ASIAN DEVELOPMENT BANK
Technical Assistance TA No. 2263-PHI

THE GOVERNMENT OF
THE REPUBLIC OF THE PHILIPPINES
METROPOLITAN WATERWORKS & SEWERAGE SYSTEM

MWSS WATER SUPPLY IMPROVEMENT STUDY

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

JULY 1996


MONTGOMERY WATSON ASIA

in association with


DCCD Engineering Corporation

MWSS WATER SUPPLY IMPROVEMENT STUDY
TA 2263 - PHI

FINAL REPORT

VOLUME I - EXECUTIVE SUMMARY

VOLUME II - MAIN REPORT

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EXECUTIVE SUMMARY

1. OVERVIEW

1.1 Introduction

Montgomery Watson Asia, acting for the Asian Development Bank, has carried out a study into the operational condition of the primary distribution system of the Metropolitan Waterworks and Sewerage System (MWSS); which supplies potable water to Metro Manila and its environs.

The objectives of Water Supply Improvement Study (ADB TA 2263 - PHI) were to:-

- assess the condition of the primary distribution system with a view to improving water distribution efficiency through reduction of leakage,
- review the adequacy of the primary distribution system to meet demands within the supply area,
- identify short-term and long-term (up to the year 2015) improvements required, including service reservoirs and pumping stations,
- identify and formulate a project suitable for international financing,
- prepare an outline strategy for leak detection and control within the primary distribution system. and.
- make recommendations on policy issues related to the water supply sector.

This Executive Summary (**Volume I**) details the principal findings and recommendations of the study. Reference should be made to the Main Report (**Volume II**) and Appendices (**Volumes III and IV**) for details of the work performed.

1.2 Summary

The Manila water supply distribution system is a complex network of pipelines of varying age, size and condition. The Primary Distribution System (PDS) is not an isolated trunk distribution system, as is in many other cities, but has connections to many consumers directly from the PDS. It is also not clearly defined by size, as many smaller diameter pipes in the system act as transfer pipelines in addition to their distribution function.

After field inspection, review of existing reports, discussion with MWSS and computer modelling of a defined primary distribution system, it is estimated that the current leakage in the PDS is in the range of 3 to 5 %.

Leakage in the PDS is considered to be above 3% based on the following reasons:

- There was evidence of a number of visible leaks on the primary distribution pipelines.
- There was evidence that there are leakage problems at a number of specific sites, such as river crossings.
- There is some evidence to suggest that burst/leakage occurrences are more prevalent in the older asbestos cement and cast iron pipelines, of which there are a significant amount in the MWSS system.

The indicators lead us to believe that leakage is not above 5 % are as follows:

- No evidence was found of primary distribution pipelines that were in a continuous leak/repair cycle.
- No evidence was found of any pipelines that appeared to have a significant problem with joint leaks.
- The level of leakage observed along the surface of the pipeline in the primary distribution system is not excessive.
- At present pressures are often low in the primary distribution pipelines, limiting leakage volumes.

The leakage levels adopted are consistent with primary distribution system leakage found in other parts of the world.

We have identified a range of measures that can be implemented to reduce the level of leakage. The recommended works to meet requirements up to the year 2005, is:-

1. Replacement/relining of 36 km of existing asbestos cement, cast iron and reinforced concrete pipes of diameters 400 mm to 1350 mm to increase the carrying capacity in selected areas of the service area.
2. Replacement of 15 km of 300 mm diameter asbestos cement pipes that is considered to be the subject of a high rate of bursts and leakage.
3. Replacement/relining of 33 km of existing cast iron, asbestos cement and steel pipes of diameters 300 mm to 1350 mm due to a significant reduction in the pipeline's carrying capacity.
4. Strengthening of the primary distribution system by installation of additional 7 km long, 2000 mm diameter pipeline; along Congressional Avenue.

5. Replacement of 400 existing gate valves with butterfly valves; of diameters 350 mm to 1500 mm diameter.

6. Replacement or installation of 160 isolating valves on the smaller laterals off the trunk primary distribution mains of 900 mm diameter and above.

7. Construction of a balancing tank to link the aqueduct from La Mesa Treatment Plant to Bagbag; and the aqueduct from La Mesa Treatment Plant to Balara.

8. Modifications to the inter-connection of the La Mesa - Balara aqueduct to Balara Treatment Plant.

9. Installation of a pressure control valve connecting the Balara - Marikina main to Makati tank.

10. Replacement of three under-river crossings.

11. Construction of a new 100 Ml reservoir to replace the existing San Juan Reservoir No 1

The above work is estimated to reduce the leakage in the PDS by 2%.

Overall project cost is summarized in **Table 1.1**, at early-1996 base cost level.

Table 1.1 - Summary of Project Costs

	Components	**Cost (₱ × 10^6)**		
		Local	**Foreign**	**Total**
A	Civil Works	482.00	566.59	1,048.59
B	Supply of Materials	283.28	357.55	640.83
	Sub-Total (A+B)	765.28	924.14	1,689.42
C	Engineering Services etc.			
	Detailed Engineering Design	23.57	28.28	51.85
	Construction Supervision	23.57	28.28	51.85
	MWSS Support Services/Admin. Costs	23.57	28.28	51.85
	Sub-Total (C)	70.71	84.84	155.55
D	Contingencies			
	Physical	83.60	100.90	184.50
	Price	225.45	88.04	313.49
	Sub-Total (D)	309.05	188.94	497.99
	Escalated Cost (A+B+C+D) (rounded)	1,145	1,198	2,343
E	Interest During Construction	310	311	621
F	**Grand Total (Million Pesos)**	1,455	1,509	**2,964**
	Grand Total (Million US $)			**114**

The Financial Internal Rate of Return (FIRR) of the Project is calculated at 13.96 per cent. The Weighted Average Cost of Capital (WACC), based on the assumed financing plan and loan terms, is calculated at 9.73 per cent and the Project is therefore considered financially viable.

The Economic Internal Rate of Return (EIRR) of the Project is 26.11 percent. With an economic opportunity cost of 15 percent, the Project represents an efficient use of resources.

The major part of NRW, including leakage losses, occurs in the secondary and tertiary mains and service connections. MWSS is currently implementing an aggressive program for the reduction of NRW and it is preferable that leakage control and rehabilitation of the PDS be carried out in unison with that of the secondary and tertiary mains. The proposed zoning of the distribution network will have an impact on the PDS, particularly smaller diameter pipelines between 300 mm and 600 mm. Planning of major changes should be deferred until zoning is complete.

The benefits of the project include :-

- improved hydraulic capacity of the PDS to cater for increased supply from the Umiray-Angat Transbasin Project and effective distribution of water to all areas;
- reduced leakage in the PDS and improved operational efficiency;
- improved distribution, especially to the South Area;
- controlled pressures in the secondary and tertiary mains and minimized increases in NRW under improved overall supply, until these mains are rehabilitated;
- increased asset value of the PDS with the replacement or rehabilitation of about 20 per cent of existing asbestos cement and cast iron pipelines.

2. MWSS SERVICE AREA

2.1 Introduction

The MWSS service area includes 8 cities and 29 municipalities. As shown on **Figure 2.1**, it encompasses the National Capital Region (NCR), Rizal Province and parts of Cavite Province.

2.2 Service Coverage

The total population in the MWSS service area was about 10.8 million in 1995. Water supply service coverage was about 67 per cent, with about 7 per cent of the population depending on public faucets.

The present MWSS service area covers the following :-

- the National Capital Region, but with low service coverage ratio in the five southern municipalities and one municipality adjacent to Bulacan in the north.
- Cavite Province, except for Cavite and Kawit, service coverage is less than 22% in the other municipalities.
- the western portions of Rizal Province.

2.3 Population and Service Coverage Projections

The population within the MWSS service area is projected to increase by about 45 per cent to 15.7 million persons by the year 2015. Water supply service coverage is planned to increase to 95 per cent by that time. 90 per cent of the population are expected to be served by house connections and 5 per cent by public faucets .

