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METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

VOLUME 2
MAIN REPORT

JUNE 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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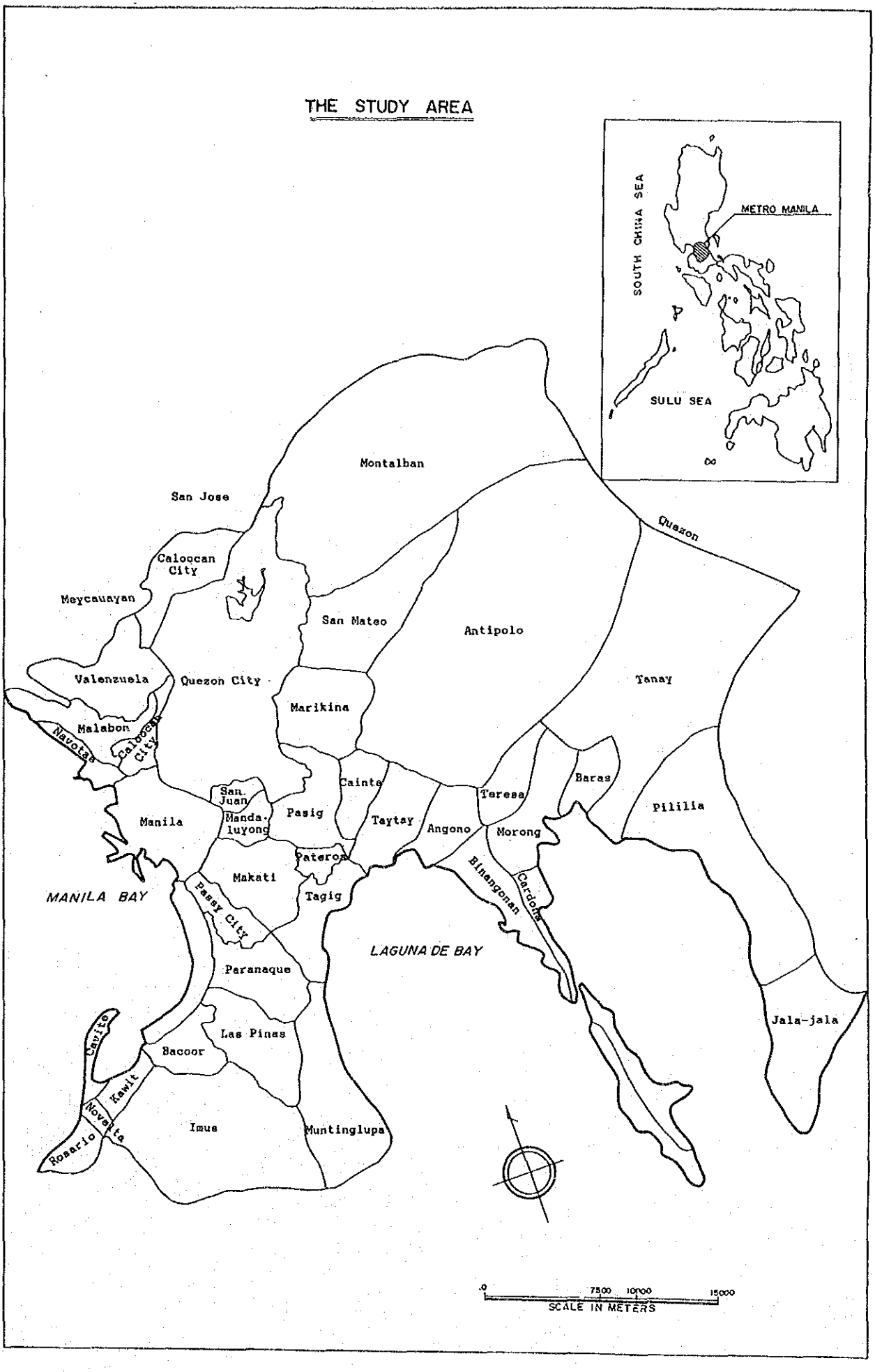
THE STUDY AREA
SOUTH CHINA SEA
METRO MANILA
SULU SEA
Montalban
San Jose
Caloocan City
Meycauayan
Valenzuela
Quezon City
San Mateo
Antipolo
Quezon
Tanay
Marikina
Malabon
Navotas
Caloocan City
San Juan
Manda-luyong
Pasig
Cainta
Taytay
Angono
Teresa
Baras
Pililia
Morong
Manila
Pateros
Makati
Pasay City
Tagig
Binangonan
Cardona
MANILA BAY
LAGUNA DE BAY
Paranaque
Las Pinas
Bacoor
Cavite
Kawit
Noveleta
Rosario
Imus
Muntinglupa
Jala-jala
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SCALE IN METERS

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STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

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ABBREVIATIONS

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AWSOP	Angat Water Supply Optimization Project
BMG	Bureau of Mines and Geosciences
BSWM	Bureau of Soils and Water Management
CDS	Central Distribution System
CMD	Cubic Meter Per Day
DTI	Department of Trade and Industry
DPWH	Department of Public Works and Highways
EMB	Environmental Management Bureau
ERS	Electric Resistivity Survey
FAWSP	Fringe Areas Water Supply Project
GMA	Greater Manila Area
GNP	Gross National Product
GRDP	Gross Regional Domestic Product
GWD-MWSP II	Groundwater Development - Manila Water Supply Project II
HLURB	Housing and Land Use Regulatory Board
IA	Implementing Arrangement
IDRCC	International Development Research Center of Canada
JICA	Japan International Cooperation Agency
LPS	Liter Per Second
MCM	Million Cubic Meters
MGB	Mines and Geosciences Bureau
MLD	Million Liters Per Day
MCD	Million Cubic Meters Per Day
MMA	Metropolitan Manila Authority
MMGWDP	Metro Manila Groundwater Development Project
MMWDP	Metro Manila Water Distribution Project
MSA	MWSS Service Area
MSL	Mean Sea Level
MWSP II	Manila Water Supply Project II
MWSP III	Manila Water Supply Project III

MWSRP I	Manila Water Supply Rehabilitation Project I
MWSRP II	Manila Water Supply Rehabilitation Project II
MWSS	Metropolitan Waterworks and Sewerage System
NAMRIA	National Mapping and Resource Information Authority
NCR	National Capital Region
NDA	No Data Available
NEDA	National Economic and Development Authority
NEPC	National Environmental Protection Council
NHA	National Housing Authority
NHRC	National Hydraulic Research Center
NIA	National Irrigation Administration
NPC	National Power Corporation
NSO	National Statistics Office
NSCB	National Statistical Coordination Board
NWRB	National Water Resources Board
OPPDC	Office of the Provincial Planning and Development Coordinator
OPPDC-RP	Office of the Provincial Planning and Development Coordinator - Rizal Province
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PGSCS	Philippine Groundwater Salinity Control Study
PIA	Philippine Information Agency
PNR	Philippine National Railways
RDFP	Regional Development Framework Plan
RPWSIP	Rizal Province Water Supply Improvement Project
WRMM-MM	Water Resources Management Model for Metro Manila

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

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CHAPTER 1 INTRODUCTION

1.1 STUDY BACKGROUND

The National Capital Region or NCR, better known as Metro Manila, lies on an alluvial plain and terrace along Manila Bay, south of the island of Luzon. Containing a land area which is less than one percent (0.21 percent) of the country's total and having thirteen percent (7.9 million) of the country's total population, the area is characterized by rapid urbanization posing serious problems in water supply, sewerage, transportation, housing, garbage disposal and other related issues.

The problem of water supply shortage in particular is of such seriousness as to spur the Metropolitan Waterworks and Sewerage System (MWSS), which has jurisdiction over Metro Manila's water supply services, to embark on implementing several projects to meet the increasing demand and to have under wraps plans for some more. Notwithstanding the amount of effort the MWSS is exerting to solve the problem, the water shortage in the metropolis remains as grave, even appearing as if it has been further compounded, considering the superannuation and leakage in the distribution pipes of the MWSS.

Metro Manila's water supply, historically, has depended on groundwater as an important source. The deep and shallow wells that were drilled provide water for industry and commerce and for the domestic supply of areas outside the coverage of the central distribution system (CDS) of the MWSS as well. Another source is the surface water of the Angat River in the Province of Bulacan.

The uncontrolled development and excessive pumping of groundwater, however, had caused the widespread decline of water levels in artesian aquifers, this decline dating back as far as the Sixties. What had thus resulted was the intrusion of salt water in the aquifers of coastal areas. Many wells had to be abandoned, new ones have to be drilled, with this seeking of fresh water in deeper aquifers becoming a vicious cycle and in the process expanding more the area affected by the intrusion of salt water.

The above phenomenon has not spared the MWSS. A considerable number of the deep wells in its service area were affected by the regional salinization and were therefore abandoned. Some of these wells form part of the well network that supplies groundwater through pipelines connected to the CDS.

To compensate for the losses from these salt-intruded wells and increase the water supply in areas covered by its central distribution system, the MWSS is currently implementing the Angat Water Supply Optimization Project (AWSOP). For areas where no future water supply plans using surface water as source exist, two projects using groundwater as source are currently under implementation. These are the Fringe Areas Water Supply Project (FAWSP) and the Rizal Province Water Supply Improvement Project (RPWSIP).

It is still projected, however, that even with the increment in supply brought forth by the above efforts, supply would not meet the increasing water demand as rapid urbanization has already taken place. The rational development and conservation of groundwater and the establishment of a system for its proper management must therefore be given greater and sustained attention.

The Philippine Government's concern, in the context of the above, prompted it to request the Government of Japan for technical assistance, which request the Japanese Government acceded to by sending a preliminary mission for the period 12-22 January 1990 to clarify the background and specifics of the request. An agreement was reached between the MWSS and the Japan International Cooperation Agency (JICA) on the Implementing Arrangement (IA) for a study. The agreement was signed on 18 January 1990 by representatives of both parties. Based on the IA, a Study Team was dispatched to carry out the study.

The Study Team stayed in the Philippines for the periods 26 August to 20 December 1990 (Stage I of the Study), 08 January to 26 March 1991 (Stage II of the Study) and 27 May to 20 December 1991 (from First to Third period of Stage III of the Study). In cooperation with MWSS personnel, the team conducted surveys on the groundwater resources of the MWSS service area (MSA).

1.2. STUDY OBJECTIVES AND SCOPE

1.2.1 Study Objectives

The Study aims at the achievement of the following:

(1) To formulate a plan for the rehabilitation, operation, maintenance and development of MWSS supervised wells in MSA.

(2) To evaluate the groundwater resources potential and formulate a groundwater development plan for the Antipolo area.

(3) To come up with solutions or remedial measures and preventive schemes for areas with heavy saline water intrusion.

(4) To formulate a plan for the establishment of a groundwater monitoring system in Metro Manila.

1.2.2 Study Scope

The Study is being carried out within the stipulations of the Implementing Arrangement (IA) abovementioned and covers the following major subjects:

(1) Rehabilitation program for MWSS wells

All operating and non-operating wells of MWSS are to be investigated. Methods of rehabilitation will be examined and evaluated based on the results of the experimental work on selected wells.

(2) Groundwater development plan in the Antipolo area

The area included in the Study is the Antipolo Plateau that is enclosed by ridges and which is about 30 km^2. A groundwater development plan will be formulated for this plateau.

(3) Elucidation of saline water intrusion mechanism

A hydrogeologic investigation is to be carried out along a survey line perpendicular to the coast of Las Piñas-Parañaque where intrusion of saline water has been observed.

Observation wells will be drilled along said line in order to measure groundwater level and water quality. Countermeasures shall be proposed based on the hydrogeologic analysis.

(4) A plan for the establishment of groundwater monitoring system

A plan will be formulated and proposed. It will be analyzed through computer simulations. The plan covers the MSA except those municipalities included in BP 799.

1.3 STUDY AREA

As shown in Figure 1.1, the Study Area covers the MWSS Service Area which comprises five (5) cities and thirty two (32) municipalities, namely:

Metro Manila: 4 cities and 13 municipalities

The cities of Manila, Pasay, Quezon and Caloocan and the municipalities of Las Pinas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig and Valenzuela.

Cavite Province: 1 city and 5 municipalities

The city of Cavite and the municipalities of Bacoor, Imus, Kawit, Noveleta and Rosario.

Rizal Province: 14 municipalities

Antipolo, San Mateo, Taytay, Cainta and Montalban. (The municipalities Batas Pambamsa 799: Angono, Baras, Binangonan, Cardona, Jala-Jala, Morong, Pililla, Tanay and Teresa

1.4 STUDY OUTLINE

1.4.1 Study Framework

The Study commenced in August 1990 and was completed in March 1992. The Study period was divided into three stages: Stage I (Basic Survey), Stage II (Detailed Survey) and Stage III (Analysis and Planning).

The Study procedure is flowcharted as shown in Figure 1.2.

(1) Stage I: Basic Survey

This stage involves the review and analysis of existing studies and data, field geological reconnaissance, arrangement of existing well inventory, questionnaire survey on groundwater utilization, preparation of the database system and appraisal survey on the ability and availability of local drilling contractors.

(2) Stage II: Detailed Survey

The Study at this point includes investigation of MWSS wells, the electric resistivity survey of the Antipolo area, drilling and pumping tests, installation of monitoring equipment, pumping tests of existing wells, simultaneous observation of water levels, survey on groundwater utilization (collection and analysis of questionnaires) and preparation of the database system. Various data obtained throughout Stage II are arranged for their use in Stage III.

(3) Stage III: Analysis and Planning

The Study at Stage III concerns the planning of the rehabilitation program for MWSS wells, the groundwater development and management program, the analysis of saltwater intrusion and the planning for the groundwater monitoring system in MSA.

1.4.2 Study Items

Stage I: Basic Survey

The Basic Survey at Stage I is undertaken to:

- o Overview existing MWSS water supply systems and MWSS's future plan, and to make clear the role and effect of the Study;
- o Reveal the hydrogeologic condition of the Metro Manila groundwater basin by field geological reconnaissance;
- o Confirm and decide on the items for inclusion to those of Stage II.

In order to achieve the targets at Stage I, the following Study Items were undertaken:

(1) Collection and arrangement of data and information related to the Study
(2) Explanation of the Inception Report
(3) Review of existing groundwater reports
(4) Arrangement of existing well inventory
(5) Field geological reconnaissance
(6) Survey on the ability and availability of local drilling companies
(7) Survey on the condition of actual groundwater utilization
(8) Review of the organization and management systems
(9) Review of existing water supply systems
(10) Review of urban planning
(11) Preparation for the establishment of a groundwater database system

Stage II: Detailed Survey

The detailed survey at Stage II is undertaken to obtain the hydrogeologic data necessary for the analysis and planning in Stage III.

In order to achieve the targets at Stage II, the following Study Items were conducted:

(1) Survey on MWSS deep wells for rehabilitation
(2) Test drillings and pumping tests
(3) Pumping test of existing deep wells
(4) Groundwater sampling and analysis
(5) Survey on groundwater use
(6) Arrangement of input data for the database system
(7) Installation of observation equipment

Stage III: Analysis and Planning

The Analysis and Planning at Stage III is undertaken to clarify the hydrogeology of the Metro Manila groundwater basin and to establish groundwater development/management plan based on the survey results obtained in Stages I and II.

In order to achieve the targets at Stage III, the following Study Items were conducted.

(1) Investigation and rehabilitation of MWSS wells
(2) Evaluation of the effects of rehabilitation works
(3) Analysis of hydrogeologic structure and aquifer unit
(4) Preparation of database system
(5) Investigation of water supply systems
(6) Urban development planning
(7) Water demand projections
(8) Groundwater modeling of flow and solute transport
(9) Investigation of organization and management systems
(10) Simultaneous hydrological observations
(11) Analysis of hydrology and water quality
(12) Preparation of water supply systems
(13) Groundwater simulations
(14) Rehabilitation program of MWSS
(15) Groundwater development plan in Antipolo
(16) Groundwater monitoring system in Metro Manila

1.5 ORGANIZATION OF THE STUDY

In carrying out the Study, the Metropolitan Waterworks and Sewerage System (MWSS) of the Republic of the Philippines acted as the counterpart agency and the Japan International Cooperation Agency (JICA), the official agency in behalf of the Government of Japan.

The study period is from August 1990 to March 1992.

