRW and Development of Water Source, January 1995

Recommendations for Presidential/Executive Actions by the Task Force

- Reallocation of Angat Reservoir water use
- Fast track procedure for award of NRW related projects through modified bidding
- Authorize MWSS to use the international shopping procedure for the purchase of equipment and material for APM I projects without the required cost ceilings and bid the other APM 3 to 7 projects by modified bidding
- To authorize DBM to provide and pay directly to MWSS all water/sewer accounts of all government offices/instrumentality

- Exempt MWSS from the CSC QS requirements
- Direct all concerned government agency for the strict compliance of the MWSS Chapter on excavation necessary for the System's operations and maintenance and expansion activities

NRW Improvement Program

In order to reduce NRW to 30% by the year 2000, a revised Revenue Improvement Program was proposed to the MWSS Management in December, 1994. This proposal is composed of 34 programs categorized into four main thrusts, namely:

- Controlling unauthorized use of water
- Improving metering efficiency
- Reducing leakage
- Improving institutional set-up

The following table lists the 34 (+2) programs by category which could directly and indirectly contribute to the reduction of NRW:

Table 4.2 NRW Improvement Program

Improvement Program	Est. Cost	Source	Period
A. Controlling Unauthorized Use of Water			
1. Fire hydrants monitoring	P 70M	ICG	1994 to 1998
2. Fire hydrants replacement	180	ICG	1995 to 2000
3. Illegal connection task force	115	ICG	1994 to 2000
4. Census investigation and evaluation	180	ICG	1994 to 2000
5. Public faucets for squatter	120	ICG	1994 to 2000
6. Depressed area water network (DAWN)	330	ICG	1994 to 2000
7. Water service connection program	912	ICG	1994 to 2000
B. Improving Metering Efficiency			
1. Installation and replacement	380	ICG+Foreign Fund	1994 to 2000
2. Delinquent accounts	245		1994 to 2000
3. Procurement of new meters	250		1994 to 2000
4. Testing of production meters	300		1994 to 2000
5. Large meter monitoring	502		1994 to 2000
6. telemetry	500		1994 to 2000
7. Zone/block	375		1994 to 2000
8. Meter reading performance	481		1994 to 2000
9. Minimizing tampering	100		1994 to 2000
10. Creation of Metering Dept.	250		1994 to 2000
C. Reducing Leakage			
1. Pipe replacement/renovation	5,400	ICG+Foreign Fund	
2. Leak repair	250	ICG	1995 to 2000
3. Leak detection	21	JICA+ICG	1994 to 2000
4. Improvement of pipe design	10	ICG	1994 to 2000
5. SLAG II	250	ICG	1994 to 2000
6. Restoration	352	ICG	1994 to 2000
7. Road under construction	32	ICG	1994 to 2000
D. Improving Institutional Set-up			
1. Streamlining of operating policies	5	ICG	1994 to 1998
2. Improvement of compensation of personnel	1,090	ICG	1994 to 2000
3. Granting of incentives to employees	590	ICG	1994 to 2000
4. Development of technical and supervisory skills	10	ICG+JICA+ Grant	1994 to 1996
5. Information system program	120	ICG	1994 to 1996
6. Accelerated revenue improvement program	560	ICG	1994 to 2000
7. F/S for renovation and upgrading of distribution system	20		1994 to 1995
8. Technical assistance for water supply improvement study	18	ADB+Loan	1995
9. Creating NRW Coordinating Group	30		1994 to 2000
10. Privatization of the operation of one sector	1		1995
11. Upgrading of communication system	38		1994 to 1995

Source: MWSS NRW Task Force, January 1995