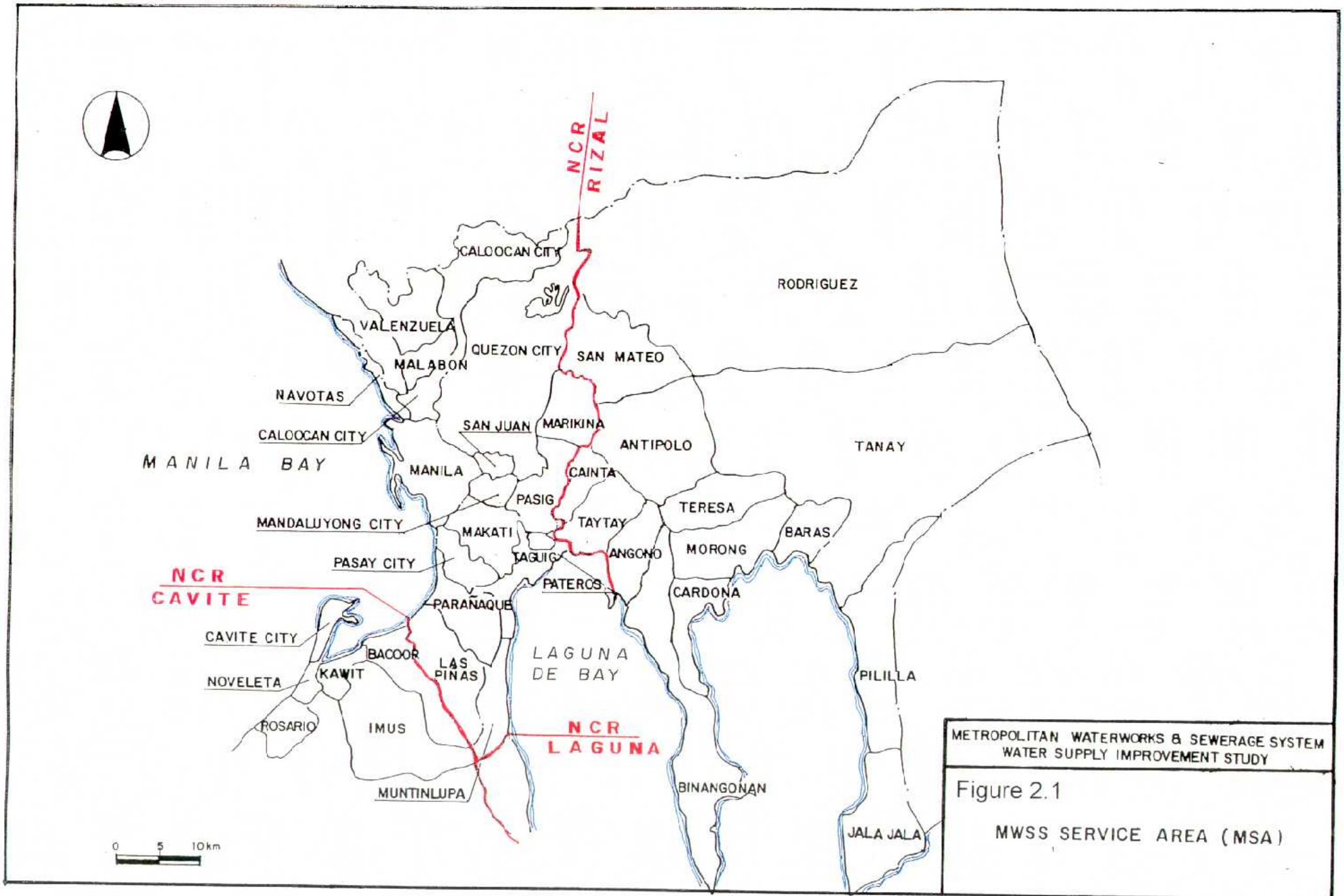
NCR
RIZAL
CALOOCAN CITY
RODRIGUEZ
VALENZUELA
QUEZON CITY
SAN MATEO
MALABON
NAVOTAS
SAN JUAN
MARIKINA
CALOOCAN CITY
ANTIPOLO
TANAY
MANILA BAY
MANILA
CAINTA
PASIG
TERESA
MANDALUYONG CITY
MAKATI
TAYTAY
BARAS
TAGUIG
ANGONO
MORONG
PASAY CITY
NCR
CAVITE
PATEROS
CARDONA
PARAÑAQUE
CAVITE CITY
BACOOR
LAS
PINAS
LAGUNA
DE BAY
PILILLA
NOVELETA
KAWIT
ROSARIO
IMUS
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Figure 2.1
MWSS SERVICE AREA (MSA)
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3. THE EXISTING MWSS WATER SUPPLY SYSTEM

3.1 General

Surface water supplies serve most of the National Capital Region via the central distribution system. Groundwater supplies also serve those areas on the fringes of the central distribution system and other areas not connected to surface supplies. There are also privately owned wells within the service area.

3.2 Surface Water Supply Sources

The main source of raw water supply is the Angat Dam and Reservoir. Treated water is produced at Balara and La Mesa water treatment plants.

Balara Water Treatment Plant is presently being rehabilitated to improve treated water quality and restore the plant to its design capacity of 1600 Mld. Treated water from the plant supplies San Juan Reservoir, with boosted supplies to Cubao along the way. Water from San Juan is subsequently distributed to the other pumping stations and reservoirs of the primary distribution system. Some plant output is also pumped directly into the Quezon City distribution system via the Balara Booster Pumping Station or flows by gravity to supply the East and South-East Sectors.

La Mesa Water Treatment Plant has an ultimate capacity of 2400 Mld. Currently the plant is not operating to its full capacity. Treated water from La Mesa flows by gravity to Bagbag Reservoir through Aqueduct No.4. Offtakes along the way supply into distribution by gravity and pumping. The remaining flow is distributed into the North, North-West and West sectors.

Waters from the two treatment plants mix in the West and South-West sectors with the hydraulic boundaries varying depending on local valving and the operation of Ermita, Algeciras and Pasay pumping stations.

3.3 Groundwater Supply Sources

MWSS operates 254 deepwells to serve areas which are not connected to the central distribution system. At present only 140 are operational. After chlorination, groundwater supplies are pumped either to elevated tanks or directly into the distribution system.

In recent years, the average supply from MWSS deepwells has been in the range of 70 to 90 Mld. Groundwater abstraction by private wells was estimated to be about 840 Mld in 1990; and is probably higher now. Some groundwater areas are already experiencing saline water intrusion as a result of excessive abstraction.

3.4 Distribution System

The central distribution system supplies treated surface water to consumers via a complex network of primary, secondary and tertiary mains. There are 13 reservoirs within the system together with 16 pumping stations. Two of these pumping stations have been decommissioned and a further three have been shut down because of non-availability of either water or power.

MWSS records give the total length of pipelines in the distribution system as approximately 4,300 km. This appears to be an under-estimate required to serve 850,000 service connections and it appears likely that some pipe installations have not been included.. The geographic information system (GIS) that is currently being developed will confirm the actual length of pipes in the distribution system.

The primary distribution system has been defined to consist of those mains which transfer water in bulk to the various supply areas. The water is then distributed within each supply area through secondary and tertiary mains.

The Terms of Reference for this Water Supply Improvement Study defined the primary distribution system as consisting of pipelines with a nominal diameter of 350 mm and above. However, model simulations carried out as part of this study (**Section 6.2**) have confirmed that there are pipelines of smaller diameter that function as primary mains. A definition of the primary distribution system based on the function of the pipe has therefore been adopted. The primary distribution system is now considered to also including some 300 mm and 250 mm diameter pipelines, as defined by the model simulations.

The primary distribution system is presently sub-divided into eight sectors. Under an ongoing telemetry contract, 57 flow meters are currently being installed to monitor inflows at sector boundaries. 180 gauging points are also being installed for pressure and flow measurement. The telemetry system will also include facilities to monitor pump status, flows, reservoir levels and water quality. This data will be used to operate the system more efficiently, as well as provide information on leakage.

3. 5 Present Supply and Consumer Service

The 2,700 Mld of treated water currently supplied from La Mesa and Balara water treatment plants is inadequate to meet demands. As a result about 50 to 60% of the supply area consumers receive only intermittent supply. The system pressure also varies in areas with continuous supply, with some areas experiencing low pressures.

4. WATER SUPPLY DEVELOPMENT PLANS

4.1 Population and Water Demand Projections

Detailed water demand projections for the MWSS supply area have most recently been produced by the JICA Master Plan Study and the MWSS Operational Strengthening Study (MOSS). These have been reviewed and discussed with MWSS. A revised demand projection has been produced for this study and is shown on **Figure 4.1**, together with the JICA and MOSS study projections. Details of the parameters adopted for this study are summarized in **Table 4.1**, together with the associated total demand projections.

Table 4.1 - Water Demand Projections Adopted for WSIS

Description	Year				
	1995	2000	2005	2010	2015
Total Population (million)	10.787	12.152	13.385	14.595	15.729
HSC & UBD Population	70 %				90 %
Blighted Population	30 %				10 %
Supply Coverage					
- House Connection	60 %	67.0 %	74 %	83 %	90 %
- Public Faucet	7.1 %	7.4 %	7.1 %	6.5 %	5.0 %
Overall Supply Coverage	67.1 %	74.4 %	79.4 %	89.5%	95 %
Billed Per Capita Usage					
(l/h/d)	127	143	160	169	180
- House Connection	30	32.5	35.0	37.5	40
- Public Faucet					
Domestic (Mld)					
- House Connection	822	1,164	1,574	2039	2,556
- Public Faucet	23.1	29.2	33.5	35.5	31.5
Commercial (Mld)	312.0	477	558	627	695
Industrial (Mld)	75.8	178	189	195	200
Total RW (Mld)	1,233	1,848	2,355	2,897	3,483
Total NRW (Mld)	1,437	1,923	1,865	1,701	1,388
Total Average Demand (Mld)	2,670	3,771	4,220	4,597	4,871
Maximum Day Demand (Mld)		4,337	4,853	5,287	5,601
Revenue Water (%)	46.2	49	55.8	63	71.5
Non Revenue Water (%)	53.8	51	44.2	37	28.5
Total	100.0	100.0	100.0	100.0	100.0

The parameters adopted are based on the following:-

- **Population** - National Statistics Office medium projection.
- **Population Served** - 95 % supply coverage (90 % house connections and 5 % public faucets) by the year 2015.
- **Domestic Consumption Rate** - projected to increase to 180 l/h/d by the year 2015. Short term per capita consumption reflects present suppressed demands. Unsuppressed demand could be in the region of 150 to 160 l/h/d.

- **Commercial Demand** - Based on MWSS Corplan's projections.
- **Industrial Demand** - Based on MWSS Corplan's projections.
- **Maximum Day Demand** - Maximum day demand factor of 1.15.
- **Overall Demand Projections** - Overall projections up to the year 2000 reflect suppressed demands, with demand dictated by supply capacity and system inadequacy.

4.2 Ongoing and Planned Projects

A number of ongoing and planned projects have been reviewed and referred to by this study. These include the Angat Water Supply Optimization Project (AWSOP), Umiray Angat Transbasin Project (UATP), Manila South Water Distribution Project (MSWDP), Metro Manila Groundwater Development Project (MMGWDP), Rizal Province Water Supply Improvement Project (RPWSIP) and the Balara Water Treatment Plant Rehabilitation.

Proposed source development schemes which will impact on the primary distribution system have been reviewed. These are the Manila Water Supply Project III (MWSP III) with Laiban Dam, Cavite Water Supply Project (CWSP) and Manila Northeast Water Supply Project (MNEWSP). All of these schemes are in the planning stage.