The Study was carried out by a joint study team composed of a JICA team and a MWSS team:

JICA Study Team

Toru HAYASHI	Team Leader/Water Supply Engineer
Akira KAMATA	Co-Team Leader/Hydrogeologist
Masaharu KINA	Urban Planner
Shoichi OOMORI	Geologist
Naoaki SHIBASAKI	Hydrogeologist
Kenji TAKAYANAGI	Hydrogeologist
Masuomi HIROYAMA	Water Quality Engineer
Reynaldo R. MEDINA	Hydrologist
Mitsuo TSUTSUMI	Drilling Supervisor
Yu AYUSAWA	Drilling Supervisor
Kakuji SUEMATSU	Well Engineer
Takafumi KIGUCHI	Water Supply Planner

MWSS Team

Rolando E. ROCA	Manager, Planning & Programming Dept.
Victor J. BALAGTAS	Project Manager C, MMGWDP
Ernesto V. ALCANTARA	Asst. Project Manager C, MMGWDP
Renee A. PINGOL	Sr. Statistician
Norma M. SANTIAGO	Sr. Hydrogeologist A
Godofredo C. CARPIO	Hydrogeologist A
Richard G. BURCE	Supervising Engineer
Romeo S. MANLAPIG	Sr. Engineer A
Rogelio G. OTIVAR	Sr. Engineer A

Enrico A. RUIDERA	Sr. Draftsman
Rodulfo M. NOVEDA	Engineering Assistant A
Rodolfo B. VICENTE	Engineering Assistant A
Oliver B. PADRON	Sr. Engineer A
Noel B. ZACARIAS	Engineering Assistant A
Daisy C. ARANAN	Data Encoder/Controller
Juliana F. VELADO	Data Encoder/Controller
Ramon N. MENDOZA	Engineering Assistant A
Lorenzo A. DUMANDAN	Engineering Assistant A
Judith S. CADAPAN	Draftsman A
Gemmalyn S. SANTOS	Administrative Service Assistant A
Olivia M. SANTIAGO	Clerk/Processor B

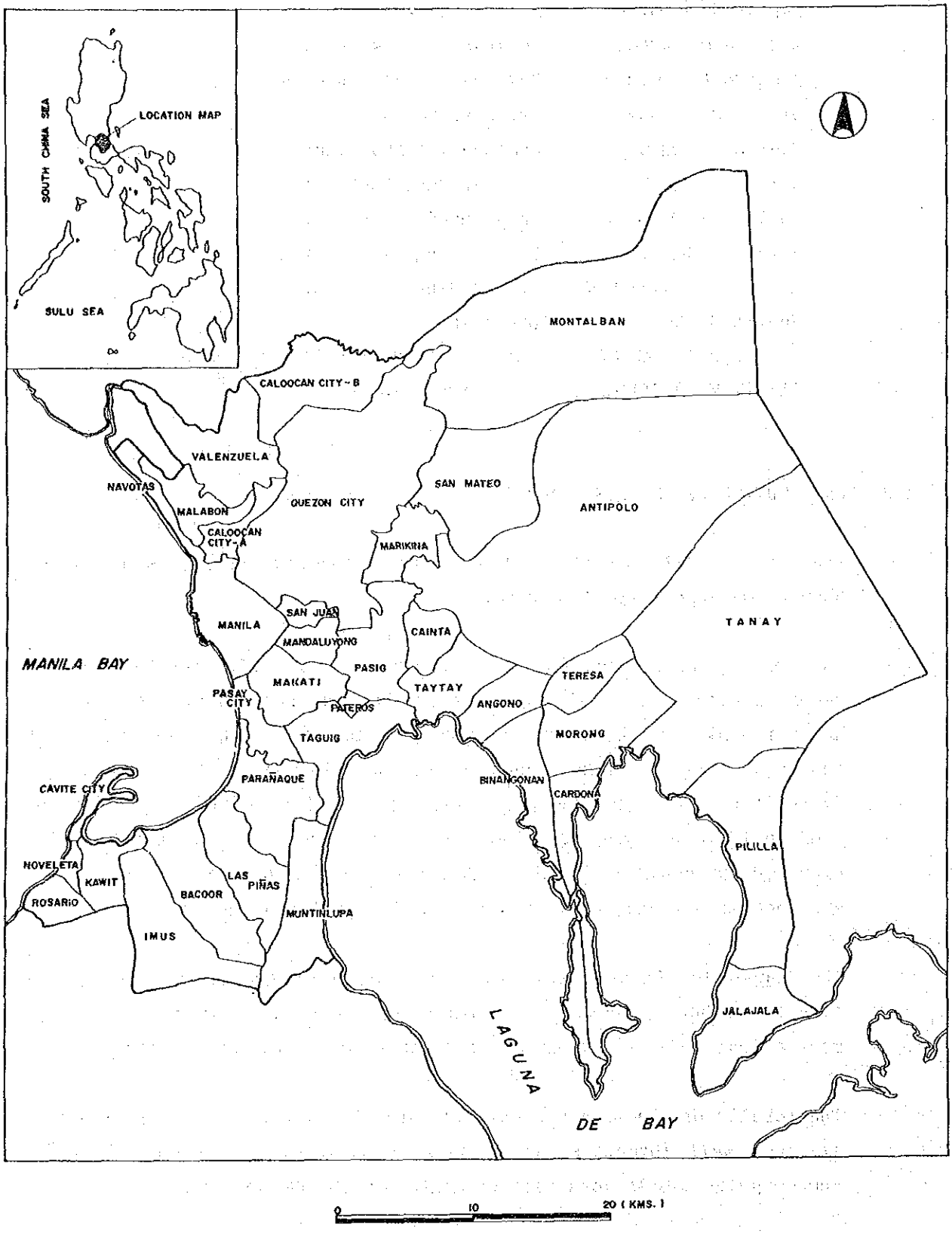
1.6 CONSTITUTION OF THE FINAL REPORT

The Final Report consists of four volumes: Summary Report, Main Report, Supporting Report and Data Report.

The Summary Report contains the summary of the Study, conclusions and recommendations. The Main Report describes the results of the Study on aquifer distribution, groundwater use, groundwater levels, water quality and rehabilitation of MWSS deep wells. The Main Report also contains the evaluation of the groundwater resources of Metro Manila based on the hydrogeologic analyses and computer simulations. It also contains the proposed groundwater development and management program. Conclusions and recommendations are summarized in the final chapter.

The Supporting Report contains the results of groundwater investigation, test borings,computer simulations, the details of urban development planning, water supply systems and future water demand study.

The results of electric resistivity survey, pumping tests, well rehabilitation, well inventory, water quality analysis, groundwater leveling and computer simulations are presented in the Data Report.



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

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FIGURE 1.1 THE STUDY AREA

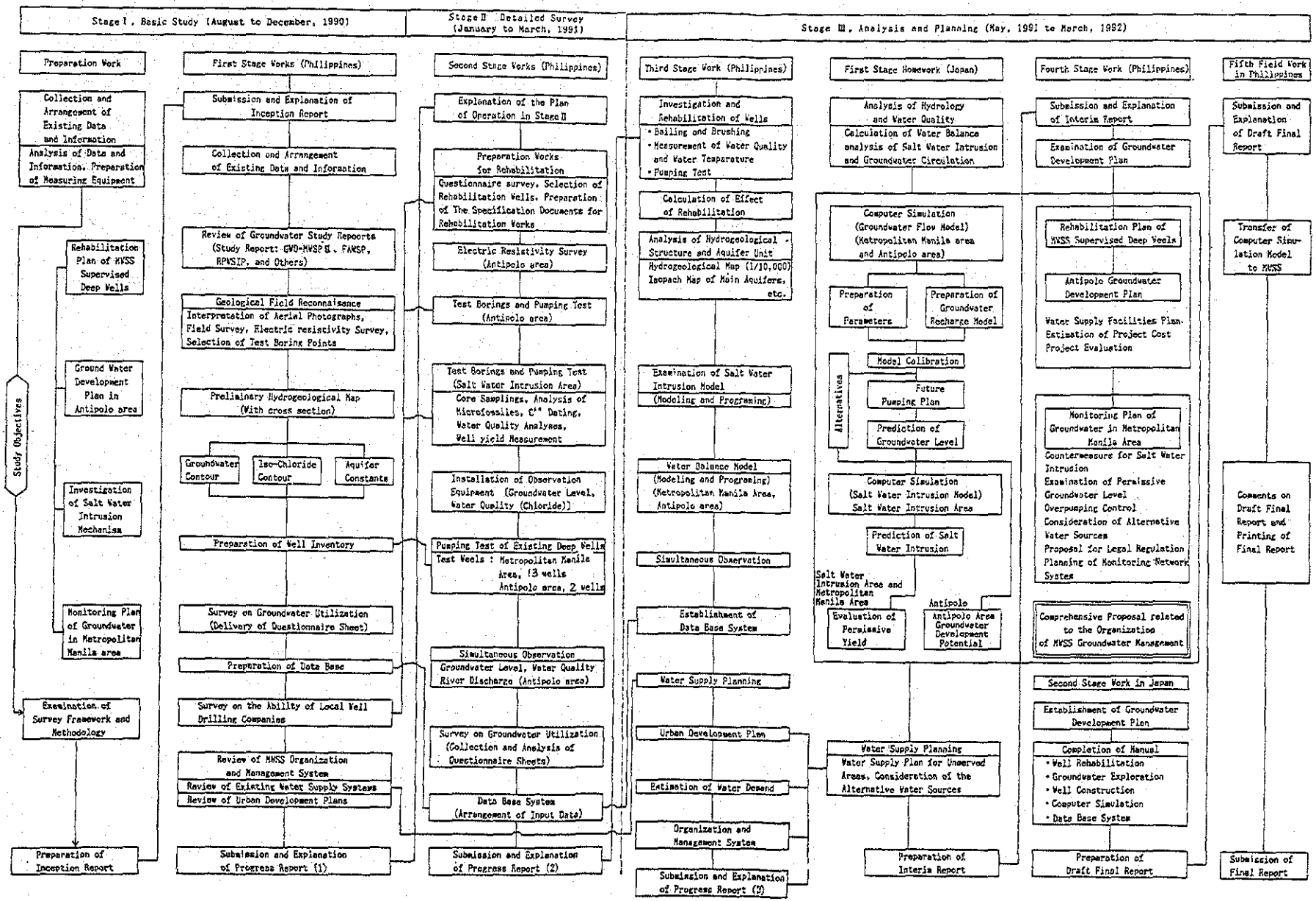

FIGURE 1.2 FLOWCHART OF THE STUDY

CHAPTER 2

SOCIO-ECONOMY AND WATER SUPPLY

CHAPTER 2 SOCIO-ECONOMY AND WATER SUPPLY

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CHAPTER 2 SOCIO-ECONOMY AND WATER SUPPLY

2.1 SOCIO-ECONOMY

2.1.1 General

There are thirteen administrative regions in the Philippines including the National Capital Region (NCR). The Study Area comprises the NCR and the two provinces (Rizal and part of Cavite) of Region IV.

The NCR, better known as Metro Manila, is composed of four (4) cities and thirteen (13) municipalities, namely: the cities of Manila, Quezon, Pasay and Caloocan; and the municipalities of Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig, and Valenzuela.

Region IV has the most number of provinces, totaling eleven (11): Aurora, Batangas, Cavite, Laguna, Mindoro Oriental, Mindoro Occidental, Marinduque, Palawan, Quezon, Rizal and Romblon. In the MSA, Rizal has fourteen (14) municipalities, while Cavite has one city and five (5) municipalities in the Study Area.

2.1.2 Land Area and Population

(1) Land Area

The Philippines has a total land area of approximately 300,000 km^2. Region IV, among all the regions, has the largest land area (46,924.10 km^2), representing 15.64 percent of the country's total. NCR, on the other hand, has the smallest land area (636 km^2), representing only 0.21 percent of the country's total.

(2) Population and Distribution

The 1990 Philippine Population Census (Preliminary Count by the National Statistics Office as of May 1990) placed the population of the country at 60,685,000. This figure is 12,587,000 more than the population ten years ago (1980) and reflects an annual growth rate of 2.3 percent

(Table 2.1.1 and Figure 2.1.1).

Among the thirteen regions, the NCR and the Southern Tagalog Region (Region IV) account for the bulk (36.7 percent) of the country's total population. The total population of Metro Manila is 7,833,000. Cavite and Rizal have respective populations of 458,771 and 880,608. NCR and Region IV are the most urbanized and economically developed of the 13 regions.

The MSA covers the whole of NCR and 3.2 percent of Region IV. It comprises five (5) cities and thirty-two (32) municipalities whose combined population in 1990 was 9,172,379 (6,805,630 in 1980). This population figure represents 15.17 percent of the country's total and reflects an increase of 34.78 percent over the 1980 figure, or an annual growth rate of 3.03 percent.

The population densities in the MSA are shown in Table 2.1.2 and Figure 2.1.2 and 2.1.3.

2.1.3 Social Profile

(1) Social Development Indicators

The NCR and Region IV as a whole has the major advantage among the regions in terms of social services, physical facilities and those amenities associated with urban life. However, a large portion of its population still bears the brunt of poverty and its attendant ills: unemployment, underemployment, congestion, ill-health and malnutrition, poor delivery of basic services, etc. Table 2.1.3 shows the social profile of the regions using major indicators.

(2) Labor Force

The economically active population within the age range of 15-64 years constitutes the country's labor force (NSO definition). In 1988, the total population of those who are 15 years old and above was 35,865,000 (Table 2.1.4).

For Metro Manila, its labor force in 1989 was estimated to be 3.1 mil-

lion, representing around 60 percent of the working age population, and which for the last three years increased at an annual average rate of 3.0 percent.

(3) Employment

Total employment in the Philippines was 20,595,000 in the third quarter of 1986 (Table 2.1.4). Employment rate for the same period was 88.9 percent, a reduction from the 95.0 percent registered in 1980. The employment rate, however, improved to 91.7 percent in 1988.

For Metro Manila, the employment rate was estimated at 82.2 percent in 1989, slightly lower than the 84.8 percent registered in the third quarter of 1988 and slightly higher than the 1986 average of 80.6 percent.

2.1.4 Economic Profile

(1) Gross Regional Domestic Product

The National Capital Region (NCR) maintained in 1989 its traditional lead among the regions by producing a hefty ₱33.2 billion worth of Gross Regional Domestic Product (GRDP). The primacy of NCR in setting the trend of the national economy may be gleaned from its performance during the 1980-1986 period when its annual contribution to the total Gross Domestic Product (GDP) averaged as much as 31 percent (Table 2.1.5).

(2) Economic Sectors

In the medium- and long-term periods, the capital region is envisioned to have its industry dominance gradually reduced by the transfer of its major socio-economic activities to the industrial centers of its regional neighbors. It will, however, hold on to its lead as center for trade, finance and commerce, education and as seat of the National Government. In consonance with the limits that its environment and geography can provide, existing levels of industrial activity shall be maintained.

(3) Household Income

According to the Family Income and Expenditures Survey (FIES) conducted by the NSO in 1985, the average annual family income in the Philippines was P31,052, in Region IV P29,985, in NCR P57,193, in Cavite Province P39,759, and in Rizal P38,518 (Table 2.1.6).

With the current economic situation, declining real incomes place increased demands on the government's shelter, health and social infrastructure programs.

(4) Industry and Trade

The industry sector in the Philippines is dominated by manufacturing whose contribution since 1972 to the value added by industry averages to around 75%. The share of construction and utilities has varied between 15% to 20% of total industry value added.

In the Study Area, the industry sector is composed of manufacturing, construction, electricity, gas and water.

2.1.5 Housing

According to the 1990 Census of Population and Housing of the National Statistics Office (NSO), there are about 1,836,564 unit-houses in the MWSS service area. Of this total, Metro Manila accounted for 1,557,000 units (84.8%), Cavite (that part of the Study Area) for 91,435 units (5.0%), and Rizal Province for 188,129 units (10.2%).

Table 2.1.7 presents by type of building the number of families in the country and the NCR. The majority (67.1%) of families in the NCR live in single houses. The remaining 32.9% live in duplex (4.23%), apartment/accesoria/condominium (21.62%), improvised buildings or barong-barong (4.9%), commercial/industrial/agricultural buildings (1.8%) and other dwellings (0.4%) such as natural shelters, boats, etc.

2.1.6 Land Use

(1) Classification of Land Use

The total land area of the Study Area is estimated at 212,555 hectares and is divided as follows:

NCR	63,600 Has.
Cavite (S.A.)	18,572 Has.
Rizal (*)	130,383 Has.

(*) NCSO, Bureau of Lands : 130,383 Has.
BSWM : 130,892 Has.
Office of the Provincial Assessor : 157,345 Has.

The data from the Office of the Provincial Assessor is the latest information (1990). However, the official data of the NCSO is the one adopted for this Study.

Land use is classified into the following six major categories: (a) Built-up area; (b) Agricultural area; (c) Forest; (d) Wetland; (e) Open Space; and (f) Others.

1) Built-up Area

In Metro Manila the built-up area occupies 47 percent of the total area. That of the Rizal province occupies 11.7 percent of the province's total.

The built-up areas of the Rizal Province are sporadically scattered. Major ones are concentrated in Cainta, Taytay and Antipolo because of their contiguity to Metro Manila.

The major built-up areas of Cavite are composed of the municipalities ringing the Metropolitan Area, namely, Bacoor, Kawit, Noveleta and Cavite City. Imus is also rapidly expanding and experiencing the suburbanizing trend of Metro Manila.