4.3 Long Term Development Scenarios

The balance between the projected water demands and possible source development scenarios is shown on **Figure 4.2**.

Angat reservoir is the main source of supply. With the completion of the Umiray-Angat Transbasin Project by 1999, its present supply capacity of between 2800 and 2900 Mld will increase to above 3500 Mld. The exact quantity MWSS will be able to abstract from the reservoir depends on future agreements with the National Water Resources Board, the National Power Corporation and National Irrigation Authority. For planning purposes, this study has assumed that MWSS abstractions would be between 3750 Mld to 4000 Mld. This supply capacity, together with the 48 Mld expected by 1997 from the Rizal Province Water Supply Improvement Project will be adequate to meet projected demands up to the year 2000 or slightly beyond.

A new source needs to be developed to meet demands beyond the year 2000. The development of the Manila Water Supply Project III, with Laiban dam as the source, is considered as the best option. However this project will have a long lead time and will need high capital investment. Alternative strategies ,such as the Cavite Water Supply Project or supply of additional water from Angat Reservoir could also be considered.

Fig.4.1 - MWSS Service Area - Water Demand Projections (Avg Day)

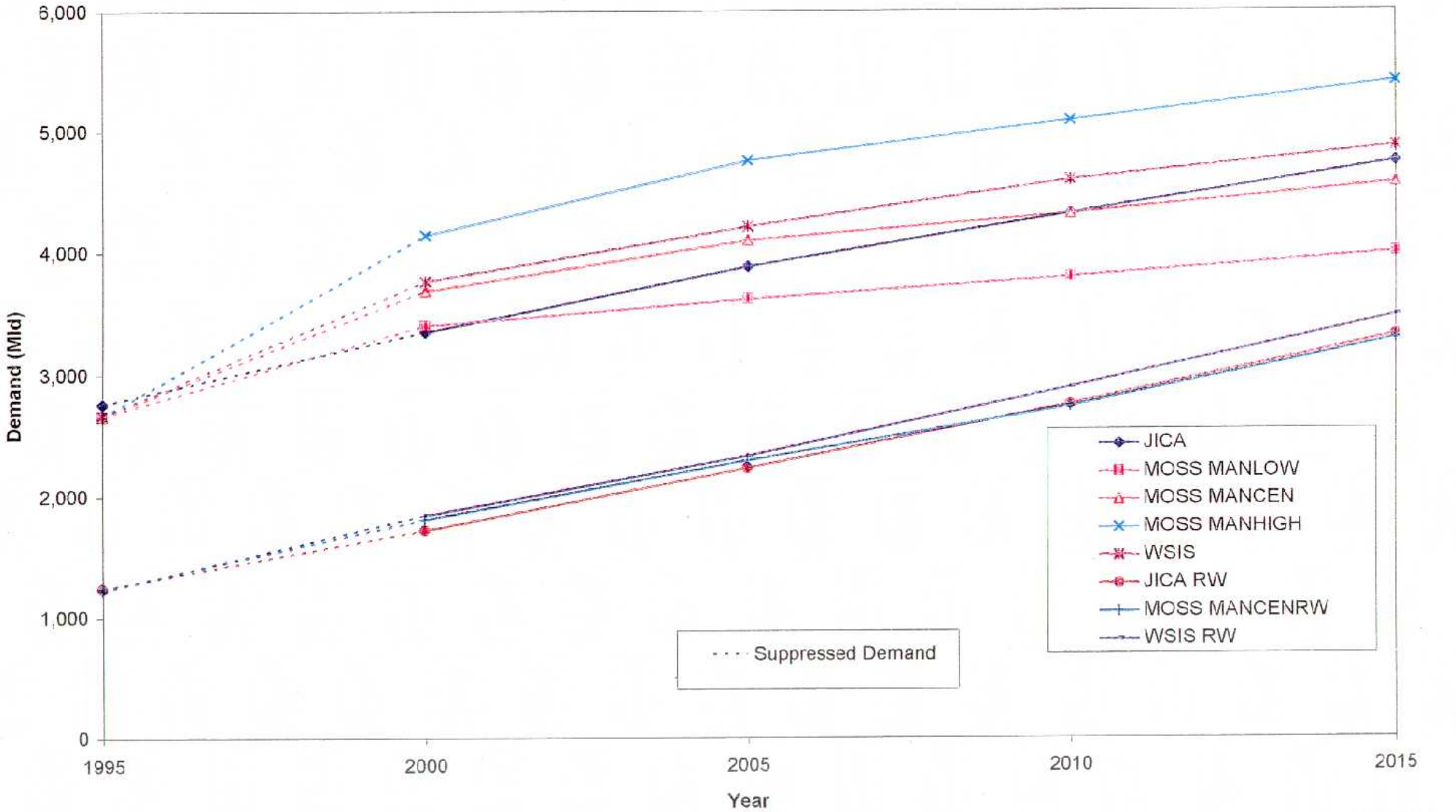

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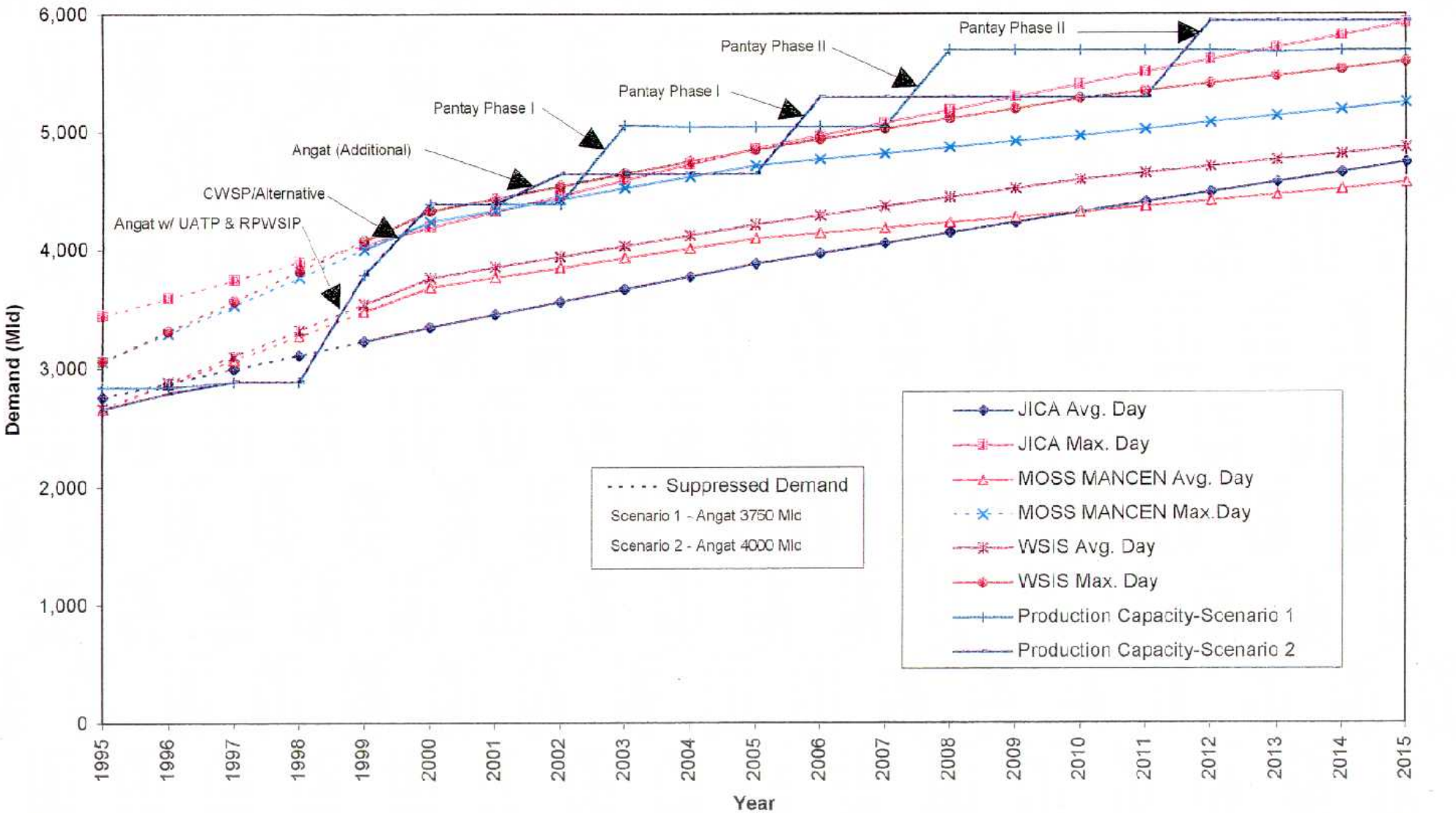
Fig. 4.2 - MWSS Service Area - Water Demand and Supply Capacity



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The necessary sequence and timing of source developments is, of course, very heavily dependent on success in achieving targeted non-revenue water levels. This should be given the highest priority and be carried out in parallel with source developments.

Two alternative scenarios based on the Cavite Water Supply Project are shown in **Figure 4.2,** with maximum supply from Angat assumed as 3,750 Mld and 4000 Mld respectively.

Manila Water Supply Project III, with Laiban dam, will still be required to meet long term demands and enable the supply to be extended beyond the existing supply area.

5. NON-REVENUE WATER

5.1 Background

The MWSS distribution system has a high Non-Revenue Water (NRW) level of about 55 per cent. Physical losses (leakage) are estimated by MWSS to be 35 to 40 per cent and remaining losses occur from meter under-registration and malfunction, theft and operational use such as firefighting. **Table 5.1** shows historic levels of NRW over the past 20 years.

Table 5.1 - Historic NRW Levels

Year	NRW (%)	Year	NRW (%)
1975	49.7	1986	66.4
1976	50.3	1987	59.7
1977	48.1	1988	57.7
1978	45.9	1989	57.7
1979	46.8	1990	57.7
1980	47.1	1991	57.1
1981	48.9	1992	55.0
1982	52.3	1993	57.4
1983	54.0	1994	59.0
1984	56.6	1995	55.5
1985	60.6		

NRW levels increased significantly in the mid-1980s, largely due to an increase in supply pressures on commissioning of La Mesa water treatment plant.

5.2 Historic NRW Reduction Efforts

The first extensive NRW study was the "Metropolitan Manila Water Distribution System, Water Losses Survey", carried out by Camp Dresser McKee in 1975 to 1977. Key conclusions were that;

- leaks from minor mains and service connections (mostly galvanized iron) accounted for about 80 per cent of total leakage; and,
- service connection leaks recurred frequently due to rapidly corroding galvanized iron pipes, faulty service tappings and poor repair practices.

In 1980, MWSS introduced its "Comprehensive Program to Reduce Leakage". This initiative was followed by the Manila Water Supply Rehabilitation Project I (1984-91) and Rehabilitation Project II (1988-94). Rehabilitation Project I comprised leakage detection, repair and rehabilitation in 56 distribution system zones and 6 sub-divisions. Works under Rehabilitation Project II initially aimed to rehabilitate a further 51 zones and 4 sub-divisions but only 25 zones and one sub-division were completed. Both Projects concentrated on tertiary mains and service connections. There appears to have been no systematic leakage detection and repair of the secondary mains (150 mm to 300 mm diameter).

Appreciable localized NRW reductions were achieved under Rehabilitation Projects I and II, as shown in **Table 5.2**. However, the reductions were not sustained and leakage returned to earlier levels after completion of the work.

Table 5.2 - Initial NRW Reduction - Rehabilitation Projects I & II

Description	NRW Before Project	NRW After Project
A. Rehab Project I [1]		
(i) 44 Rehabilitated Zones	72.5 %	30.7 %
(ii) 12 Zones Still Under Rehabilitation	72.0 %	57.5 %
Total Project	72.4 %	41.2 %
B. Rehab Project II [2]		
(i) 24 Selected Zones	56.5 %	28.8 %
Total Project	62.8 %	53.1 % [3]

Sources:- 1) MWSRP I - ADB Project Completion Report. Nov 1993
2) MWSS 3rd Quarter Report MWSRP II
3) Post-Rehab after civil works

Table 5.3 illustrates that NRW reductions achieved were not sustained.

Table 5.3 - Remeasured NRW In Previously Rehabilitated Zones

Zone	Sub-Zone	Post Rehab NRW		Remeasured NRW	
		NRW %	Date Measured	NRW %	Date Measured
Zone 65	A	14.15	July 1991	30.6	1 Apr 1993
	B, C	17.44	July 1991	52.36	1 Apr 1993
Zone 109	A	22.36	May 1988	49.23	1 Apr 1993
Zone 79	A	21.35	Mar 1991	76.95	1 Jan 1995
	B	35.73	June 1991	62.35	1 Oct 1994
	C	24.05	June 1991	47.01	1 Jan 1996

Some sub-zones have recently been remeasured under the ongoing World Bank-funded "Manila Renovation of Water Distribution Network Project". Initial NRW results are;

- Zone 79 (Rehab Zone) - range 28 to 81 per cent in six sub-zones
  range 8 to 10 per cent in two sub-zones
- Zone 14 (Rehab Zone) - 81 per cent

The principle reasons for initial NRW reductions not being sustained appear to be;

- zonal monitoring, and leakage detection and repair were not continued with sufficient intensity;
- poor workmanship; and
- use of inferior quality materials.

5.3 Ongoing NRW Reduction Programs

5.3.1 NRW Reduction Component of Umiray-Angat Transbasin Project (UATP)

The ADB recently approved a loan for the Umiray-Angat Transbasin Project, under which is a NRW reduction program with three main components:-

(i) Zonal Measurement and Improvement - configuration of zonal boundaries initiated under Manila Water Supply Rehabilitation Projects I and II, for effective supply control and measurement through district metering.

(ii) Renovation and Rehabilitation - replacement of old and deteriorated pipes to arrest recurring leaks; elimination of "spaghetti connections"; replacement of defective service connections; and, installation of pressure reducing valves.

(iii) Revenue Recovery - replacement and relocation of consumer meters; closing of illegal connections; and, closing/relocation of tampered and defective fire hydrants.

This project is programmed for completion by 1998. Rehabilitation will mainly cover secondary and tertiary mains and service connections. Sector offices are currently preparing proposals and budgets for the rehabilitation works.

5.3.2 Manila Renovation of Water Distribution Network Project (MRWDNP)

An ongoing World Bank-funded study will formulate a project for leakage reduction, and infilling and expansion of the secondary and tertiary distribution network. The study, scheduled for completion in November 1996, has been underway for only a few months and it is too early to draw any firm conclusions from work to date.

5.4 Experience Elsewhere

Data on leakage from primary distribution mains are not as readily available as those for whole distribution systems. Nevertheless, experience shows that leakage from primary mains is usually limited because:

- there are usually relatively few off-take points on primary mains;
- off-takes are generally by means of a Tee-connection, where the risk of leaks developing is far less than at tapping points more commonly used on smaller mains;
- primary mains have the highest pressures and leaks are more likely to be visible;
- visible leaks tend to be repaired as a priority; and

- as there is a relatively short length of primary mains when compared with other distribution pipelines, any problematic primary mains tend to be noticed and investment focused to overcome the problems.

Even a large leak in a primary main can represent a very small percentage of the water flowing down the main. This means that using general meter data to assess primary mains leakage is very tentative. Most leakage data on primary mains therefore tends to be derived from sample tests, carried out under controlled conditions.

Table 5.4 presents some data on primary mains leakage from projects in which the Consultant has been involved elsewhere in South East Asia.

Table 5.4 - Trunk Main Leakage Elsewhere in South East Asia

SYSTEM	LOSSES	PRESSURE (BAR)	REPORT SOURCE	COMMENTS
Johor Baru, Malaysia	2%	Unspecified	Johor Baru Non-Revenue Water Control Project, Final Report 1992	World Bank funded project that concluded that trunk main leakage was very limited.
Labuan, Malaysia	6%	5	Labuan Water Supply Distribution System Study and Leakage Control Report 1991	One long AC main tested. [1]
Brunei Muara	less than 1%	3	A Policy For Reducing Leakage In The State of Brunei 1986	Sample on one steel and one AC main with a submarine flexible pipe section
Thailand	2.7%	0 to 4	Chonburi Leakage Control Policy and Management Study Report 1986	Test on a 14.5 km length of 600 mm AC pipe

Note 1) Losses in a second main, identified as having major subsidence problem, were 12%.

This data show trunk main leakage averaging less than three per cent. This is consistent with conclusions of many water supply utilities in Asia and elsewhere; for example, the generally accepted norm for trunk main leakage in the UK is under two per cent.

6. PRIMARY DISTRIBUTION SYSTEM

6.1 Area Division for Analysis

For analysis, the existing PDS and proposed extensions were divided into four separate sub-areas shown on **Figure 6.1**. With minor variations, these sub-areas are consistent with the 'blocks' proposed in the JICA Master Plan Study, and are;

(i) Northern Area supply system (JICA Block 1).

(ii) Central Area supply system (JICA Blocks 2, 3, 4 and 5 and part Block 7).

(iii) Southern Area supply system (JICA Block 6).

(iv) Eastern Area (JICA Block 7 except that included in Central Area).

The older PDS mains are in the Central Area. Those in the Northern and Southern Areas are relatively new and are being extended under the Angat Water Supply Optimization Project and the Manila South Water Distribution Project. Future improvements and extensions to the Southern Area, and additional PDS mains in the Eastern Area under the proposed Manila Water Supply Project III, are described in the JICA Master Plan.

6.2 Model Simulation of Central Area

6.2.1 Model Simulation

An EPANET-based network model was developed for this study from the existing mainframe MDCSIP network model.

Adequacy of the PDS served by the Central Area (Angat-Novaliches) supply system (see **Figure 6.1**), and improvements necessary to meet future requirements, greatly depend on the maximum supply that will be available from the Angat source, as well as the timing and location of any additional source development.

Two scenarios for supply from Angat reservoir were considered, namely 3,750 Mld and 4,000 Mld. Several solutions were investigated for years 2000 and 2005 and the adequacy of the recommended solution checked for years 2010 and 2015.

6.2.2 General Conclusions

Principle conclusions from the model simulations are:-

(a) Subject to some minor improvements and modifications, the Central Area PDS is adequate to meet Central Area demands up to about 2005 and can also provide some supply to the Southern Area.