2) Agricultural Area

This category includes all areas that are intended for agriculture: rice field, cropland, plantation, etc.

In Rizal, the total agricultural area is about 19,167 hectares or 14.7 percent of the total area of the province. The southern part of Imus constitutes this type of area in Cavite.

3) Forest

Forests are found mainly in the mountainous parts of Montalban, Antipolo and Tanay, and also in the lower hills and along waterways or creeks. They cover about 16,618 hectares or 12.7 percent of the total area of the Rizal province and are the next most extensive natural cover of the Rizal province.

4) Wetland

Wetland areas are found in low-lying coastal plains adjacent to large bodies of water.

5) Open Space

This category consists of those areas associated or mixed-up with built-up areas. Most of the open spaces are found in the NCR.

6) Others

Under this category are areas which could not be classified under the preceeding five categories.

(2) Land Use Development

Responding to the social, economic and political activities in recent years, changes in the land use pattern in Metro Manila may be summarized as follows:

- Increase in the number and density of squatter housing areas.

- The development of middle and upper class residential subdivisions on urban peripheries where land is inexpensive.

- The development in the main urban area of townhouses and high-rise condominiums for the middle and upper income market.

- The conversion of agricultural and fishpond areas for residential and/or commercial use.

- The emergence and intensification of suburban commercial nodes at intersections of major transport routes in response to the need of the growing number of residential subdivisions in the suburbs.

- The location of new and the relocation of existing industries at cheaper sites to the north (Bulacan), east (Rizal) and south (Cavite). These sites are along major transport routes.

2.1.7 Infrastructure

In contrast to the rapid population growth witnessed during the past few decades, the infrastructure situation in the NCR has not kept pace as to be adequate to the basic needs of the inhabitants.

(1) Transportation

The transport system of the country and Study Area remains to be dominated by land transportation facilities. This type of system accounts for 65 percent of the total domestic passenger traffic. The latest technology in land transport is the Light Rail Transit which was opened in Metro Manila to decongest the streets.

The public transportation in Metro Manila, Cavite and Rizal is predominantly road-based, consisting largely of jeepneys and buses for primary and secondary routes, and tricycles and pedicabs for feeder routes.

(2) Sewerage System

Two sewerage systems are working in the NCR. One is the Central Manila

Sewerage System constructed before 1909 with an original overload capacity of 450,000 people. Presently, this system covers 1,850 hectares and serves 530,000 people. It has a total length of 240 km. The other is in Quezon City and Makati, and which is made up of isolated systems in subdivisions and commercial areas serving 350,000 people. Total length is about 140 km. The rest of the NCR populace discharges its wastewater either into storm drains, septic tanks or directly to esteros.

(3) Power Supply

The country's electric power is generated by the state-owned National Power Corporation (NPC). Power generation is done through geothermal means or through the use of oil, coal, hydropower, and other energy resources. The generated power is supplied (at 115 kv or at 230 kv) to the Manila Electric Company (MERALCO) which distributes power over the whole of NCR, Rizal and Cavite.

2.2 WATER SUPPLY SYSTEMS

2.2.1 General Situation in the Country

(1) Present Water Supply Services

As of end-1987, around 63% of the country's total population have access to public water supply systems. The rest of the population, approximately 37%, sourced their water from open dug wells, rainwater cisterns, lakes and streams, a number of which are of doubtful quality. The served population then was 86% for Metro Manila and its contiguous areas, 55% for other urban areas,and 62% for the rural areas. Out of the 86% covered in Metro Manila, however, only 57% were directly served with MWSS water, 16% were served indirectly by MWSS through ambulant vendors, and the rest acquired water through private wells and other undetermined sources. Present water supply coverage in the country is shown in Table 2.2.1. Numbers of families by main water sources and its percentage are shown in Table 2.2.2 and Figure 2.2.1.

In Metro Manila, water supply service consists of individual house

connections, private wells, some public standpipes in blighted areas and ambulant vendors. In large urban centers outside Metro Manila, majority of the people is served by Level III systems. In the rural areas, however, the most common water supply facilities are protected wells and developed springs. There are also some Level II and III systems but the latter are generally found only in large poblaciones. Table 2.2.3 shows the condition of existing water supply facilities.

(2) Institutional Aspect

Provision of water supply facilities is under the responsibility of the Department of Public Works and Highways (DPWH) and two of its attached agencies namely: the Metropolitan Waterworks and Sewerage System (MWSS) and the Local Water Utilities Administration (LWUA). The MWSS operates the water supply and sewerage systems in Metro Manila and its contiguous areas, while the LWUA handles the development and improvement of water and sewerage systems in the areas not covered by MWSS.

The DPWH is concerned mainly with the development of Level I systems and is the lead agency in establishing national water supply plans and programs upon which all other agencies involved in the sector base their respective development plans. Other agencies involved in water supply include the National Water Resources Board (NWRB) and the Department of Interior and Local Governments (DILG). DILG's participation is limited to the general administrative/institution building activities, while NWRB's involvement is mainly on policies and regulations concerning the proper utilization and rights thereof of water resources all over the Philippines.

A matrix of responsibility of the concerned agencies in the water supply sector is presented in Table 2.2.4.

(3) Master Plan of the Philippines

To provide direction, establish priorities, and rationalize implementation of projects in the sector, the Philippine Government prepared in 1980 the Integrated Water Supply Program for the period 1980-2000 and the 1982 Philippine Rural Water Supply Master Plan. These were later superseded in 1987 by the Water Supply, Sewerage, and Sanitation Master

Plan for the period 1988-2000. This latest plan contains the sectoral objectives, policies, programs, institutional arrangements, and financial and economic considerations.

The Master Plan calls for a two-stage implementation of projects: the first stage covering the period 1988 to 1992 and the second stage encompassing the period 1993-2000.

As shown in Table 2.2.5, the following activities are envisaged during the first stage (1988-92):

In Metro Manila and its contiguous areas, a package of projects is to be undertaken to improve the existing facilities and expand their coverage. These are the Manila Water Supply Rehabilitation Project I (MWSRP I), the Metro Manila Water Distribution Project (MMWDP), the Angat Water Supply Optimization Project (AWSOP), Manila Water Supply Rehabilitation Project II (MWSRP II), Fringe Areas Water Supply Project (FAWSP) and Rizal Province Water Supply Improvement Project (RPWSIP). These projects are targeted to expand and improve the service coverage of the system to 87% of the metropolitan population.

The second stage (1993-2000) of this Master Plan considers the complete water supply coverage of both urban and rural areas with emphasis on proper operation and maintenance of facilities, and the gradual construction of sewerage systems. Table 2.2.6 reflects the physical targets, investment requirements and service coverage per sector of the second stage.

In Metro Manila, the Manila Water Supply Project III was planned to boost the service coverage to 97%. (This project, however, has been deferred after the commencement of the construction stage due to high cost of construction.)

2.2.2 Present Situation in the MWSS Service Area (MSA)

(1) Service Area

Based on the Republic Act No. 5234, the MWSS has jurisdiction over the following areas (refer to Figure 2.2.2):

- Metropolitan Manila (National Capital Region):

  4 cities: Manila, Pasay, Quezon, and Caloocan

  13 municipalities: Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig, Valenzuela

- Rizal Province:

  14 municipalities: Angono*, Antipolo, Baras*, Binangonan*, Cainta, Cardona*, Jala-Jala*, Montalban, Morong*, Pililla*, San Mateo, Tanay*, Taytay, Teresa*

  * Merged into MSA by the Batas Pambansa Blg. 799, approved April 27, 1984.

- A Part of Cavite Province:

  1 city: Cavite

  5 municipalities: Bacoor, Imus, Kawit, Noveleta, Rosario

- Lungsod Silangan (Tagalog word, Eastern Cities - not specified)

- Other areas that may come within the development path of the expanding Metropolitan Manila Area, which areas the Board of MWSS may determine and declare as contiguous to its service area and requiring immediate attention, under such terms and conditions that may be agreed upon by the parties concerned. -- Subject to the approval of the President.

The Central Distribution System (CDS) of MWSS, which distributes water from two surface water treatment plants, covers areas within Metro Manila plus some parts of Bacoor and Kawit of Cavite Province. Peripheral areas of Metro Manila such as the northern part of Caloocan City, the northern part of Quezon City, most of Valenzuela, the eastern part of Marikina, a part of Taguig, a part of Parañaque, most of Las Piñas, and most of Muntinlupa, are not covered by the CDS. These areas and other areas in the Rizal and Cavite provinces predominantly rely on isolated groundwater supply systems operated by MWSS and other public entities such as Water Districts, municipalities, and barangays. Figure 2.2.3 presents the areas covered by existing MWSS water supply systems. The meshed area in this figure is covered by the CDS and is mainly supplied with surface water; the striped area (outlying area) is served by the MWSS groundwater supply systems. The groundwater supply is thus

very important to places under these latter areas, though representing only a small percentage of the total water supply of MWSS.

AWSOP that is currently under implementation targets an additional 15 m^3/sec of surface water. It also aims to expand the area covered by CDS. After completion of this project, the northern part of abovesaid outlying area will be part of the CDS.

In the future, there will be a diminution in the relative importance of groundwater because of the increase in surface water supply. However, the areas that could not be reached by surface water, i.e., areas in the Rizal Province, shall solely rely on groundwater.

(2) Served Population and Water Amount

Table 2.2.7 presents the statistics on MWSS water supply and the size of the population served for the period 1984-1990. Figure 2.2.4 is derived from the said table's data for the year 1990. Based on the 1990 data, total population served is 8.2 million or 90% of total population within MSA. Of this figure, 2.6 million or 29% of total population is estimated as illegal users of the system.

Per capita water consumption from 1984 to 1990, however, has been decreasing. From the per capita water consumption for house connections in the year 1984, a decrease of 22% or 39 lpcd was registered. This fact does not imply a water saving by users, but it results from water shortage caused by inadequate water supply capacity of the MWSS system. In this regards, the development of new water sources for MWSS is an urgent necessity.

(3) Existing Water Supply Facilities

a) Outline of the System

The MWSS's water sources consist of surface water and groundwater. The raw water drawn from surface water facilities, namely, Ipo Dam (Angat River, Ipo River), La Mesa Dam (Novaliches Watershed), and Alat Diversion Dam (Alat River), are conveyed to two (2) treatment plants, namely, the Balara Treatment Plant (Nos. 1 and 2) and the La Mesa Treatment

Plant.

Treated water from the Balara Treatment Plant is sent to the San Juan and the Pasig Reservoirs and the Balara Pumping Station. That from the La Mesa Treatment Plant is sent to the Bagbag Reservoir.

The groundwater drawn from MWSS deepwells are injected directly into the distribution systems after chlorination.

The distribution system serving Metro Manila and Cavite City operates eight booster pumping stations and eight mini-booster pumping stations.

The outline of the system from the surface water sources to the treated water reservoirs is illustrated by Figure 2.2.5.

b) Water Source

Surface water and groundwater sources of MWSS have a total capacity of around 2.495 MCM per day as presented in Table 2.2.8.

The water drawn from these sources are conveyed to treatment plants through two tunnels and four aqueducts.

In 1990, the total volume of raw water drawn from all surface water sources was 916.9 MCM. Average daily supply was 2.512 MCM or about 101% of available water source yield. Table 2.2.9 compares the raw water supply drawn from all surface water source for the period 1986 to 1990.

Average daily raw water supply from surface water sources for the last five years was about 2.436 MCM. Considering the drought during dry season, this amount cannot be expected to answer the water demand. New water sources must be developed.

Table 2.2.10 presents the monthly raw water supply amount. Figure 2.2.6 which was derived from this table shows that the monthly raw water supply withdrawals from Ipo/Alat/La Mesa dams vary widely. During dry season, the supply is extremely low from these dams. As shown in this figure, stable supply of MWSS System relies on Angat Dam. Under AWSOP, an additional 15 m^3/sec (1.296 MCM/day) of water will be supplied

to the system from Angat Dam through Ipo Dam and a new conveyance system.

Based on the 1990 MWSS Annual Report, MWSS gained about 33 MCM of groundwater through MWSS-owned deepwells.

c) Water Production

MWSS's two treatment plants, namely, the Balara Treatment Plant (Nos. 1 and 2) and the La Mesa Treatment Plant, have a combined treatment capacity of around 2.6 MCM/day (Figure 2.2.7 and 2.2.8). In addition to this output, about 82,000 m3/day of groundwater were produced by MWSS through its 131 operational deepwells scattered within the MSA excluding BP799 coverage. Table 2.2.11 presents the statistics on water production by MWSS from 1985 to 1990. Outlines of the two treatment plants are presented in Table 2.2.12.

As of March 1991, MWSS has 258 deepwells of which 131 wells are in operation. The water from these wells are injected into the distribution pipelines directly or distributed through booster pumping stations. Details on groundwater use are discussed in Section 3.3 of the Main Report.

d) Water Distribution

Water from the Balara and the La Mesa treatment plants and groundwater deepwells are distributed to the Central Distribution System (CDS) and other isolated distribution systems directly or through distribution reservoirs and booster pumping stations (Figure 2.2.9).

(4) Water Quality

Table 2.2.13 presents the results of physical and chemical analyses conducted in 1989 on raw water, chemically treated water, sedimented water, filtered water and finished water of the Balara and the La Mesa treatment plants. Though values of other water quality parameters are almost passable, the turbidity of the finished water of Balara is relatively high.

Based on the Accomplishment Report for CY 1989 of the MWSS's Central Laboratory Division, the percentage of satisfaction in the bacteriological examination on 1,714 water samples from MWSS house connections was 100%, while 747 samples from MWSS deepwells shows 78.4% satisfaction. (This is shown in Table 2.2.14.) On the other hand, the Process Quality Unit reported less satisfaction percentages for the same kind of examination. The residual chlorine of samples seems to be caused by low pressure in the distribution system, poor construction work of the service connections, and small distribution pipe sizes.

2.2.3 Ongoing and Proposed Projects

(1) Ongoing Projects

MWSS is implementing several rehabilitation and expansion projects with the twin aims of reducing non-revenue water (NRW) and increasing the number of service concessionaires (Table 2.2.15).

(2) Proposed Projects

Table 2.2.16 outlines the MWSS proposed projects. These projects are planned with the principal objectives of expanding the service area and augmenting the water production capacity.

2.2.4 Future Water Source and Production Capacity

(1) Water Source

Based on the implementation plans of ongoing projects, only the AWSOP can be expected to augment the yield of water sources by an annual average of 1.3 MCM/day or 15 m^3/sec. Several projects though are lined up by the MWSS to further augment the water sources yield: RPWSIP, UATP, MWSP III, MNEWSP (Table 2.2.17). However, these projects are still on the feasibility study or detailed design stage and financial sources for them have yet to be finalized. As such, their implementation schedules could only be tentative.

(2) Water Production

Since the completion of the La Mesa Treatment Plant in 1985, water production capacity of MWSS has remained at 2.636 MCM/day. Among MWSS's ongoing projects, only AWSOP is planned for augmenting this capacity through construction of the La Mesa Treatment Plant No. 2 with a capacity of 0.9 MCM/day.

Several courses for increasing supply are being resorted to. One involves the recovery of NRW. Targeted to be recovered by the MWSRP I and II are 0.765 MCM/day of NRW. As more than half of this amount is estimated to be taken up by leakage from the distribution lines, around 0.4 MCM/day of treated water will be available for consumption. Another course of increasing supply involves project proposals to augment water production capacity, but these are still on the feasibility study or detailed engineering stage.

The highest probability of being implemented among the MWSS proposed projects on increasing production capacity appears to fall on the MNEWSP. This project which will use Wawa River as water source is expected to contribute 72 MLD. Other projects propose utilization of Laguna de Bay and groundwater. For reasons of finances and the long construction period required, implementation of MWSP III has been deferred. This project could have been the biggest step yet to be taken in augmenting water production capacity.

TABLE 2.1.1 POPULATION AND GROWTH RATE BY REGION FOR CENSUS YEARS

	POPULATION (THOUSANDS)												GROWTH RATE (%)				
	1960		1970		1975		1980		1985 (Estimate)		1990		1960/ 1970	1970/ 1975	1975/ 1980	1980/ 1985	1985/ 1990
Philippines	27,088	100.0	36,684	100.0	42,071	100.0	48,098	100.0	54,688	100.0	60,685	100.0	3.1	2.8	2.7	2.6	2.4
NCR (National Capital Region)	2,462	9.1	3,697	10.8	4,970	11.8	5,296	12.3	6,942	12.7	7,929	13.1	4.9	4.6	3.6	3.2	3.1
Region																	
1. Ilocos	2,428	9.0	2,991	8.1	3,269	7.8	3,541	7.4	3,903	7.1	3,551	5.9	2.1	1.8	1.6	2.0	1.6
2. Cagayan Valley	1,202	4.4	1,691	4.6	1,933	4.6	2,215	4.6	2,521	4.6	2,341	3.9	3.5	2.7	2.8	2.6	2.0
3. Central Luzon	2,525	9.3	3,615	9.9	4,210	10.0	4,803	10.0	5,456	10.0	6,199	10.2	3.7	3.1	2.7	2.6	2.5
4. Southern Tagalog	3,081	11.4	4,457	12.1	5,214	12.4	6,119	12.7	7,089	13.0	8,266	13.6	3.8	3.2	3.3	3.0	3.0
5. Bicol	2,363	8.7	2,967	8.1	3,194	7.6	3,477	7.2	3,922	7.2	3,910	6.4	2.3	1.5	1.7	2.4	1.3
6. Western Visayas	3,078	11.4	3,618	9.9	4,146	9.8	4,526	9.4	5,092	9.3	5,393	8.9	1.6	2.8	1.8	2.4	1.8
7. Central Visayas	2,523	9.3	3,033	8.3	3,387	7.9	3,787	7.9	4,195	7.7	4,593	7.6	1.9	2.2	2.3	2.1	1.9
8. Eastern Visayas	2,041	7.5	2,381	6.5	2,600	6.2	2,799	5.8	2,073	5.6	3,055	5.0	1.6	1.8	1.5	1.9	0.9
9. Western Visayas	1,351	5.0	1,869	5.1	2,048	4.9	2,528	5.3	2,863	5.2	3,159	5.2	3.3	1.8	4.3	2.1	2.3
10. Northern Mindanao	1,297	4.8	1,953	5.3	2,314	5.5	2,759	5.7	3,718	5.8	3,510	5.8	4.2	3.5	3.6	2.9	2.3
11. Southern Mindanao	1,353	5.0	2,201	6.0	2,715	6.5	3,347	7.0	3,836	7.0	4,457	7.3	5.0	4.3	4.3	2.8	2.9
12. Central Mindanao	1,383	5.1	1,941	5.3	2,070	4.9	2,271	4.7	2,598	4.8	3,171	5.2	3.4	1.3	1.9	2.7	3.5

Source: 1960-1980 Philippine Statistical Yearbook 1989 (NEDA)
1985 Philippine Yearbook 1989 (NSO)
1990 1990 Census of Population and Housing (NSO)

TABLE 2.1.2 POPULATION DENSITY OF THE STUDY AREA

City/Municipality	POPULATION DENSITY (Persons/Ha.)				
	1970	1975	1980	1985	1990
NCR	62.4	78.1	93.2	109.2	123.2
1. Manila	347.5	386.2	425.7	461.1	414.4
2. Pasay	148.4	183.5	207.0	238.7	254.7
3. Quezon	45.4	57.6	70.1	82.9	98.2
4. Caloocan	49.2	71.2	83.8	97.4	133.7
5. Las Pinas	11.0	19.7	32.9	50.1	68.9
6. Makati	88.6	111.9	124.6	140.9	151.2
7. Malabon	60.5	74.7	81.6	94.1	118.4
8. Mandaluyong	57.5	70.1	79.0	89.9	95.0
9. Marikina	29.2	43.3	54.4	66.8	79.2
10. Muntinlupa	13.9	20.2	29.3	39.3	59.5
11. Navotas	320.2	373.5	485.2	566.8	715.4
12. Paranaque	25.4	41.5	54.5	69.6	78.3
13. Pasig	120.4	161.5	206.6	257.5	303.8
14. Pateros	24.5	31.6	38.7	46.5	49.0
15. San Juan	100.5	117.8	125.1	137.0	122.1
16. Taguig	16.4	21.9	39.8	49.3	79.2
17. Valenzuela	20.9	32.0	45.2	61.8	72.3
CAVITE	12.4	14.4	17.5	21.0	24.7
18. Bacoor	9.2	11.9	17.2	22.3	30.6
19. Cavite City	64.0	69.7	74.1	81.7	77.5
20. Imus	4.5	5.0	6.1	7.4	9.5
21. Kawit	21.1	25.2	29.4	35.3	35.6
22. Noveleta	19.5	22.4	26.7	31.6	40.0
23. Rosario	42.0	50.7	58.8	71.5	80.0
RIZAL	2.4	3.2	4.3	5.2	6.8
24. Angono	4.7	6.8	10.2	13.0	17.5
25. Antipolo	0.9	1.3	2.3	3.0	5.7
26. Baras	3.1	4.2	4.8	5.7	7.1
27. Binangonan	7.2	8.7	11.1	12.9	12.8
28. Cainta	20.3	36.3	57.9	81.2	107.5
29. Cardona	5.4	6.8	7.9	8.8	10.5
30. Jala-Jala	1.6	1.9	2.4	2.8	3.3
31. Morong	5.0	5.6	6.6	7.0	8.6
32. Pililla	2.0	2.6	3.1	3.6	4.4
33. Montalban	0.7	1.0	1.3	1.6	2.0
34. San Mateo	4.5	6.0	8.0	9.5	12.6
35. Tanay	1.0	1.4	1.7	2.0	2.0
36. Taytay	13.8	17.3	22.3	25.6	33.3
37. Teresa	5.0	7.2	7.9	8.6	11.1

TABLE 2.1.3 REGIONAL SOCIAL PROFILE

	CBR 1986	CDR 1987	IMR 1986	LITERACY RATE 1989	PREVAL. RATE 1989	UNEMPL. RATE(%) 1985
Philippines	26.70	5.80	35.00	89.90	19.42	7.12
NCR	32.10	7.00	33.40	98.10	9.44	22.11
CAR	-	-	-	86.30	17.07	-
Region I	29.40	7.00	37.70	90.60	19.87	3.65
Region II	27.90	5.80	43.60	88.50	17.41	5.76
Region III	28.50	5.50	29.60	93.60	18.70	6.91
Region IV	28.70	6.30	37.30	93.00	20.15	6.56
Region V	27.40	7.30	41.40	87.60	27.53	2.97
Region VI	20.20	6.20	43.50	88.00	22.77	4.52
Region VII	27.80	6.50	35.20	88.00	17.07	3.38
Region VIII	18.40	5.80	41.00	81.00	28.57	5.53
Region IX	19.10	3.30	32.40	81.70	16.85	6.55
Region X	28.40	4.90	33.20	90.50	19.04	4.20
Region XI	30.10	4.40	23.00	90.40	17.21	5.17
Region XII	18.30	2.70	25.30	78.9	19.46	1.99

Notes:

CBR - Crude Birth Rate per 1,000 population
CDR - Crude Death Rate per 1,000 population
IMR - Infant Mortality Rate per 1,000 population
LITERACY RATE - For the household population 10 years old and above
PREVALENCE RATE -

Sources: 1989 Philippine Statistical Yearbook, NSCB
1989 Functional Literacy, Education and Mass Media Survey, Department of Health

TABLE 2.1.4 HOUSEHOLD POPULATION 15 YEARS OLD AND OVER BY EMPLOYMENT STATUS AND BY REGION

Region	1986				1988			
	Number ('000)	% in Labor Force	Employment Rate %	Unemployment Rate %	Number ('000)	% in Labor Force	Employment Rate %	Unemployment Rate %
Philippines	33,838	63.8	88.9	11.1	35,865	65.4	91.7	8.3
Region IV	4,558	63.8	87.0	13.0	4,729	64.6	91.8	8.2
NCR	4,727	58.6	71.4	28.6	5,005	60.2	82.8	17.2
Cavite (*)	606	54.6	94.3	5.8	657	54.5	96.4	3.6
Rizal	455	62.2	84.8	15.2	480	67.7	91.1	8.9
Total	5,788	58.5	74.8	25.2	6,142	60.2	84.8	15.2

* All Cavite Province. The numbers are not applicable for the Study Area, but may be used as reference however.

Source: National Statistic Office (NSO), Region IV

TABLE 2.1.5 GROSS REGIONAL DOMESTIC PRODUCT, FOR 1987-1988
(at constant 1972 prices)

REGION	Actual (in PM)		Growth Rate	Per Capita GRDP (in P)	Growth Rate (in %)
	1987	1988*	1987-1988	1988	1987-1988
PHIL.	95,948	101,758	6.63	1,733	3.56
NCR	28,502	31,323	9.90	4,143	6.89
I	4,323	4,507	4.25	1,090	2.28
II	2,301	2,432	5.70	897	3.16
III	7,664	8,286	8.12	1,413	5.59
IV	14,221	14,929	4.97	1,941	2.19
V	3,120	3,257	4.41	776	2.09
VI	6,545	6,902	5.44	1,269	3.19
VII	6,905	7,421	7.48	1,669	5.45
VIII	2,323	2,383	2.60	735	0.76
IX	3,350	3,492	4.24	1,141	1.96
X	5,248	5,570	6.13	1,620	3.41
XI	7,082	7,186	1.47	1,739	-0.98
XII	3,844	4,064	5.74	1,451	3.14

(*) As of January 1989

Sources: Economic and Social Statistics Office
National Statistical Coordination Board

TABLE 2.1.6 FAMILY INCOME DISTRIBUTION AND SOURCES

Income Distribution (Unit: %)

Region/Province	Average Family Income (in Peso)	Below P 10,000	P 10,000 19,999	Below P 19,999 Sub-Total	P 20,000 39,999	Above P40,000
REGION IV	29.985	12.7	33.1	45.8	33.2	21.0
Cavite	39.759	0.0	16.2	16.2	48.3	35.5
Rizal	38.517	4.9	35.5	40.4	30.9	28.7
METRO MANILA	57.193	1.5	11.9	13.4	37.0	49.6
PHILIPPINES	31.052	15.2	33.7	48.9	30.7	20.4

Income Sources (Unit: %)

Region/Province	Wages and Salaries Agriculture	Wages and Salaries Non-Agriculture	Entrepreneurial Activities Agriculture	Entrepreneurial Activities Non-Agriculture	Other Income Sources
REGION IV	10.30	35.97	24.00	11.21	18.53
Cavite	4.00	67.48	6.20	7.39	14.39
Rizal	8.57	44.89	17.09	13.71	15.73
METRO MANILA	0.50	57.96	0.09	16.60	24.85
PHILIPPINES	9.20	31.24	28.62	12.40	18.54

Source: 1985 Family Income and Expenditures Survey (NSO)

TABLE 2.1.7 NUMBER OF FAMILIES BY TYPE OF BUILDING OCCUPIED, PHILIPPINES, NCR AND REGION IV, 1985

Area/Region	Total Number of families	Type of Building					
		Single House	Duplex	Apartment/ accesoria/ condominium	Improvised (Barong-Barong)	Commercial/ industrial/ agricultural	Other housing units, natural shelter, boat, etc.
Philippines	9,847,340	8,830,688	234,349	409,406	313,960	49,371	9,566
Metro Manila Area (NCR)	1,310,549	879,680	55,408	283,357	63,492	23,662	4,950
IV. Southern Tagalog	1,303,730	1,199,302	42,645	19,894	37,563	2,723	1,603

Source: 1985 Family Income and Expenditures Survey (NSO)

TABLE 2.2.1 PRESENT WATER SUPPLY COVERAGE: 1987

(million)

Area	Total Population	(%)	Population Served						Underserved/ Unserved Population	(%)
			Total	(%)	Wells/Developed Spring	(%)	Piped System	(%)		
Philippines	57.36	100	36.17	63	17.92	31	18.25	32	21.19	37
Urban	23.53	100	15.39	65	12.52	53	2.87	12	8.14	35
Metro Manila and and its contiguous area*	8.16	100	7.01	86	6.84	84	0.17	2	1.15	14
Others	15.37	100	8.38	55	5.68	37	2.70	18	6.99	45
Rural	33.83	100	20.78	62	5.40	16	15.38	46	13.05	38

* Excluding the 303,433 population of the towns of Rizal province under BP 799.

Source: Department of Public Works and Highways, Water Supply, Sewerage, and Sanitation Master Plan of the Philippines: 1988-2000.

TABLE 2.2.2 NUMBER OF FAMILIES BY MAIN SOURCE OF WATER SUPPLY, BY REGION, URBAN AND RURAL: 1985

Area/Region	Total Number of Families	Faucet inside the house/yard community wtr.system	Faucet, other community water system	Tubed /piped well, own use	Tubed /piped well, others	Dug well	Spring, river, stream, etc.	Rain	Peddler
Philippines	9,847,339	1,853,841	1,723,961	1,678,497	1,631,065	1,702,881	929,892	118,825	208,378
	(100%)	(19)	(13)	(17)	(17)	(17)	(9)	(1)	(2)
Urban	3,726,049	1,462,080	777,429	517,756	478,673	244,330	59,765	14,505	171,511
	(100%)	(39)	(21)	(14)	(13)	(7)	(2)	(0)	(5)
Rural	6,121,290	391,761	946,532	1,160,740	1,152,392	1,458,551	870,126	104,321	36,867
	(100%)	(6)	(15)	(19)	(19)	(24)	(14)	(2)	(1)
Metro Manila Area (NCR)	1,310,549	738,297	292,377	61,783	65,789	32,978	-	-	119,325
	(100%)	(56)	(22)	(5)	(5)	(3)	(-)	(-)	(9)
I. Ilocos	711,232	100,683	90,894	216,201	173,249	94,134	35,529	542	-
II. Cagayan Valley	462,088	18,195	12,915	166,107	127,900	103,281	31,901	1,364	426
III. Central Luzon	956,921	181,438	103,870	380,517	255,389	16,978	14,752	-	3,978
IV. Southern Tagalog	1,303,729	227,001	287,491	256,822	222,193	205,930	100,253	1,294	2,745
	(100%)	(17)	(22)	(20)	(17)	(16)	(8)	(0)	(0)
V. Bicol	668,473	104,311	132,255	88,488	65,793	182,640	86,157	-	8,830
VI. Western Visayas	881,554	70,807	120,490	109,445	119,298	360,119	85,821	9,045	6,530
VII. Central Visayas	783,846	99,975	138,570	60,326	148,001	166,741	116,040	20,760	33,433
VIII. Eastern Visayas	567,496	53,634	157,361	39,594	112,786	137,640	60,793	693	4,996
IX. Western Mindanao	494,818	37,418	72,497	38,272	51,003	174,204	104,750	6,094	10,580
X. Northern Mindanao	565,270	109,462	171,727	23,622	54,236	98,859	99,104	5,778	2,482
XI. Southern Mindanao	705,453	84,995	94,402	160,893	174,835	46,363	64,590	70,553	8,823
XII. Central Mindanao	435,911	27,625	49,111	76,429	60,595	83,015	130,203	2,701	6,231

* Bracketed figures indicate percentages to total number of families.

Source: National Statistics Office, 1985 Family Income and Expenditures Survey.

TABLE 2.2.3 EXISTING WATER SUPPLY FACILITIES: 1987

Area	Type of Facility	Number	Population Served	Total Population	Percent of Population served
Metro Manila and its contiguous areas	Dams	4	7,008,000	8,160,000	86%
	Tunnels	2	-		-
	Aqueducts	7	-		-
	Treatment plants	2	-		-
	Balancing Reservoir	2	-		-
	Pipelines	3,000	-		-
	Pumping stations and reservoir	9	-		-
	Active deepwells	118	-		-
	Fire hydrants	2,350	-		-
	House Service Connection	543,900	-		-
Other urban areas	Waterworks systems (Level III)	214	3,970,000	15,370,000	26%
	Communal faucet systems (Level II)	1,900	1,710,000		11%
	Point sources (Level I)	9,000	2,700,000		18%
Rural areas	Piped systems (Level II & III)	3,232	5,400,000	33,830,000	16%
	Shallow wells	464,678	15,380,000		46%
	Deep wells	193,404			
	Developed springs	9,726			
			36,168,000	57,360,000	63%

Source: Department of Public Works and Highways, Water Supply, Sewerage and Sanitation Master Master Plan of the Philippines: 1988-2000.

TABLE 2.2.4 RESPONSIBILITY OF GOVERNMENTAL AGENCIES

Coverage Area / Responsibility Area / Agency	Metro Manila & its Contiguous Areas			Other Urban and Rural Areas			
	MWSS	DPWH	NWRB	LWUA	DPWH	DLG	NWRB
PLANNING	X (Area Wide)	Sector	C	Other Urban & Rural Areas (Area Wide)	Sector		C
PROGRAMMING	X			L-II/III	L-I Source Dev.	L-I	
FINANCING	X			X	X	X	
INSTITUTIONAL	X			X	Interim	Interim	
ENGINEERING	X			X	X	X	
CONSTRUCTION	X			L-II/III Source Dev.	L-I	L-I	
OPERATION AND MAINTENANCE	X			WD/ RWSA			

X - Directly Responsible
C - Coordination

Source: Department of Public Works and Highways, Water Supply, Sewerage, and Sanitation Master Plan of the Philippines: 1988-2000.