(b) The improvements required are sensitive to the available supply capacity from Angat. The two scenarios considered would provide supplies to the Southern Area as summarized in **Table 6.1.**

Table 6.1 - Possible Supplies to Southern Area

Year	Angat Supply Capacity (Mld)	Gravity/ Pumped Supply	Possible Supply to Southern Area		Remarks
			Avg. Day (Mld)	Max. Day (Mld)	
2000	3,750	Gravity	464 (464)	216.5 (534)	Max. day - La Mesa plant operated at overload
		Pumped			
	4,000	Gravity			
		Pumped		466.5 (534)	Balara low lift pumps
2005	3,750	Gravity	436 (601)		
		Pumped			
	4,000	Gravity	600 (601)		La Mesa operated at overload
		Pumped		189 (691)	Balara low lift pumps

Note :- Figures within brackets are the Southern Area demands

(c) The improvements required to cater for a gravity supply system to the Central Area and provide supply to the Southern Area are:-

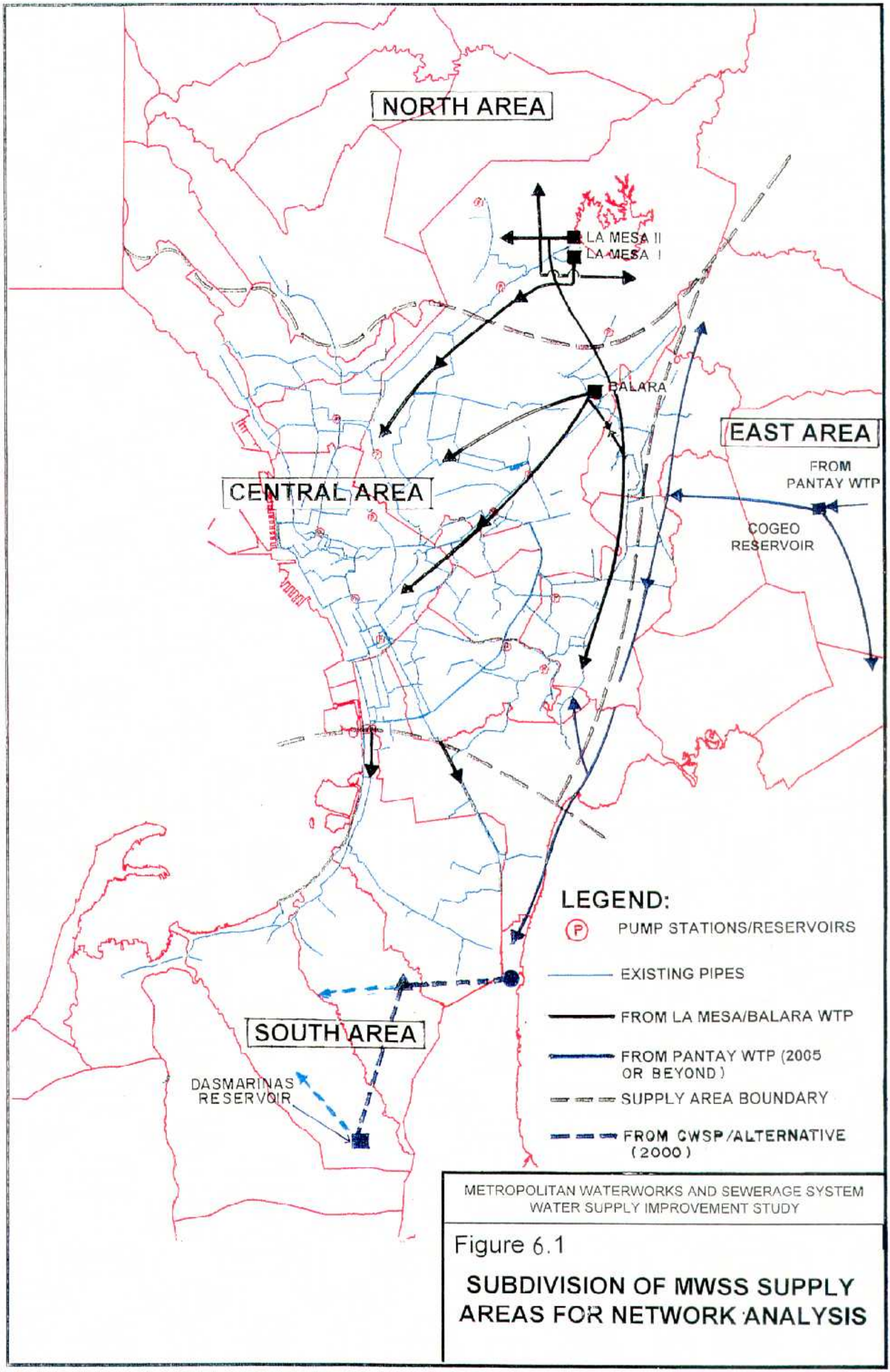
(i) an additional 7 km of 2000 mm diameter steel mains to strengthen the PDS;

(ii) replacement of asbestos cement pipes and relining of cast iron and reinforced concrete pipes with Hazen-Williams "C" values of 75 and less, total length about 33 km; (total length subject to verification by field testing and confirmation during the detailed design stage).

(iii) construction of a balancing tank to link the 3200 mm aqueduct from La Mesa Treatment Plant No. 1 to Bagbag; and the 2800 mm aqueduct from La Mesa Treatment Plant No. 2 to Balara, to optimize outputs and increase supply along the Marikina aqueduct to Pasig and Bonifacio;

(iv) modifications to the inter-connection of the La Mesa-Balara aqueduct to Balara Treatment Plant outlet, to maintain a higher hydraulic head in the aqueduct to serve Pasig and Bonifacio and by-pass the treatment plant;

(v) installation of a pressure control valve on the 1500 mm diameter branch main to Makati tank off the Balara-Marikina main;



METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
WATER SUPPLY IMPROVEMENT STUDY

Figure 6.1

SUBDIVISION OF MWSS SUPPLY AREAS FOR NETWORK ANALYSIS

(d) The installation of low lift pumps at Balara treatment plant, after 2000 would be feasible if supply capacity from Angat is confirmed as 4,000 Mld. This would not be required if an alternative scheme such as the Cavite Water Supply Project, is implemented to meet demands in the south.

(e) Improvements to the PDS proposed above will meet projected future demands until 2005. Further improvements will be needed to meet post-2005 demand; their extent will depend on future source development strategy and the supply to be made available from Angat.

6.2.3 Pressurization of Trunk PDS Mains

Modelling outputs confirm that elimination of throttling on the larger PDS mains, generally 900 mm diameter and above, will permit 2005 water treatment plant outputs to be distributed with the minimal reinforcements described above, additional to those proposed under the Angat Water Supply Optimization Project.

A more equitable distribution from the PDS could be achieved by establishing a "high-pressure primary system". This would involve throttling or closing the off-takes from all mains of 900 mm diameter and larger, and opening the presently throttled line valves in these pipelines. The methodology would be as follows :-

- valves on 750 mm to 300 mm diameter mains on the PDS to be throttled at selected locations based on pressures; and

- valves on secondary and tertiary mains of 300 mm diameter and less to be completely isolated where feasible or throttled until the distribution zones in the relevant area are established.

This would pressurize the larger PDS mains, enabling the additional supply available by 1999/2000 to be distributed to the southern area. A parallel benefit would be NRW control in the secondary and tertiary mains, by keeping pressures as low as feasible until these mains were rehabilitated. This would be a temporary arrangement only, whilst awaiting the systemwide zonal configuration for leakage monitoring and control and installation of pressure reducing valves on the off-takes from the PDS mains.

The number of valves needing to be throttled or isolated is estimated at:-

300 mm diameter and below : 161
400 mm diameter and above : 85

6.2.4 PDS Storage

The existing storage, together with that being provided under Angat Water Supply Optimization Project, is adequate for the Central Area up to the year 2005.

After 2005, additional storage at Bagbag will be required. The additional capacity required will depend on whether the West Area pumping stations continue to be operated or whether some of them are decommissioned.

If the rehabilitation of Caloocan and D.Tuazon pumping stations (see **Section 6.2.5**) is deferred or deprioritized, increased storage at Bagbag may be required before 2005.

6.2.5 PDS Booster/Storage Pumping Stations

Rehabilitation of booster/storage pumping stations is being carried out under the Angat Water Supply Optimization Project. The stations will then be adequate up to 2005.

Balara, Cubao, San Juan and Pasig pumping stations are designed to operate almost continuously. Consideration should be given to substituting some fixed speed pumps in these stations with variable speed pumps, to minimize high system pressures during low demand periods.

The proposed rehabilitation of the Caloocan and D.Tuazon pumping stations could be deprioritized. The need to upgrade the pumping stations further, after 2005 should be reviewed. As an alternative to upgrading pumping stations in the Western Area, strengthening pipelines and decommissioning of pumping stations could be undertaken, as proposed in the JICA Master Plan.

6.3 PDS Facilities Assessment

6.3.1 Pipelines

Initial assessment of PDS rehabilitation requirements has been based on classification of each pipeline according to two prioritization criteria, which are:-

- **risk of failure** - based on burst/repair history, pipe material/jointing system, pipe age, surface type; and
- **consequence of failure** - based on pipe diameter, major bridge crossings, likelihood of third party damage due to flooding, severe traffic disruption

Table 6.2 summarizes the resulting priority classification.

Table 6.2 - PDS Priority Classification Chart

CONSEQUENCE OF FAILURE	RISK OF FAILURE		
	LOW	MEDIUM	HIGH
HIGH			HIGH PRIORITY
MEDIUM		MEDIUM PRIORITY	
LOW	LOW PRIORITY		

Out of a PDS total mains length of about 535 km, some 51 km (39.9 km of asbestos cement, 9 km of cast iron and 2.1 km of reinforced concrete) have been identified as high priority for rehabilitation. An estimated 400 valves in the PDS also need rehabilitation.

Beyond 2005, more pipelines will require rehabilitation as their condition deteriorates. Priority should be given to asbestos cement pipes and the older cast iron pipes. The total lengths and ages of asbestos cement and cast iron pipelines in the PDS are summarized in **Table 6.3**.

Table 6.3 - Summary of Asbestos Cement and Cast Iron Pipelines in PDS

Pipe Material	Length (m)			Total Length (m)
	Pre-1970	1970 to 1979	1980 and After	
A. 350mm diameter and above				
Asbestos Cement	19,192	29,926	7,455	56,573
Cast Iron	4,502	90,231	6,102	100,835
Sub-Total (A)	23,694	120,157	13,557	157,408
B. 250-300 mm diameter [1)]				
Asbestos Cement	2,600	52,443	7,302	62,345
Cast Iron	3,015	19,214	-	22,229
Sub-Total (B)	5,615	71,657	7,302	84,574
Grand Total (A+B)	**29,309**	**191,814**	**20,859**	**241,982**

Note 1) In the Central Area supply system

MWSS should develop a systematic database to facilitate proper understanding of the condition of all underground pipeline assets and allow future rehabilitation expenditure to be properly prioritized. Data entries should include formal recording of pipe repair activities and sampling of pipes for condition assessment, as well as updated data relating to location, sizes, materials and age contained in existing MWSS pipe databases.