TABLE 2.2.5 PHYSICAL TARGETS, INVESTMENT REQUIREMENTS AND SERVICE COVERAGE, FIRST STAGE (1988-1992)

Particulars	Implementing Agency	Physical Targets	Investment Requirements (million P)	Population Served (million)		% of Population Served	
				Additional	Cumulative	Additional	Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WATER SUPPLY			21,691.85				87
I. Metro Manila and its Contiguous Areas			9,568.85	1.440	8.448	4	87
1. Manila Water Supply Rehabilitation Project I	MWSS	- Replacement of 131,000 house con. - Removal 28,000 spaghetti con. - Replacement of 200 km. pipelines - Installation of 600 flow rec. stations - Replacement of 108,000 pcs. water mts. - Repair of 22,500 pcs. water meters - Installation of 12,000 pcs. new water meters - Repair of 300 pcs. valves - Replacement of 2.25 pcs. valve	973.57				
2. Metro Manila Water Distribution Project		- Const. of 28 km. new pipelines - Inst. of 100,000 new house con. - Intercon. 72 sub. to serve 15,600 households - Infilling of 24 areas with secondary and tertiary pipelines - Const. of tertiary pipelines for 160 low-income areas - Drilling and equipping of 5 new deep wells	829.51				
3. Manila Water Supply Project II		- Completion of ongoing works	176.08				
4. Angat Water Supply Optimization Project		- Const. of new 6.4 km. tunnel - Const. of new 16.3 km. aqueduct - Expansion of La Mesa Treatment Plant - Const./Inst. of distribution pipelines pumping stations and reservoir - Inst. of additional house service connections	5,363.10				
5. Manila Water Supply Rehabilitation Project II		- Replacement of 104,000 house con. - - Removal of 13,000 spaghetti con. - Replacement of 50 km. pipelines Inst. of 1,040 flow rec. stations connections - Repair of 7,280 pcs. water meters - Installation of 3,120 water meters - Inst. of 1,560 new valves - Replacement of 11,440 water meters Repair or replacement of 1,560 valves	1,043.40				
6. Fringe Areas Water Supply Project		- Construction of deep wells - Const./Inst. of pipelines - Rehab. of existing facilities Inst. of new house service connection	1,021.55				
7. Water Supply Development in Rizal		- Const. of shallow and deep wells - Const./Inst. of pipelines - Development of springs Installation of house service connection	161.64				
II. Other Urban Areas	LWUA, DLG	- Construction of: 450 Piped Systems 450 Piped Systems (L-II/III) Repair/Rehab. of 250 systems	4,367.00 3,943.00 424.00	4.913 4.913	13.766	22	77
III. Rural Areas	DPWH, DLG, LWUA	- Construction of: 933 Piped Systems 933 Piped Systems (L-II/III) 87.46 Point Sources (L-I) Repair/Rehab. of 21,620 systems	7,756.00 1,668.00 5,990.00 98.00	13.723 0.473 13.25	34.030	30	92

Source: Department of Public Works and Highways, Water Supply, Sewerage and Sanitation Master Plan of the Philippines: 1988-2000.

TABLE 2.2.6 PHYSICAL TARGETS, INVESTMENT REQUIREMENTS AND SERVICE COVERAGE, SECOND STAGE (1993-2000)

Particulars	Implementing Agency	Physical Targets	Investment Requirements (million P)	Population Served (million)		% of Population Served	
				Additional	Cumulative	Additional	Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WATER SUPPLY							
I. Metro Manila and its Contiguous Areas			22,689.21				94
1. Manila Water Supply Rehabilitation Project III	MWSS	- Const. of 113 meters rockfilled dam - Const. of 2,400 mid treatment plant - Const. of 14 km tunnel - Const. of 23.2 mega watts hydro-electric plant - Const. of pumping stations and reservoirs - Const. of about 500 km. pipelines - Installation of 170,000 new house service connections	129,000.00	2.705	11.153	10	97
II. Other Urban Areas	LWUA	- Construction of: 654 Piped Systems (L-II/III) Repair/Rehab. of 350 systems	6,915.00 6,321.00 594.00	9.025 9.025	23.506	18	95
III. Rural Areas	DPWH, LWUA	- Construction of: 794 Piped Systems (L-II/III) 13,340 Point Sources (L-I) Repair/Rehab. of 21,000 systems Replacement of 9,500 systems	2,874.21 1,929.00 755.46 161.25 28.50	2.715 0.715 2	36.030	1	93

Source: Department of Public Works and Highways, Water Supply, Sewerage and Sanitation Master Plan of the Philippines: 1988-2000.

TABLE 2.2.7 MWSS WATER SUPPLY STATISTICS, 1984 TO 1990

Year	1984	1985	1986	1987	1988	1989	1990
1) Pop'n under MWSS (million)	7.480	7.712	7.938	8.167	8.405	8.651	9.133
2) Water Production							
a) Surface Water (million m3)	642.24	757.37	874.07	834.75	849.34	859.10	875.80
b) Groundwater (million m3)	25.56	29.45	30.43	27.87	29.48	28.96	33.33
Total	667.80	786.83	904.51	862.62	878.82	888.06	909.13
Increase	-	119.03	117.68	(41.89)	16.20	9.24	21.07
3) Water Comsumption							
a) Volume Sold (million m3)	289.90	302.85	310.78	336.51	359.45	375.77	384.67
%	43.4%	38.5%	34.4%	39.0%	40.9%	42.3%	42.3%
b) NRW (million m3)	377.90	483.98	593.73	526.11	519.37	512.29	524.46
%	56.6%	61.5%	65.6%	61.0%	59.1%	57.7%	57.7%
Total	667.80	786.83	904.51	862.62	878.82	888.06	909.13
c) House Connection (mil. m3)	168.55	183.55	195.47	218.48	225.85	235.74	244.97
d) P.F. & Other Conn. (mil. m3)	121.35	119.30	115.31	118.03	133.60	140.03	139.70
e) Illegal Use (mil. m3)	151.16	193.59	237.49	210.44	207.75	204.92	209.78
Sub Total	441.06	496.44	548.27	546.95	567.20	580.69	594.45
%	66.0%	63.1%	60.6%	63.4%	64.5%	65.4%	65.4%
f) Leak, Meter Error (mil. m3)	226.74	290.39	356.24	315.67	311.62	307.37	314.68
%	34.0%	36.9%	39.4%	36.6%	35.5%	34.6%	34.6%
Total	667.80	786.83	904.51	862.62	878.82	888.06	909.13
4) Number of Connections							
a) House Connection	321,512	377,538	442,323	490,223	508,545	543,128	599,754
b) Public Faucet	1,020	1,080	1,160	1,230	1,300	1,420	1,490
c) Others	27,039	27,368	26,919	26,703	44,688	43,910	47,343
Total	349,571	405,986	470,402	518,156	554,533	588,458	648,587
Increase	-	56,415	64,416	47,754	36,377	33,925	60,129
5) Estimated Population Served							
a) House Connection (million)	2.604	3.058	3.583	3.971	4.119	4.399	4.858
b) Public Faucet (million)	0.496	0.525	0.564	0.598	0.632	0.690	0.724
Sub Total	3.100	3.583	4.147	4.569	4.751	5.089	5.582
Increase	-	0.483	0.564	0.422	0.182	0.338	0.493
c) Illegal Use (million)	1.358	1.955	2.738	2.483	2.381	2.399	2.649
Total	4.458	5.538	6.884	7.052	7.132	7.489	8.232
Increase	-	1.080	1.347	0.167	0.080	0.357	0.743
6) Per Capita Water Consumption (lpcd)							
a) for distributed water	410	389	360	335	338	325	303
b) for effective water	271	246	218	212	218	212	198
c) for domestic water	177	164	149	151	150	147	138

Note: 5a = 4a x 8.1, 5b = 4b x 486, 5c = (3b x 0.4 x (3c/3a)) / (3c/4a) x 8.1
6a = (3a+3b) / (5a+5b+5c), 6b = (3c+3d+3e) / (5a+5b+5c), 6c = 3c / 5a

Source: Corporate Planning Group

TABLE 2.2.8 CAPACITY OF WATER SOURCES

Source		Area of Watershed (km^2)	Water Right or Capacity (m^3/day)	Status
Angat Dam (Angat River)		568	1,901,000 1/	Used
Ipo Dam (Angat River, Ipo River)	Old	-	(Submerged by New Dam)	
	New	70	474,000 2/	Used
La Mesa Dam (Novaliches Watershed)		27	100,000 3/	Used
Alat Diversion Dam (Alat River)		14	20,000 4/	Used
Marikina River Pumping Stations 5/	1st	-	189,000	Abandoned
	2nd	-	189,000	Abandoned
Wawa Dam (Wawa River)		280	57,000	Abandoned
Groundwater			82,000 6/	Used
Total			3,012,000 m^3/day	
	Used w/o Groundwater		2,495,000 m^3/day	

1/: Allocated, 22 CMS
2/: AWSOP; derived from catchment area, rainfall, and permeability coefficient
3/: AWSOP; calculated based on water balance
4/: AWSOP; based on measurement
5/: Abandoned due to bad water quality
6/: Annual average pumpage of MWSS-owned deep wells

TABLE 2.2.9 RAW WATER DRAWN FROM SURFACE WATER SOURCES

(thousand m^3)

year	1986	1987	1988	1989	1990
Total	879,956.2	877,733.1	871,413.4	899,157.9	916,875.4
Daily Avg.	2,410.8	2,404.7	2,387.4	2,463.5	2,512.0

Source: MWSS Annual Report 1986, 1987, 1988, 1989, 1990

TABLE 2.2.10 DRAWN RAW WATER BY MONTH: 1990

MONTH 1990	RAW WATER				RECOVERED WASH WATER	TOTAL TREATED WATER
	ANGAT DAM	IPO/ALAT/ LA MESA DAM	MARIKINA PUMP STN.	SUB-TOTAL		
1	65,876,000	8,072,900	0	73,948,900	2,286,000	76,234,900
2	62,673,400	2,017,800	0	64,691,200	2,153,000	66,844,200
3	71,790,700	60,600	0	71,851,300	2,466,800	74,318,100
4	67,951,100	458,900	0	68,410,000	2,299,200	70,709,200
5	71,517,200	(1,688,700)	0	69,828,500	2,794,500	72,623,000
6	51,647,000	17,343,700	0	68,990,700	1,981,500	70,972,200
7	43,104,200	33,127,900	0	76,232,100	2,478,500	78,710,600
8	35,250,800	44,201,900	0	79,452,700	1,405,600	80,858,300
9	74,386,800	5,815,500	0	80,202,300	1,811,700	82,014,000
10	58,703,900	22,451,300	0	81,155,200	2,669,900	83,825,100
11	57,995,300	19,112,600	0	77,107,900	2,398,700	79,506,600
12	67,467,400	10,420,800	0	77,888,200	2,474,400	80,362,600
TOTAL	728,363,800	161,395,200	0	889,759,000	27,219,800	916,978,800
DAILY AVG.	1,995,517	442,179	0	2,437,696	74,575	2,512,271
%	81.9%	18.1%	0	100.0%	-	-
1989						
TOTAL	703,683,900	170,540,000	0	874,223,900	24,961,000	899,184,900
DAILY AVG.	1,927,901	467,233	0	2,395,134	68,386	2,463,520
%	80.5%	19.5%	0	100.0%	-	-

Source: Weekly Status of Water Production and Elevations, Water Sources and Treatment Dept., MWSS

TABLE 2.2.11 MWSS WATER PRODUCTION: 1985 TO 1990

(unit: m^3)

Year	Treated Surface Water			Groundwater from Wells			Total
	Balara T.P.	La Mesa T.P.	Sub Total	Manila & Suburbs	Cavite Waterworks	Sub-Total	
1985	480,875,282	276,501,100	757,376,382	22,934,495	6,519,749	29,454,244	786,830,626
1986	534,394,436	339,681,600	874,076,036	22,840,692	7,590,881	30,431,573	904,507,519
1987	521,429,600	313,332,400	834,762,000	19,816,742	8,055,750	27,872,492	862,634,492
1988	509,568,000	339,772,700	849,340,700	21,418,094	8,059,931	29,478,025	878,818,725
1989	511,068,700	348,015,800	859,084,500	20,989,504	7,977,002	28,966,506	888,051,066
1990	504,033,800	371,767,600	875,801,400	22,553,080	10,773,164	33,326,244	909,127,644
AVG.	510,228,303	331,511,867	841,740,170	21,758,768	8,162,746	29,921,514	871,661,684
Daily.	1,397,886	908,252	2,306,138	59,613	22,364	81,977	2,388,115

Source: Water Sources & Treatment Dept., MWSS

TABLE 2.2.12 OUTLINE OF TREATMENT PLANTS

	Balara Treatment Plant		La Mesa Treatment Plant
	No.1	NO.2	
Year Completed	: 1935	: 1958	: 1985
Location	: Balara, Quezon City	: same as left	: Novaliches, Quezon City
Design Capacity	: 100 MGD (Normal) = 378,000 m^3/d 125 MGD (Maximum) = 473,000 m^3/d	: 200 MGD (Normal) = 757,000 m^3/d 300 MGD (Maximum) = 1,136,000 m^3/d	: 1,500,000 m^3/d
Chemical Mixing	: Hydraulic Jump	: Rapid Mixing 2 units	: Flush Mixer 6 units
Coagulant Used	: Alum	: Alum	: Ferric Chloride/Alum/Polymer
Flocculation Basin	: 2 units	: 12 units	: 72 units
Volume	: 2,016 m^3	: 20,300 m^3	: 20,736 m^3 (8x8x4.5x72)
Detention Time	: 2,016 / (378,000-132,000) = 11.8 min.	: 20,300 /757,000 = 38.6 min.	: 20,736 / 1,500,000 = 19.9 min.
Sedimentation Basin	: 2 units	: 12 units	: 12 units
Volume	: 4 MG/unit x 2 = 30,000 m^3 (210 x 21 x 3.8 m x 2 units)	: 106,000 m^3 (73.2 x 18.3 x 6.0 x 6) 73.2 x 18.3 x 7.2 x 6)	: 83,800 m^3 (16 x 97 x (4.5 + 1.5) x 12)
Detention Time	: 189 min.	: 201 min.	: 80 min.
Accelator	: 2 units	: -	: -
Capacity	: 17.5 MGD/unit (Normal) = 132,000 m^3/d 25.0 MGD/unit (Maximum) = 189,000 m^3/d	: -	: -
Coagulant Used	: Ferric Chloride/Alum/Polymer	: -	: -
Filter	: 10 units	: 20 units	: 24 units
Type	: Dual Media Rapid Sand Filter	: same as left	: 3 layer RSF
Filtration Area	: 162 m^2/unit	: 162 m^2/unit	: 180 m^2/unit
Capacity	: 12.5 MGD/unit = 47,300 m^3/d/unit	: 10 MGD/unit = 37,800 m^3/d/unit 15 MGD/unit (Maximum)	: 62,640 m^3/d/unit
Filt. Velocity	: 290 m/d	: 233 m/d	: 348 m/d

Source: Water Distribution & Maintenance Dept.