6.3.2 Pumping Stations

MWSS may wish to review the order of priority and the need for rehabilitation; particularly for some of the pumping stations in the western area which are served by Bagbag reservoir.

6.3.3 Service Reservoirs

Refurbishment of the existing reservoirs is also included as part of the Angat Water Supply Optimization Project. Apart from some minor additional rehabilitation works, one major item of additional rehabilitation work has been identified in this study. This is replacement of the San Juan (Old) Reservoir with a new 100 Ml reservoir.

6.4 General Leakage Assessment

6.4.1 Background

The complex PDS has many off-takes and interconnections, almost none of which are metered. Unless every off-take and connection was identified and closed, it is impossible to measure leakage in just the PDS. Assessment of leakage in the PDS has therefore been based on:

- a detailed review of historical burst/leakage data.
- field leakage measurements on seven representative lengths where off-takes were minimal and could be temporarily closed;
- field inspections for leakage in suspect areas identified by MWSS;
- field inspections of a 21 km representative sample of larger PDS mains for visible evidence of leaks;
- field inspections of a further 45 km of smaller PDS mains (asbestos cement and cast iron) to record visible leaks;
- analysis of leakage questionnaire responses from a broad range of MWSS staff; and
- detailed interviews with specific MWSS operational staff.

6.4.2 Observations

Historical MWSS data indicated that only 50 reported leaks were repaired on the PDS mains from 1989 to mid-1995. Of these 43 were on either asbestos cement or cast iron pipelines. In comparison, MWSS data indicate that, in the first six months of 1995 alone, 1,559 leaks were repaired on the general distribution system.

The seven field leakage measurements the PDS indicated that no measurable leakage was taking place.

Field inspection of the 21 km representative sample of larger PDS mains indicated few visible signs of leakage. Further inspection of 45 km of smaller asbestos cement and cast iron PDS mains detected visible leakage at 16 locations.

Leakage questionnaire responses and interviews with MWSS operational staff indicated that leakage in the PDS is perceived as a problem at a limited number of specific locations. In particular, several under-river crossings are experiencing regular problems. PDS pipelines in Epifanio Delos Santos Avenue have general leakage problems, but capital investment is already underway to rectify these.

During the field inspections, large numbers of visible leaks were counted on the smaller secondary and tertiary mains. This tends to suggest that, if leaks were widespread on the PDS, they would also be visible at the ground surface.

6.4.3 Conclusions of the Assessment

Based on the above, it is concluded that the bulk of the present physical water losses in the MWSS supply system are occurring in secondary and tertiary pipelines and service connections. Specific conclusions are;

- No evidence was found of any PDS mains being in a continuous leak/repair cycle.
- No evidence was found of any pipelines having a particular problem with joint leaks.
- There is evidence of a small number of visible leaks on the PDS.
- There is evidence of leakage problems at a number of specific sites, such as river crossings.
- There is evidence to suggest that burst/leakage occurrences are more prevalent in the older asbestos cement and cast iron pipelines. Replacing these mains for reasons of hydraulic deficiency or structural deterioration should make a significant contribution to leakage reduction in the PDS.

The facts that the MWSS PDS is an interconnected network of mains rather than a dedicated primary distribution system, and that surface evidence was found of a number of leaks, point to leakage levels in excess of two to three per cent normally associated with primary distribution mains. All available evidence suggests, however, that leakage from PDS mains is a small proportion of total system losses and is likely to be no more than about five per cent.

Present pressures in the PDS are often low. Increasing pressures from stepped-up supply will tend to increase the number of bursts, as well as the volume of water lost at existing leaks. The pressure dependency of leakage means that a financial analysis based on current PDS leakage levels is likely to be conservative.

6.5 Extensions to North and South Service Areas

North Area - The La Mesa pumping station, pipelines and reservoir facilities being provided under the Angat Water Supply Optimization Project will be adequate to handle projected flows up to 2005. Further improvements may be required after 2005 if development in the area matches projections.

South Area - The Fort Bonifacio II pumping station and the uprated Pasay pumping station, together with pipelines and other related facilities being provided under Angat Water Supply Optimization Project and the Manila South Water Distribution Project will be adequate until 2005.

7. IMPROVEMENTS AND REHABILITATION PROJECT

7.1 Strategy for Improvements and Rehabilitation for Central Area

The improvement/rehabilitation requirements for the PDS serving the Central Area have been considered for the two possible scenarios of available supply capacity from Angat reservoir, namely, 3,750 Mld and 4,000 Mld **(see Section 6.2.2).** Facilities that need to be improved or rehabilitated during the planning period up to year 2015 are detailed in **Table 7.1**.

Table 7.1 - Improvements or Rehabilitation for Central Area PDS

	Description	Angat Supply Capacity (Mld)	
		3,750 or 4,000	4,000
1	Replacement of ACP	✓	
2	Relining of CIP, SP and RCP with Hazen C ≤ 75	✓	
3	Strengthening of PDS	✓	✓
4	Replacement of Gate Valves with Butterfly Valves	✓	
5	Isolation of Laterals and Installation of Gate Valves	✓	
6	Inter-connections	✓	
7	Additional Storage	✓	✓
8	Existing Pumping Stations :- Decommission Rehabilitation	✓	 ✓
9	Balara Low Lift Pumping Station		✓

7.2 Priority Ranking of Components

The major part of NRW, including leakage losses, occurs in the secondary and tertiary mains and service connections. MWSS is currently implementing an aggressive program for the reduction of NRW and it is preferable that leakage control and rehabilitation of the PDS be carried out in unison with that of the secondary and tertiary mains. The proposed zoning of the distribution network will have an impact on the PDS, particularly smaller diameter pipelines between 300 mm and 600 mm. Planning of major changes should be deferred until zoning is complete.

The strategy for improvement and rehabilitation of the primary distribution system has therefore been developed in two stages:-

- Stage 1 - 1996-2005, immediate improvements which can and should proceed independently of zoning; and

- Stage 2 - 2006-2015, which should await overall distribution system zoning and could be implemented in two sub-stages, 2006-2010 and 2011-2015.

Table 7.2 presents the proposed Central Area works in line with this strategy.

Table 7.2 - Proposed Priority Ranking For Central Area Improvements

Description	Ranking		Implementation Period		
	Stage 1	Stage 2	1996-2005	2006-2010	2011-2015
1. Pipe Replacement					
1.1 Identified Priority List	✓		✓		
1.2 AC pipes under roads	✓	✓	✓	✓	
1.3 Other AC pipes		✓		✓	✓
2. Pipe Relining					
2.1 Manila Area	✓		✓		
2.2 San Juan Area	✓		✓		
2.3 Quezon Area		✓		✓	
2.4 Other Areas		✓			✓
3. Strengthen PDS					
3.1 Under WSIS	✓		✓		
3.2 Decommission pumping stations in West		✓		✓	
3.2 Rehabilitate other pump stations		✓		✓	
4. Replace Gate Valves in PDS	✓		✓		
5. Isolate Laterals & Install Gate Valves					
5.1 PDS Mains ≥ 900 mm diameter	✓		✓		
5.2 PDS Mains < 900 mm diameter		✓		✓	
6. Inter-connections					
6. La Mesa TP1 and TP 2 including balancing tank	✓		✓		
6.2 La Mesa-Balara aqueduct and Marikina aqueduct	✓		✓		
6.3 Pressure relief valves on branch to Makati Reservoir	✓		✓		
7. Additional Storage					
7.1 San Juan (100 Ml) to replace existing No.1	✓		✓		
7.2 Bagbag (100 Ml)		✓		✓	
8. Existing Pumping Stations					
8.1 Deprioritize Caloocan and D.Tuazon	✓		✓		
8.2 Decommission other pumping stations in West		✓		✓	
8.3 Rehabilitate other existing pumping stations		✓		✓	
9. Balara Pumping Station		✓		✓	

7.3 Project Scope

It is recommended that a Project comprising Stage 1 items in **Table 7.2** is implemented now, to meet requirements up to 2005. A more detailed description of the Project scope follows:-

To reduce PDS leakage and minimize pipe bursts when system pressures increase:

(a) Replacement and/or relining of 36 km of old and defective, large sized asbestos cement, cast iron and reinforced concrete pipelines, ranging from 400 mm to 1350 mm in diameter. Asbestos cement pipes will be replaced. Cast iron and reinforced concrete pipes will be relined.

(b) Replacement of 15 km of old and defective, medium sized asbestos cement pipelines, of 300 mm diameter.

(c) Replacement of under-river crossings at Puruza, Onyx Bridge and PG-6 to Moriones Bridge

To remove PDS hydraulic capacity and supply constrictions in the Central Area:

(d) Relining and/or replacement of 33 km of old asbestos cement, cast iron and steel pipelines, with Hazen-Williams "C" values of 75 and less. Asbestos cement pipes will be replaced. Cast iron and steel pipes will be relined.

To strengthen and improve the PDS:

(e) Installation of an additional 7 km long, 2000 mm diameter pipeline, along Congressional Avenue, Roosevelt Avenue and Del Monte Avenue into D.Tuazon, to improve supplies to the Western Area.

(f) Replacement of 400 existing gate valves with butterfly valves, on mains of 350 mm to 1500 mm diameter, to facilitate: isolation of sections of the PDS for leakage control; and, more effective distribution to the southern area.

(g) Replacement or installation of 160 isolating valves on the smaller laterals off the PDS trunk mains of 900 mm diameter and above, to facilitate pressurization.

To optimize supplies:

(h) Construction of a balancing tank to link the 3200 mm aqueduct from La Mesa Treatment Plant No.1 to Bagbag; and the 2800 mm aqueduct from La Mesa Treatment Plant No.2 to Balara, to optimize La Mesa outputs and provide additional supply along Marikina aqueduct to Pasig and Bonifacio.

(i) Modifications to the inter-connection of the La Mesa-Balara aqueduct and Balara Treatment Plant outlet, to provide a higher hydraulic head in the Marikina aqueduct to serve Pasig and Bonifacio.

(j) Installation of a pressure control valve on the 1500 mm diameter branch off the Balara-Marikina main to Makati tank, to improve inflow into Makati tank

(k) Construction of a new 100 Ml reservoir to replace the dilapidated San Juan Reservoir No. 1, to improve reliability of present supplies and provide the additional storage needed by about 2003.

The locations of the project facilities are shown on **Figure 7.1**.

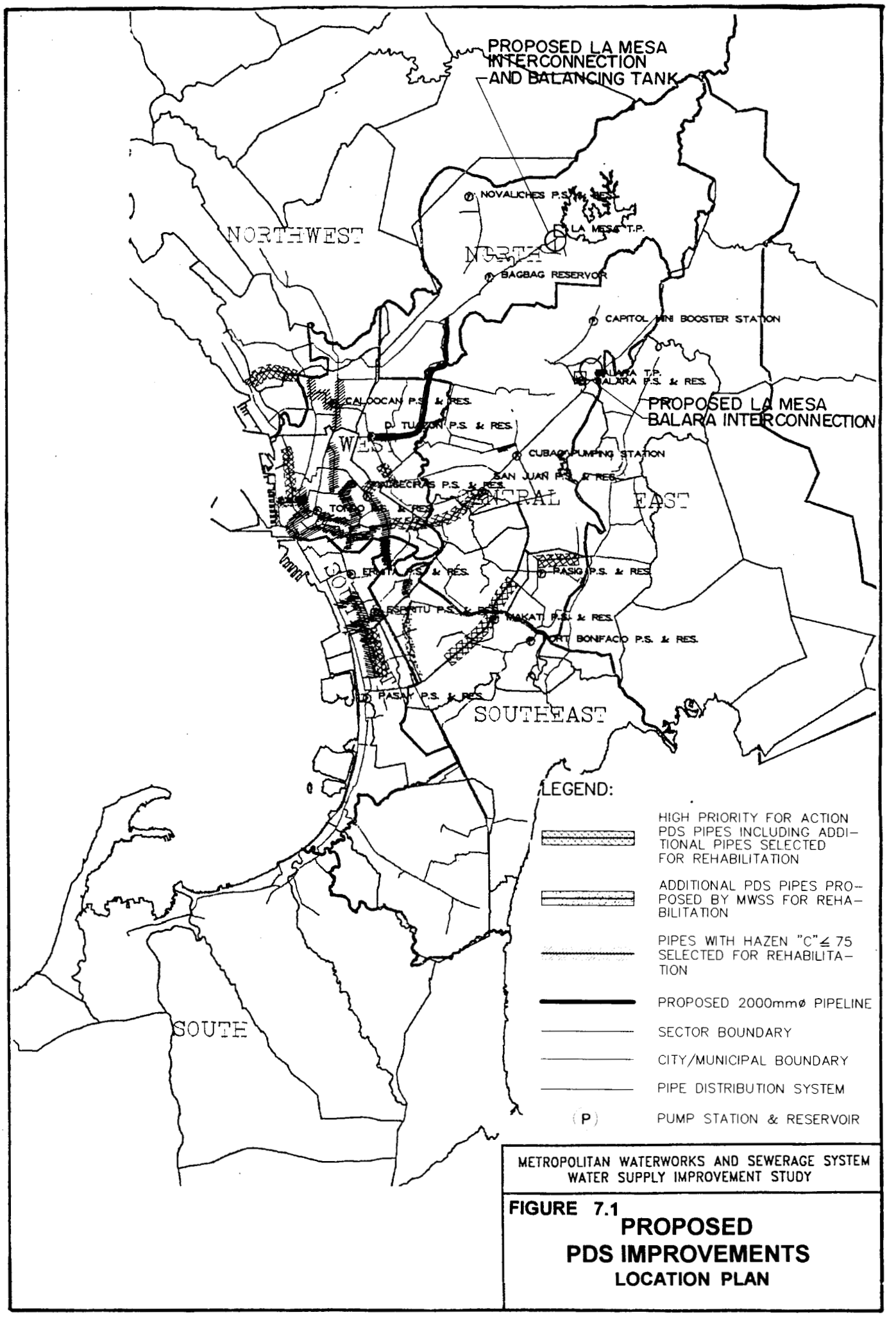
7.4 Capital Cost Estimates

Project capital cost estimates are presented in **Table 7.3**, at early-1996 costs.

Table 7.3 - Summary of Project Costs

	Components	Cost (₱ × 10^6)		
		Local	Foreign	Total
A	Civil Works	482.00	566.59	1,048.59
B	Supply of Materials	283.28	357.55	640.83
	Sub-Total (A+B)	765.28	924.14	1,689.42
C	Engineering Services etc.			
	Detailed Engineering Design	23.57	28.28	51.85
	Construction Supervision	23.57	28.28	51.85
	MWSS Support Services/Admin. Costs	23.57	28.28	51.85
	Sub-Total (C)	70.71	84.84	155.55
D	Contingencies			
	Physical	83.60	100.90	184.50
	Price	225.45	88.04	313.49
	Sub-Total (D)	309.05	188.94	497.99
	Escalated Cost (A+B+C+D) (rounded)	1,145	1,198	2,343
E	Interest During Construction	310	311	621
F	**Grand Total (Million Pesos)**	1,455	1,509	**2,964**
	Grand Total (Million US $)			**114**

Note:- exchange rate used, US$ 1 = P 26.00



METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM
WATER SUPPLY IMPROVEMENT STUDY

FIGURE 7.1

PROPOSED PDS IMPROVEMENTS LOCATION PLAN

7.5 Recurrent Cost Estimates

Based on a small full-time team in the Water Transmission and Meter Management Department carrying out the principal activities of: leakage detection and control; leak repair; routine valve inspection and operation; and, valve repairs or replacement of defective valves; the annual estimated operation and maintenance cost of the whole PDS is estimated at ₱5.0 million.

7.6 Implementation Strategy and Schedule

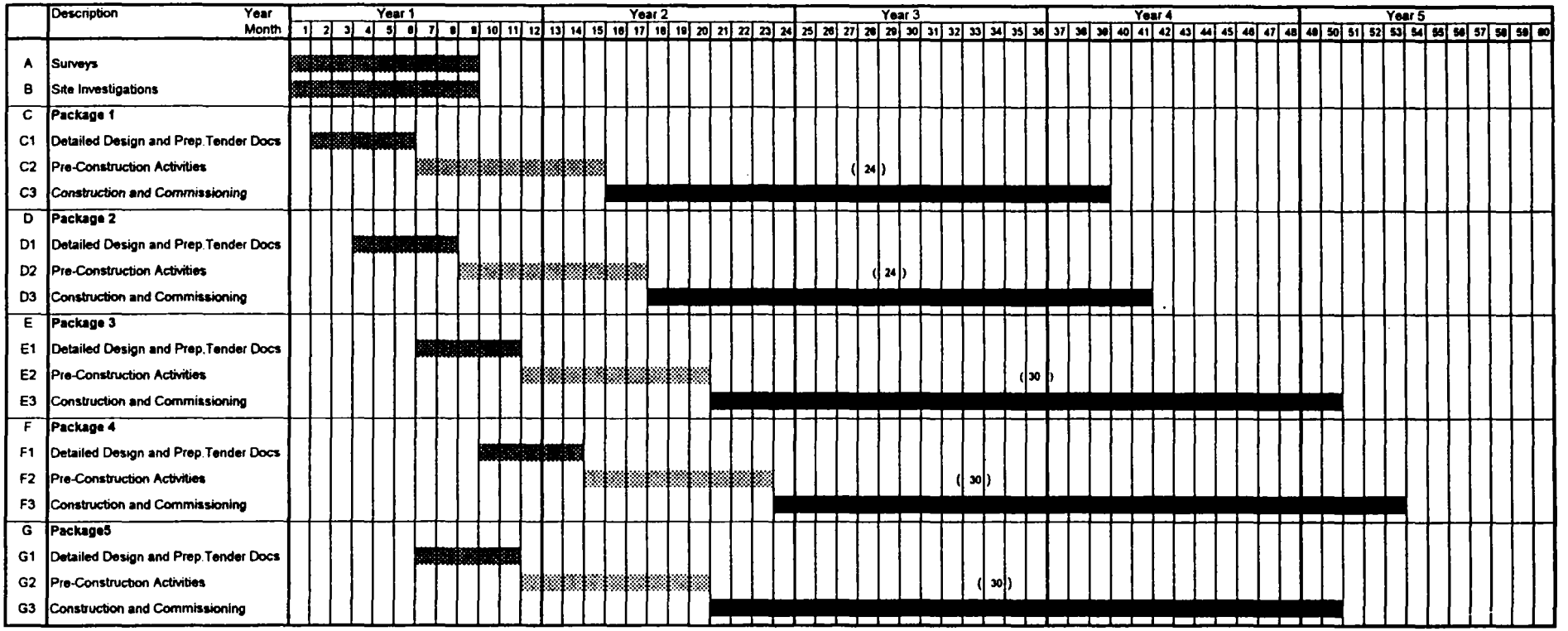
The proposed Project implementation schedule is shown in **Figure 7.2**, which also shows the five proposed construction procurement packages.

The Project start date is assumed as the beginning of 1997. This will allow the remainder of 1996 for loan sourcing and appointment of consultants. The timing of pre-construction activities is based on the latest "Proposed Schedule of Pre-Construction Activities for Civil Works Contracts (for Foreign Assisted Projects Costing More than ₱50.0 Million)". It is understood that MWSS Board approval of this schedule is awaited.