TABLE 2.2.13 PHYSICAL AND CHEMICAL ANALYSES AT MWSS TREATMENT PLANTS
(FROM JANUARY 1 TO DECEMBER 31, 1989)

SAMPLE		pH	Turbidity units	Acidity mg/l	Free CO2 mg/l	Alkalinity mg/l	Bicarbonates mg/l	Hardness mg/l	Chlorides mg/l	Iron mg/l	Residual Chlorine mg/l
Balara Treatment Plant											
Raw Water	Avg.	7.38	19.23	9.10	8.00	54.26	66.20	50.94	7.02	0.15	
	Min.	7.15	6.16	7.15	6.29	51.38	62.68	44.94	5.21	0.09	
	Max.	7.49	49.40	10.33	9.09	58.67	71.58	53.73	8.22	0.25	
Treated	Avg.	7.13	15.38	8.63	7.59	52.06	63.44	50.71	6.93		
	Min.	6.76	5.98	6.80	5.98	48.80	59.53	45.79	5.26		
	Max.	7.36	44.22	10.93	9.61	56.83	69.33	56.50	9.19		
Influent	Avg.	7.10	8.51	8.57	7.54	52.33	63.84	51.00	7.02		
	Min.	6.76	6.07	7.38	6.49	48.26	58.88	45.68	5.68		
	Max.	7.35	15.66	10.48	9.22	57.67	70.36	53.27	9.15		
Filtered Water	Avg.	7.08	3.51	7.91	6.96	51.79	63.18	51.39	7.09		
	Min.	6.86	2.79	7.00	6.16	48.78	59.51	44.78	4.67		
	Max.	7.36	6.39	10.06	8.85	56.33	68.72	56.20	9.41		
Finished Water	Avg.	7.10	3.62	8.13	7.15	51.73	63.11	51.10	7.40	0.07	0.52
	Min.	6.76	2.77	6.76	5.94	49.38	60.24	46.18	5.82	0.05	0.31
	Max.	7.32	6.21	10.23	9.00	57.18	69.76	53.25	11.00	0.08	0.73
La Mesa Treatment Plant											
Raw Water	Avg.	7.22	16.92	11.62	10.23	69.06	84.25	53.08	4.37	0.08	
	Min.	7.16	5.16	10.13	8.91	57.43	70.07	47.94	3.16	0.05	
	Max.	7.30	40.93	13.37	11.76	85.68	104.53	67.00	6.24	0.20	
Treated	Avg.	7.06	17.72	11.54	10.18	65.51	79.92	52.80	4.71	0.09	
(Before Settlement)	Min.	6.97	4.53	10.12	9.08	54.77	66.82	48.97	3.76	0.05	
	Max.	7.19	61.75	13.92	12.55	77.00	93.94	68.25	6.08	0.29	
Influent	Avg.	7.05	6.14	11.58	9.25	64.86	79.12	52.71	5.67	0.05	0.96
(Settled)	Min.	6.96	3.41	10.29	9.06	52.84	64.46	47.71	4.87	0.05	0.90
	Max.	7.15	13.75	13.52	11.37	73.90	90.16	68.00	7.30	0.06	1.07
Filtered Water	Avg.	7.06	1.92	11.21	9.87	63.94	78.00	52.32	5.72	0.05	0.71
	Min.	6.98	1.15	9.26	8.15	53.77	65.60	45.90	4.81	0.05	0.61
	Max.	7.16	3.92	13.15	11.57	72.13	88.00	68.25	7.36	0.05	0.78
Finished Water	Avg.	7.07	2.01	11.07	9.73	64.10	78.44	52.17	5.71	0.05	0.78
	Min.	6.99	1.12	9.59	8.44	53.87	65.72	48.06	4.65	0.05	0.61
	Max.	7.17	4.78	13.17	11.59	71.58	87.33	67.00	7.16	0.05	0.80
Bagbag Reservoir	Avg.	7.09	1.56	11.29	9.94	63.48	78.09	52.48	5.60		0.22
	Min.	7.04	1.09	10.10	8.89	54.00	65.88	47.66	4.85		0.14
	Max.	7.16	2.46	13.03	11.47	71.95	87.78	69.05	6.11		0.32

TABLE 2.2.14 RESULTS OF BACTERIOLOGICAL QUALITY ANALYSIS (FROM JANUARY 1 TO DECEMBER 31, 1989)

Location	Total No.of	No.of Samples of Samples	Percentage of w/ MPN <2.2	Avg. Residual Satisfaction	Chlorine mg/l
Central Labo. Div.	MWSS Tap Water from Manila City	1,026	1,026	100.0%	0.33 range(0.30-0.43)
	MWSS Tap Water from Other Cities and Municipalities	688	688	100.0%	0.34 (0.20-0.61)
	MWSS Deepwells	735	576	78.4%	0.33 (0.20-0.40)
Process Quality Unit	Manila Tap Water	922	861	93.3%	0.32 (0.13-0.44)
	Suburbs Tap Water	629	445	70.7%	0.19 (0.09-0.85)

TABLE 2.2.15 ONGOING PROJECTS OF MWSS

PROJECT	EXPECTED VOL. TO BE INCREASED /RECOVERED	IMPLEMENTATION SCHEDULE START/ COMPLETE	TOTAL PROJECT COST	SOURCES OF FUND	PROJECT COMPONENTS	REMARKS
Manila Water Supply Rehabilitation Project I (MWSRP I)	NRW Recovery 500 MLD	1983/1991	P 1832.91 M	CC =P 794.00 M ADB =$ 29.16 M	- Replacement of 150 kms. tertiary distribution lines - Installation of 280 public faucets - Construction of 50 kms. new tertiary dist. lines - Construction and replacement of 108,000 house service connections - Relocation of 12,000 water meters	completed in 1991
Manila Water Supply Rehabilitation Project II (MWSRP II)	NRW Recovery 265 MLD	1988/1992	P 1376.52 M	ADB 947=$ 26.40 M OBP =P400.00 M CC =P 89.23 M Equity=P 172.15 M	- Replacement of 1,000 kms. tertiary distribution lines - Installation of 285 public faucets - Construction of tertiary dist. lines - Construction and replacement of 87,121 water meters	
Metropolitan Manila Water Distribution Project (MMWDP)	-	1986/1992	P 1,111.76 M	CC =P509.68 M IBRD 2676=$ 24.53 M	- Construction of 280 kms. dist. lines - Construction of 100,000 house service connections (including interconnection of 72 sub-divisions)	
Angat Water Supply Optimization Project (AWSOP)	Increase 1,300 MLD (Angat R1v.)	1989/1994	P 8,400 M	IBRD 3124=$ 40.00 M ADB 986 =$ 103.70 M OECF =$ 80.00 M Bonds =P1,300.00 M CC =P 27.19 M Equity =P2,121.69 M	- Auxiliary Unit Powerhouse - 6.1 kms. tunnel - 900 MLD Water Treatment Plant - 16 kms. Aqueduct - 4 Treated Water Reservoirs - 11 Pumping Stations upgrading work - 4 Pumping Stations construction work - 137 kms. primary dist. lines - 178 kms. secondary dist. lines - 360,000 house service connections - La Mesa By-ass Aqueduct	
Locally Funded Project			P 100 M (annualy)	Local = P 100 M	- normal act. including improvement, expansion, replacement, interconnection, and other miscellaneous works that fall outside of ongoing foreign assisted projects	

SOURCE: 1) FCBD - PCK used in 1991 Budget
(FCBD -Financial control and Budget Department)
(PCK - Project Cost Estimate)
2) PPD - Engineering Area Project Cost Estimates for Total Project Costs
(PPD - Planning and Programming Department)

TABLE 2.2.16 PROPOSED PROJECTS OF MWSS

PROJECT	EXPECTED VOL. TO BE INCREASED /RECOVERED	IMPLEMENTATION SCHEDULE START/COMPLETE	TOTAL PROJECT COST (mil. P)	FUND ALLOCATION Activity	L.C. (mil. P)	F.C. (mil. $)	PROJECT COMPONENTS	REMARKS
Rizal Province Water Supply Improvement Project (RPWSIP)	Increase 48 MLD (37-Laguna de Bay 11-Groundwater)	1991/1998	895.1		667.06	7.93	- Intake structure - Water Treatment Plant - Pumping Station - Reservoir - Distribution Pipeline - Deep Wells - Elevated Tanks - Distribution Tanks	On-going detailed engineering construction '92
Fringe Areas Water Supply Project (FAWSP)	Groundwater	1989/1993	252.4	F/S D/S C	38.00 10.00 204.51		- Deepwells (construction and rehabilitation) - Pump Stations - Distribution Network - 40,000 House Service Connections	On-going test wells construction as part of F.S. Construction April '91
Metro Manila Groundwater Dev't. Project (MMGWDP)	-	1990/1992	90	F/S	14.92	2.7	- Execution of study on groundwater development	On-going development study
Umiray-Angat Transbasin Project (UATP)	Increase 800 MLD (Umiray River)	1991/1995	2,454	F/S D/S C	3.50 7.30 800.00	1.27 8.86 44.73	- Diversion Dam - Tunnel/Aqueduct - Watershed Erosion Control	Technical assistance started February 1991 construction June'93
Manila South Water Distribution Project (MSWDP)		1991/1993	1,707		1,311.50	13.42	- Clean Water Reservoirs - Booster Pumping Stations - 52.8 kms. Primary Dist. Network - 220 kms. Secondary and Tertiary Dist. Network - 99,100 House Service Connections	On-going detailed engineering
Manila Water Supply Project III (MWSP III)	Increase 1,900 MLD (Kaliwa River)	1998/2004	12,923				- Laiban Dam - Tunnel - Power Plant - Treatment Plant - Treated Water Reservoir - Distribution System	Detailed engineering for review Construction deferred

TABLE 2.2.16 PROPOSED PROJECTS OF MWSS (cont'd)

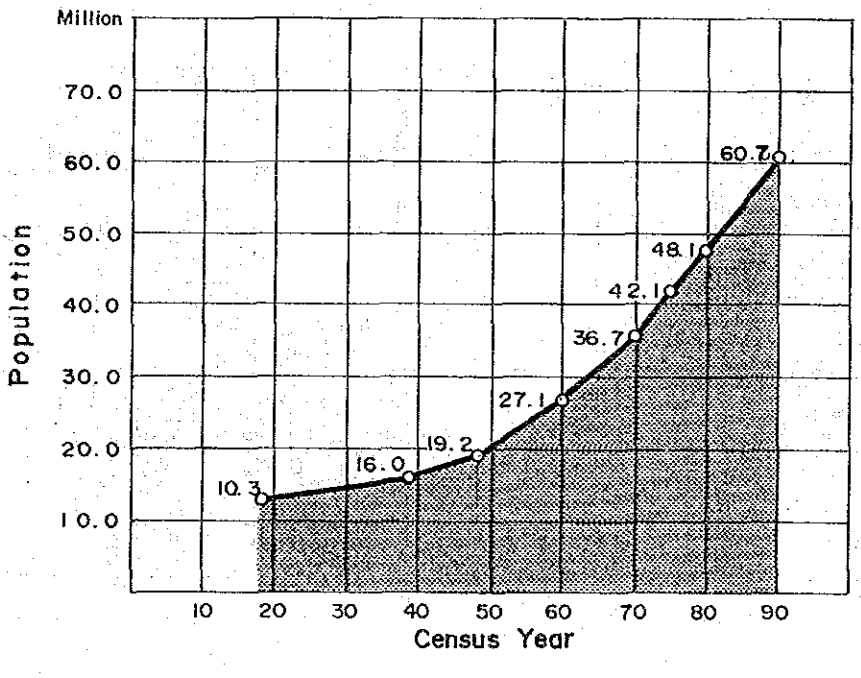
PROJECT	EXPECTED VOL. TO BE INCREASED /RECOVERED	IMPLEMENTATION SCHEDULE START/COMPLETE	TOTAL PROJECT COST (mil. P)	FUND ALLOCATION Activity	L.C. (mil. P)	F.C. (mil. $)	PROJECT COMPONENTS	REMARKS
Manila North-East Water Supply Project (MNEWSP)	Increase 72 MLD (Wawa River)	1991/1995	580	F/S	4.58	1.28	- Rehabilitation of Intake Structure	F.S. to start June 1991
				D/S	3.00	0.47		Construction Jan. '94
				C	245.00	9.2	- Water Treatment Plant - Treated Water Reservoirs - Transmission Main/Aqueduct - Distribution System - Wells - 43,000 House Service Connections	
Balara Treatment Plant Rehabilitation Project (BTPRP)	-	1991/1994	486.32	F/S	2.60	0.86	- Rehabilitation of Balara Treatment Plant	Technical assistance to start Aug. 1991 by JICA
				D/S	9.20	1.23		Construction Dec. '93
				C	103.30	10.33		
Cavite Water Supply Project (CWSP)	Increase 300 MLD (Laguna de Bay)	1992/1995	1,489				- Water Treatment Plant - Treated Water Reservoir - Booster Pumping Station - 150 kms Dist. Network - 75,000 House Service Connections	F/S Jan '92-Dec '92 D/S Jan '93-Dec '93 Construction Jan'94 Dec '94

(PPD - Planning and Programming Dept.)

TABLE 2.2.17 PLANNED AUGMENTATION OF WATER SOURCES

YEAR	PROJECT	CAPACITY (m^3/day)
1993	AWSOP	129,600
1995	MNEWSP	72,000
1997	UATP	777,600
2011	MWSP III	1,900,000

GROWTH OF PHILIPPINE POPULATION



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 2.1.1 GROWTH OF PHILIPPINE POPULATION
JAPAN INTERNATIONAL COOPERATION AGENCY	

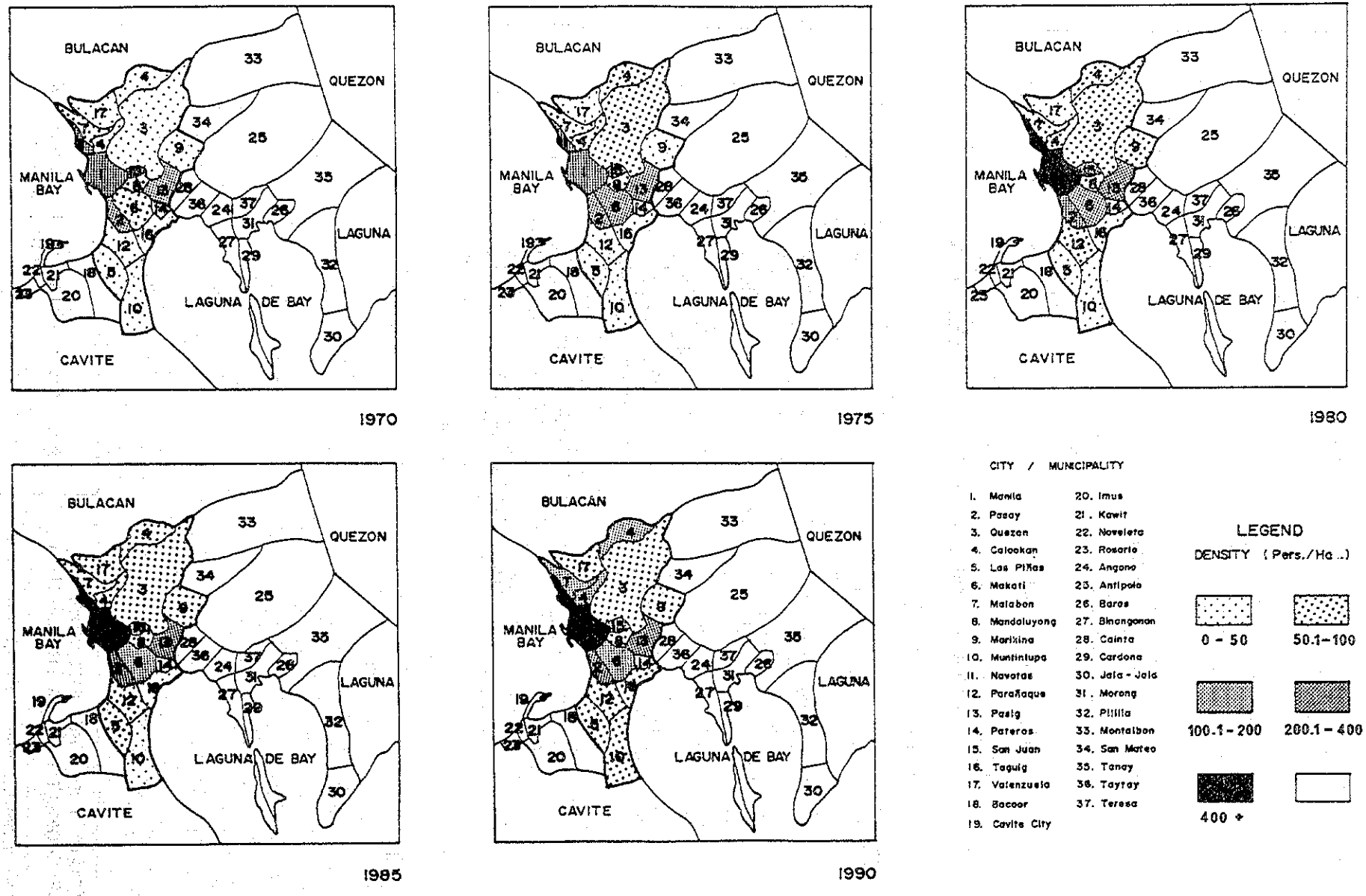
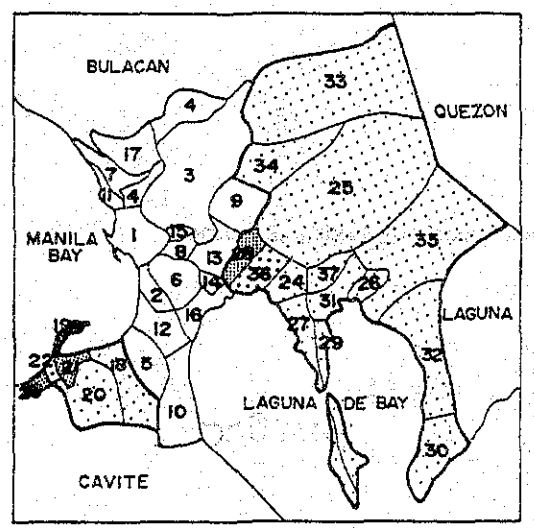
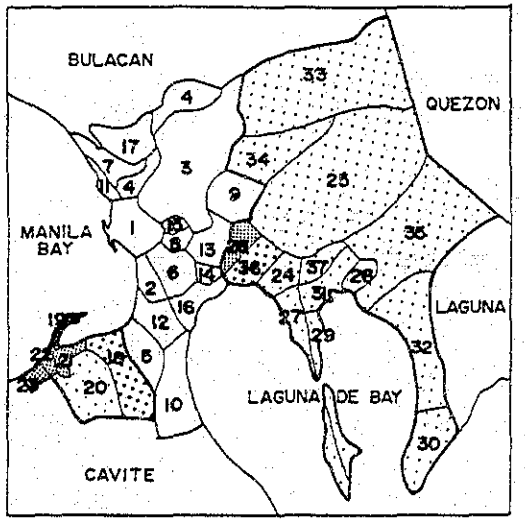


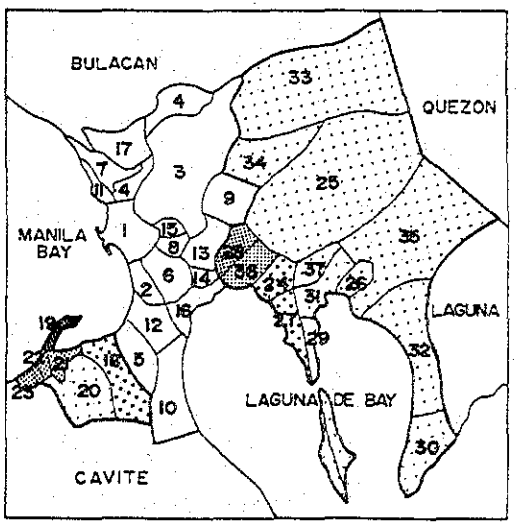
FIGURE 2.1.2 **POPULATION DENSITY OF NCR**



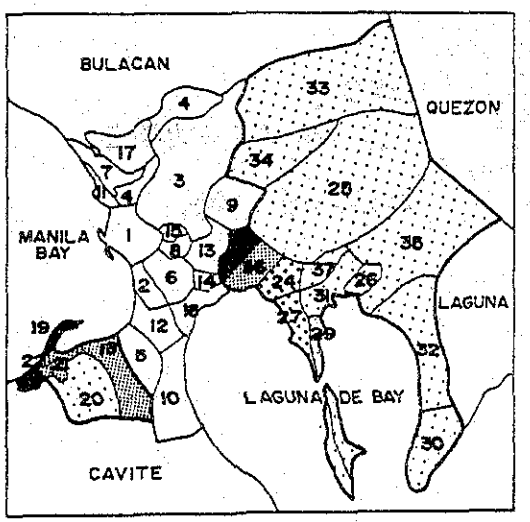
1970



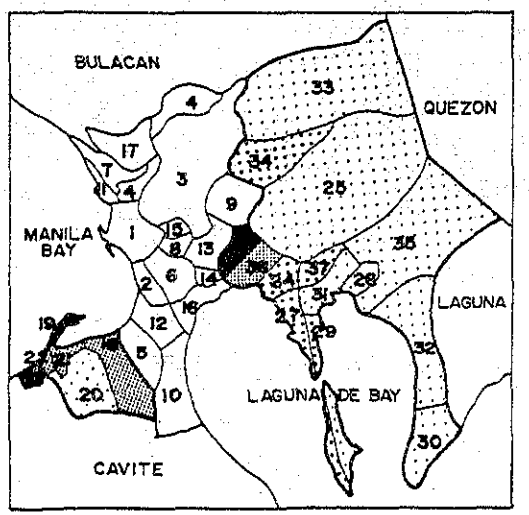
1975



1980



1985



1990

CITY / MUNICIPALITY

1. Manila	20. Imus	
2. Pasay	21. Kawit	
3. Quezon	22. Noveleta	
4. Caloocan	23. Rosario	
5. Las Piñas	24. Angono	
6. Makati	25. Antipolo	
7. Malabon	26. Baras	
8. Mandaluyong	27. Binangonan	
9. Marikina	28. Cainta	
10. Muntinlupa	29. Cardona	
11. Navotas	30. Jala - Jala	
12. Parañaque	31. Morong	
13. Pasig	32. Pillila	
14. Pateros	33. Montalban	
15. San Juan	34. San Mateo	
16. Taguig	35. Tanay	
17. Valenzuela	36. Taytay	
18. Bacoor	37. Teresa	
19. Cavite City		

LEGEND

DENSITY (Pers./Ha.)

0 - 10	10.1 - 20
20.1 - 40	40.1 - 60
60.1 - 80	80.1 +

FIGURE 2.1.3 **POPULATION DENSITY OF CAVITE AND RIZAL**

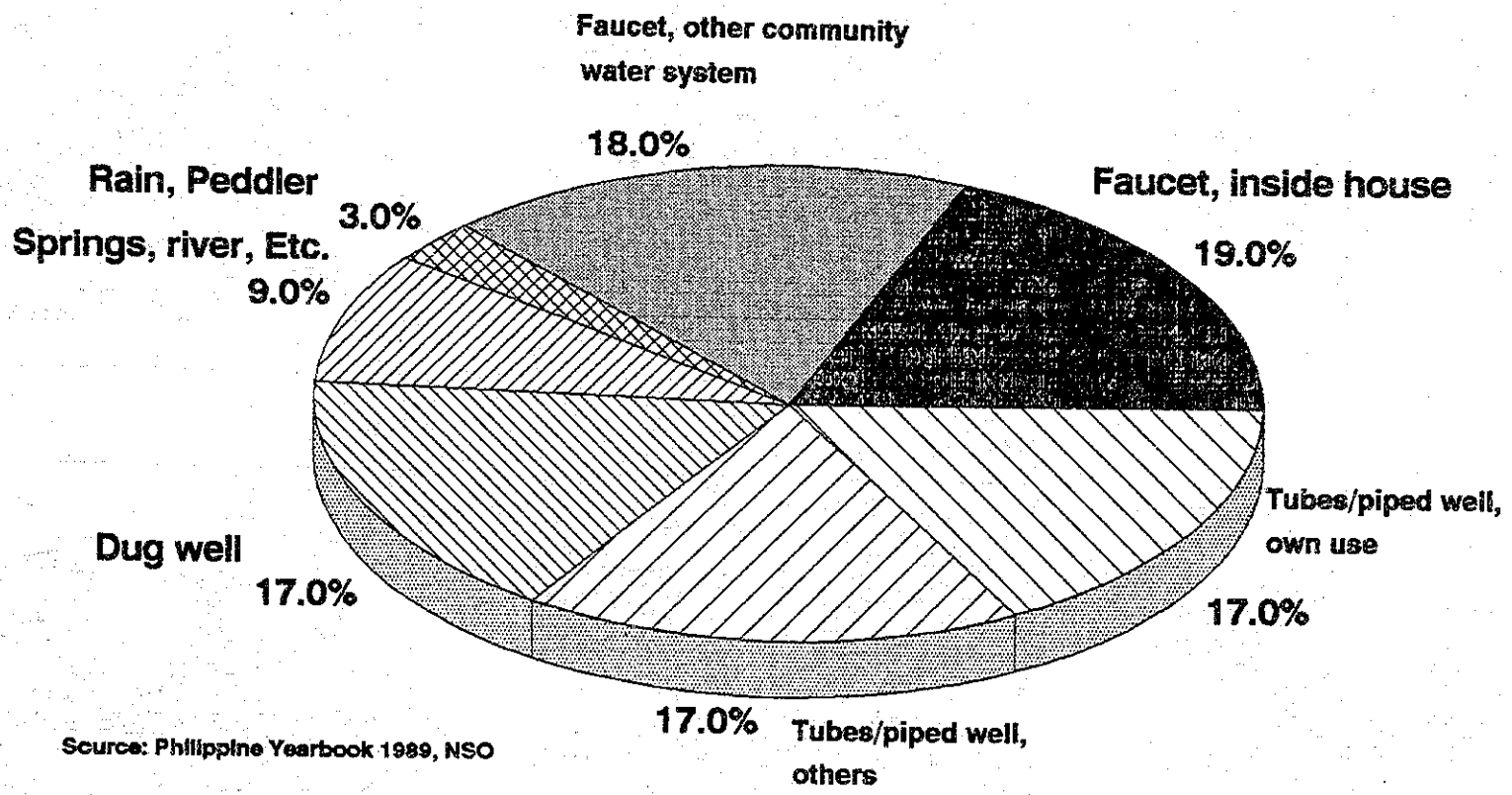
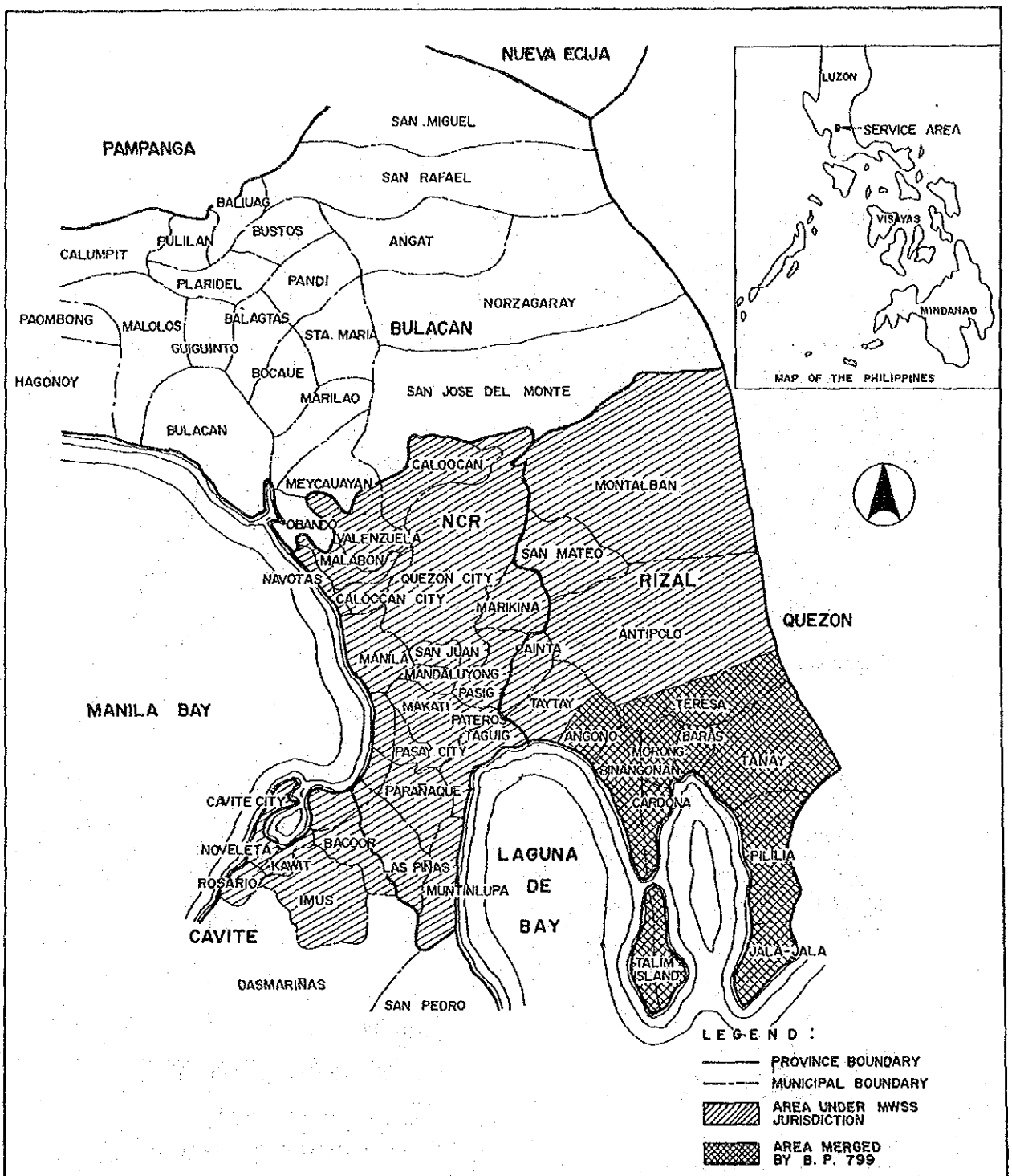
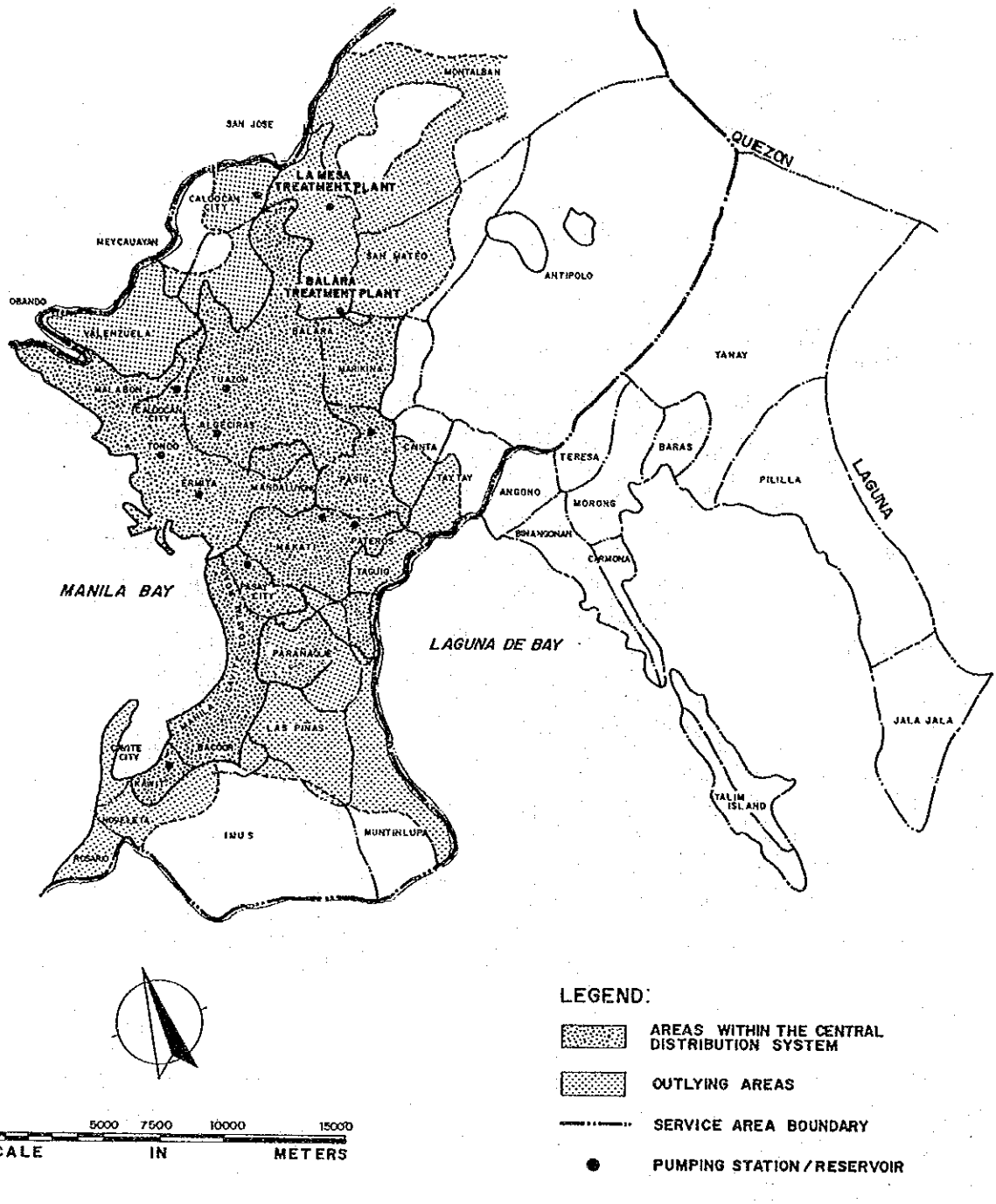


FIGURE 2.2.1 PERCENTAGE OF FAMILIES BY MAIN SOURCE OF WATER SUPPLIY, 1985



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 2.2.2
JAPAN INTERNATIONAL COOPERATION AGENCY	MWSS SERVICE AREA



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 2.2.3
PRESENT WATER SUPPLY SERVICE AREA BY MWSS

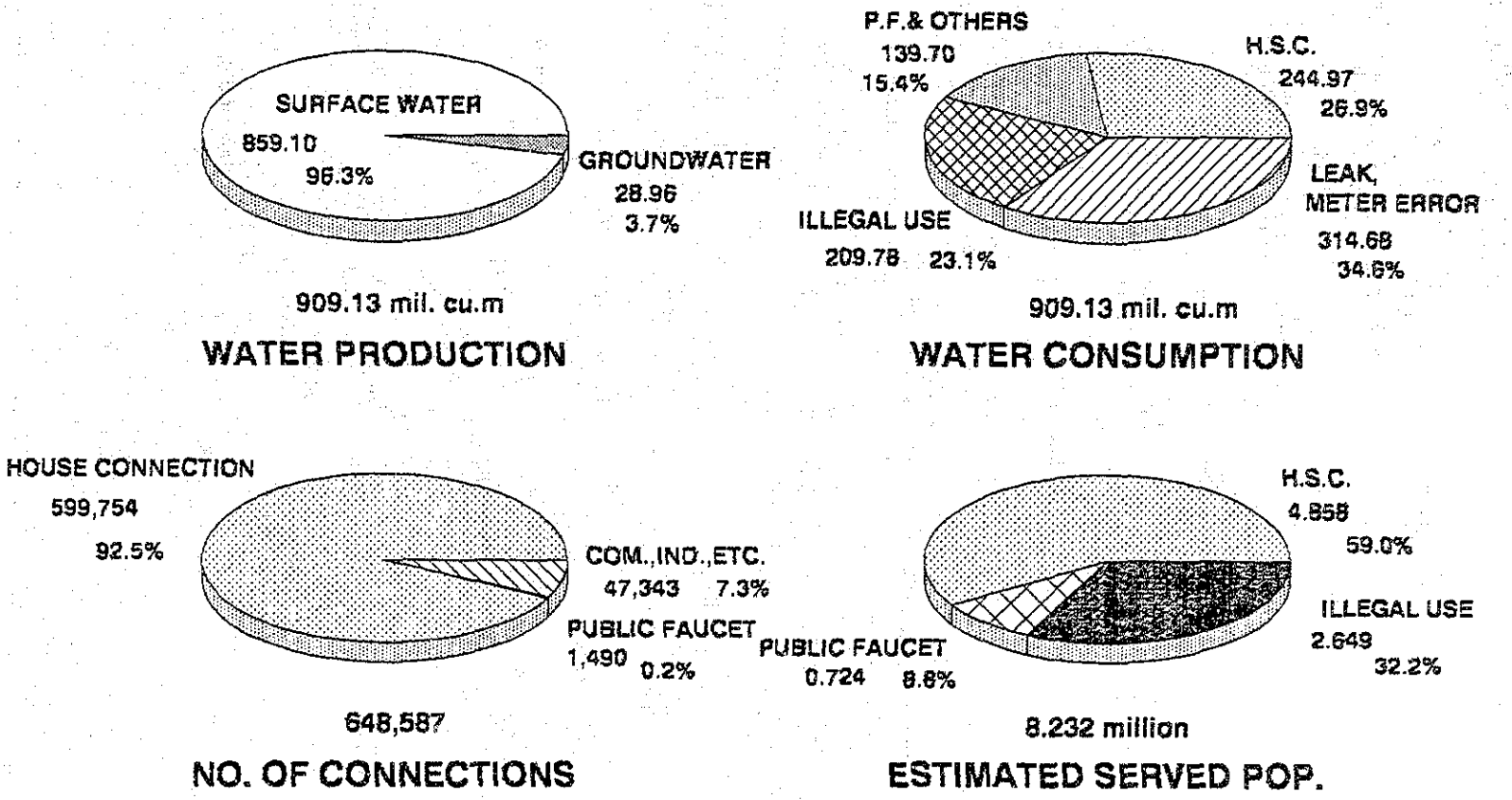
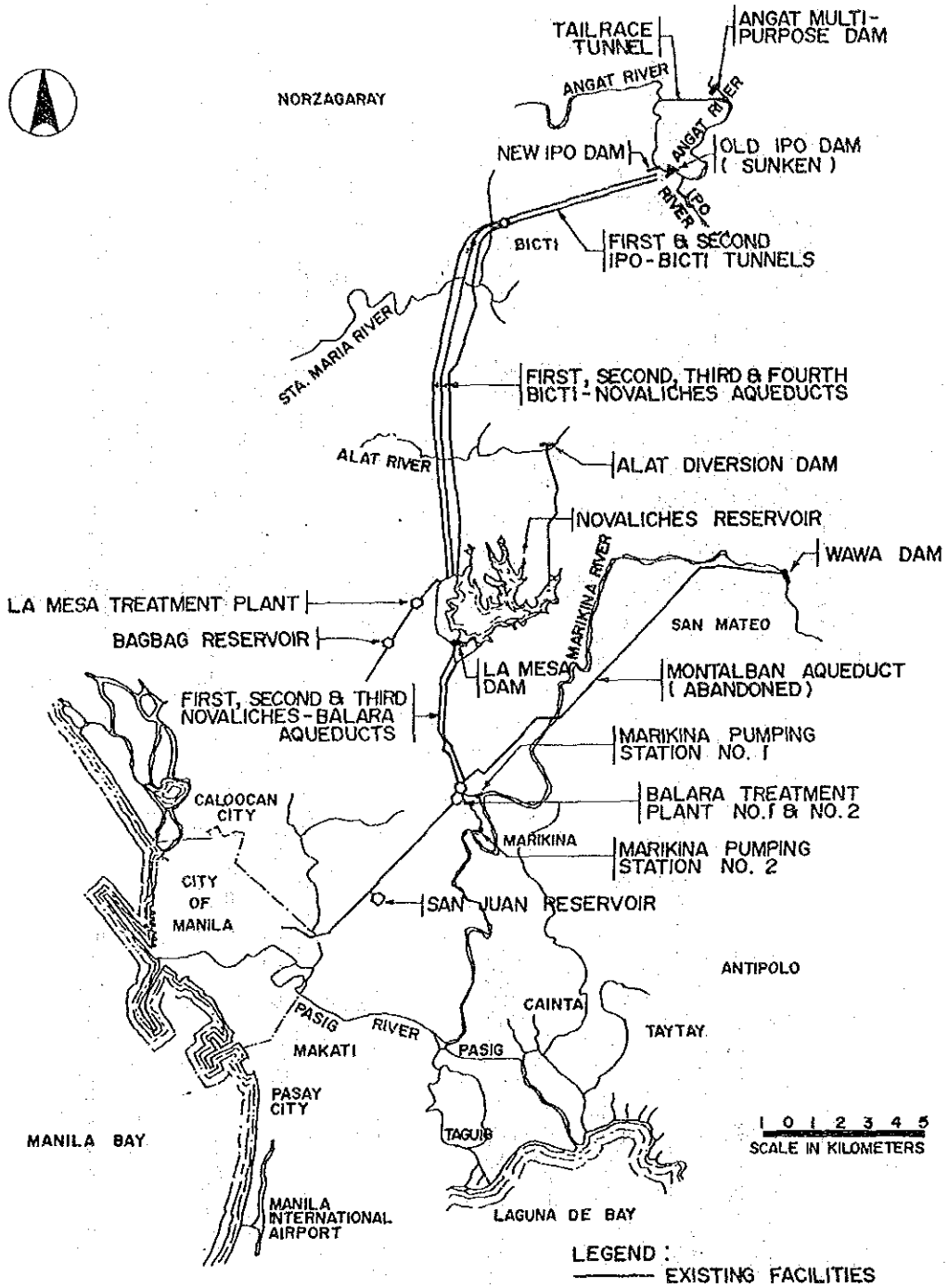


FIGURE 2.2.4 MWSS WATER SUPPLY STATISTICS (1990)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 2.2.5
JAPAN INTERNATIONAL COOPERATION AGENCY	EXISTING & MAJOR SUPPLY FACILITIES

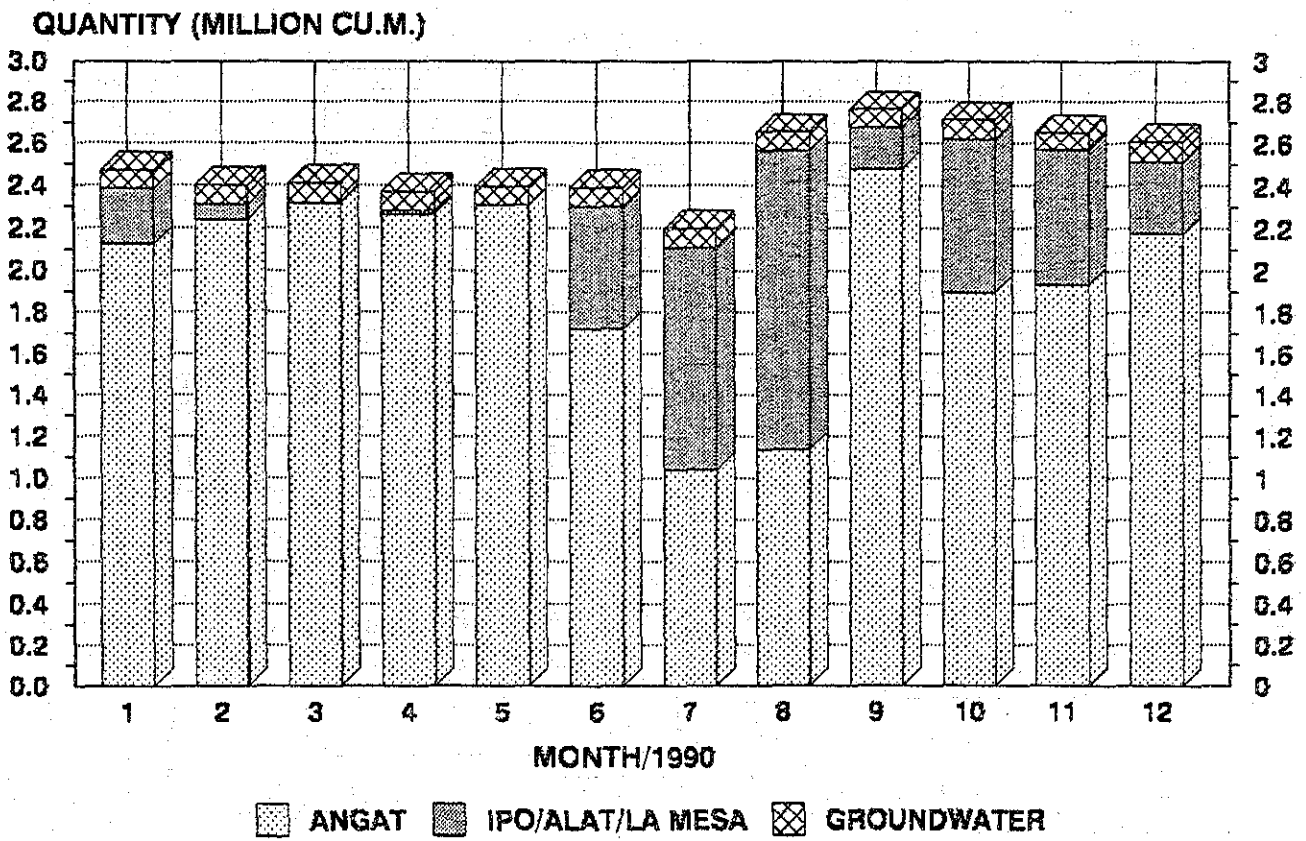
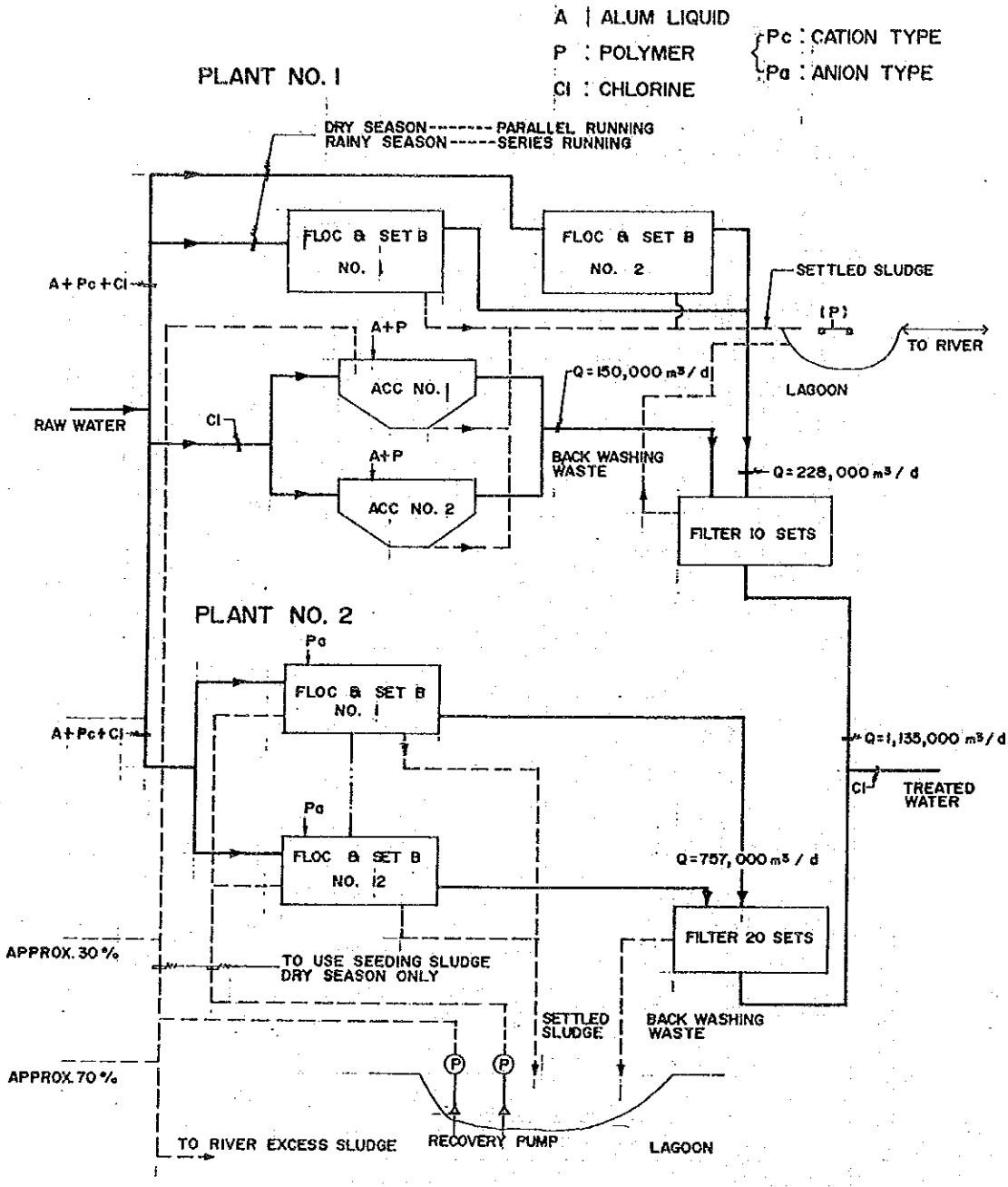
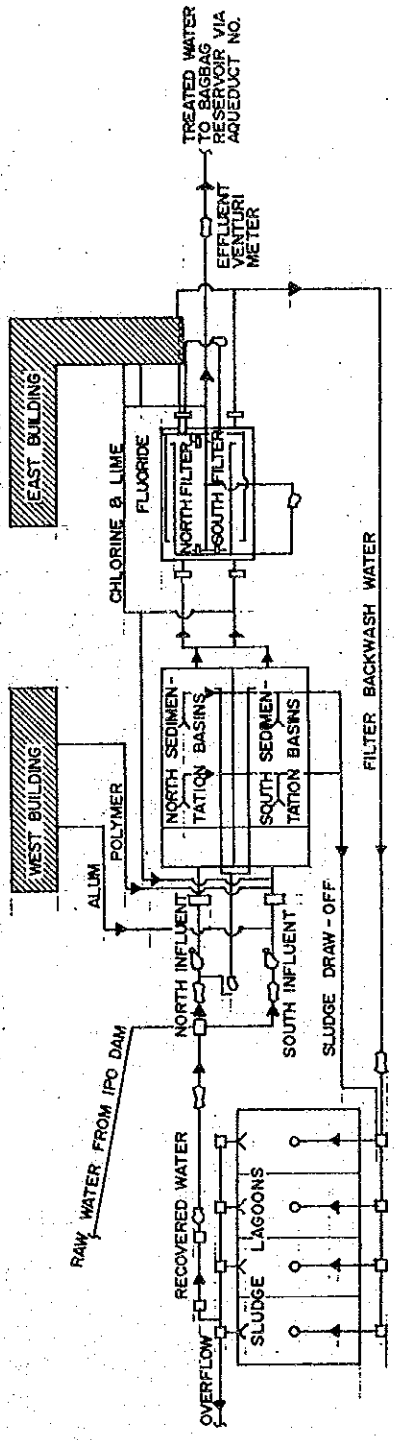


FIGURE 2.2.6 RAW WATER BY SOURCE (MONTHLY DAILY AVERAGE)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 2.2.7
JAPAN INTERNATIONAL COOPERATION AGENCY	FLOW DIAGRAM OF BALARA TREATMENT PLANT



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 2.2.8

FLOW DIAGRAM OF LA MESA TREATMENT PLANT