7.7 Benefits of Project

The benefits of the project include :-

- improved hydraulic capacity of the PDS to cater for increased supply from the Umiray-Angat Transbasin Project and effective distribution of water to all areas;
- reduced leakage in the PDS and improved operational efficiency;
- improved distribution, especially to the South Area;
- controlled pressures in the secondary and tertiary mains and minimized increases in NRW under improved overall supply, until these mains are rehabilitated;
- increased asset value of the PDS with the replacement or rehabilitation of about 20 per cent of existing asbestos cement and cast iron pipelines.



Notes :- 1 Package 1 - Replace existing gate valves on PDS with butterfly valves (350 mm dia and Above) and Replace or r Install of valves on PDS laterals (300 mm and below) mm and Below)

2. Package 2 - Supply and lay steel main and construction of balancing tank, modifications to inter-connections, installation of presure control vale and replace under-river crossings
3. Package 3 - Rehabilitation of existing mains by relining or replacement
4. Package 4 - Rehabilitation of existing mains by relining or replacement
5 Package 5 - Construction of new San Juan Reservoir

Figure 7.2
Primary Distribution System Improvements
Project Implementation Schedule

8. FINANCIAL ANALYSIS

8.1 Basic Assumptions

The financial analysis of the project has been based on the following assumptions:-

- a leakage reduction of 2 per cent of total production;
- under the Angat Water Supply Optimization Project, the PDS will handle a flow of 3,600 Mld, while the Angat supply capacity will increase by at least 3,750 Mld when the Umiray-Angat Transbasin Project is completed; 30 per cent of the additional 150 Mld distributed water is attributed to the PDS improvements;
- price contingencies at 8 per cent per annum (local costs) and 2.7 per cent per annum (foreign costs);
- physical contingencies at 10 per cent;
- MWSS's recently proposed tariff increase will be implemented, giving a weighted average tariff of ₱ 8.780/m^3 compared to the present ₱ 6.430/m^3

8.2 Investment and Financial Plans

Based on the proposed Project implementation schedule (**Figure7.2**), the annual investment requirements are summarized in **Table 8.1**

Table 8.1 - Investment Plan (₱ Million)

Component	Annual Investment (₱ × 10^6)					Total Investment		
	1997	1998	1999	2000	2001	LC	FC	Total
Civil Works	0	180	490	357	84	515	597	1112
Supply of Materials	0	87	494	0	0	252	329	581
Engineering Services	51	16	59	21	5	69	83	152
Total Base Cost	51	283	1043	379	90	836	1009	1845
Physical Contingencies	5	28	104	38	9	84	101	185
Price Contingencies	3	31	170	85	25	225	87	313
Interest During Construction	10	47	141	212	212	310	311	621
Total Project Cost	**69**	**389**	**1458**	**713**	**335**	**1455**	**1509**	**2964**

The proposed financing plan for the Project is shown in **Table 8.2**:-

Table 8.2 - Financing Plan

Source	Amount	
	(₱ × 10^6)	(US$ × 10^6)
Bank Loan	1,717	66.0
Counterpart Financing:		
• Government Loan	1,130	43.5
• MWSS Internal Cash	117	4.5
Total	**2, 964**	**114.0**

The proposed Bank loan is assumed to carry an annual interest rate of 6.89 per cent, a 20 year repayment period with a grace period of 5 years, and a commitment fee of 0.75 percent per annum based on a percentage of the undisbursed loan amounts. The loan is assumed to finance 60 per cent of the escalated Project cost plus interest during construction (IDC) on the foreign cost component.

Counterpart financing for the Project is assumed to be provided by the Government and MWSS. As the authorized capital of MWSS is already fully subscribed, it is assumed that the Government will provide a long term loan to MWSS to finance 35 percent of total project cost. The loan is assumed to carry an annual interest rate of 14 percent and a 20-year repayment period with a grace period of 5 years. The remaining five percent of Project cost is assumed to be financed from internal cash generation of MWSS. It is considered unlikely that MWSS can generate a higher proportion than what is assumed.

8.3 Results

The Financial Internal Rate of Return (FIRR) of the Project is calculated at 13.96 per cent. The Weighted Average Cost of Capital (WACC), based on the above financing plan and loan terms, is calculated at 9.73 per cent and the Project is therefore considered financially viable.

8.4 Risks

A sensitivity analysis of the effect of Project risks on the FIRR is shown in **Table 8.3**.

Table 8.3 - Sensitivity Analysis for FIRR

Scenario	NPV (₱ × 10^6)	FIRR	Change
a) **Base Case**	**488.99**	**13.96%**	
b) New water tariff not implemented	- 128.26	8.58%	-5.39%
c) 10% decrease in benefits	241.31	11.86%	-2.11%
d) 10% increase in cost	290.21	12.05%	-1.91%
e) One year delay in implementation	332.43	12.42%	-1.54%
f) Conditions c, d.and e combined	- 98.37	8.98%	-4.99%

Scenarios b and f, the latter a combination of three risks, give an FIRR lower than the WACC of 9.73 per cent and would make the Project marginally non-viable financially.

The basis of the above FIRR calculation and sensitivity analysis is that all water saved in the PDS will realise additional revenue. This will not occur unless NRW is reduced system-wide, failing which water saved by the PDS risks being lost as leakage and other NRW in the downstream secondary and tertiary systems. A reasonable assumption is that, if NRW is reduced in the secondary and tertiary systems by an amount equal to or greater than the reduction in the PDS, all water saved from the PDS will translate into additional revenue. If NRW in the secondary and tertiary systems remains at current levels of around 55 per cent, the base case FIRR is calculated at only 4.50 per cent. It is therefore imperative that parallel improvements are undertaken to reduce NRW in the remaining parts of the system.

8.5 Average Incremental Financial Cost

To estimate the average incremental financial cost (AIFC), the capital and operating costs of the Project and the amount of water to be generated by the project are discounted by the average financial cost of the capital. The calculated AIFC based on a weighted average financial capital cost of 9.73 percent is ₱ 7.568 per cu.m.

The present base rate charged by MWSS to the consumers is ₱ 6.43 per cu.m, which is lower than the AIFC. The base rate, however, is due for increase in mid-1996 to ₱ 8.78 per cu.m. In this case, the new rate fully covers the AIFC.

9 ECONOMIC JUSTIFICATION OF PROJECT

9.1 Benefits Considered

The economic benefits of the proposed project include:-

- The reduction of leakage in the primary distribution system will result in more water being made available for distribution.
- Improvement of the primary distribution system will allow proper distribution of the additional water which will be generated by the Umiray-Angat Transbasin Project.
- The provision of improved water supplies, with adequate pressures, will increase consumer satisfaction.
- Health benefits - particularly savings in cost of time due to illness, savings in economic loss due to premature death and savings in cost of medical expenses.
- Fire protection benefits.
- Increase in land value.
- Catalyst to economic activity.
- The reduction in the work burden on women in ensuring that the family have access to safe water. This generally translates into the time in gathering water for the household and in taking care of ill family members specially children due to contaminated water. Thus, women will now have more time in their hands for more productive endeavors and the general improvement of their health.

Some of the above benefits cannot be quantified. The economic benefits considered in the analysis were limited to:-

- Consumer satisfaction benefits;
- Health benefits; and,
- Fire protection benefits

9.2 Economic Costs

The economic capital costs and maintenance and operating expenses have been computed from the financial cost estimates on the following basis :-

- Price contingencies have been excluded.

- Physical contingencies have been included because they represent a real cost to the society

- Import duties and taxes estimated have been excluded as these are transfer payments.

- Due to under-employment, the opportunity costs of unskilled labor is considered lower than the wage rate, thus unskilled labor has been given a shadow price. A conversion factor of 0.8 of the market wage rate has been used. Skilled labor, because it is in demand, is considered to be fully utilized. Market wage rates have therefore been used for skilled labor.

- All prices have been expressed in domestic prices. Foreign exchange costs have been adjusted by a conversation factor of 1.20, the difference being the willingness by domestic consumers to pay above the direct foreign exchange cost. This conversation factor is based on National Economic Development Authority's guidelines in evaluating public sector projects.

- The discount rate of 15 percent currently being used by the National Economic Development Authority (NEDA) for evaluating public infrastructure projects was used as the opportunity cost of the capital.

- No replacement costs were considered in the analysis. The average asset life assumed for the various components of the Project is 30 years.

9.3 Results

The **economic internal rate of return (EIRR)** of the project is 26.11 percent. With an economic opportunity cost of 15 percent, the Project represents an efficient use of resources.

The **net present value (NPV)** is ₱ 901.48 million and the benefit/cost ratio is 1.51 percent, both at a discount factor of 15 percent.

The base case projections were subjected to sensitivity analysis, the purpose of which is to provide information on which assumptions the project results are most sensitive to. A summary of the results are as follows:-

Table 9.1 - Sensitivity Analysis For EIRR

Variable	% Change in Variable	NPV (in ₱ Million)	EIRR	Change
Base case		**901.48**	**26.11%**	
Capital cost	+10%	727.11	23.16%	2.95
Operating cost	+10%	899.77	26.09%	0.02
Consumer satisfaction	-10%	697.88	23.62%	2.49
Health benefits	-10%	860.13	25.60%	0.51
Fire protection	-10%	880.20	25.84%	0.27
Capital plus operating costs	-10%	725.40	23.14%	2.96

9.4 Average Incremental Economic Cost

To estimate the average incremental economic cost (AIEC), the capital and operatiing costs of the Project were discounted by the economic opportunity cost of capital. For this Project the economic opportunity cost of capital is assumed at 15 percent, the rate used by NEDA for evaluating infracture projects. The calculated AIEC for the Project is ₱ 10.171 per cu.m.

The AIEC is about 16 percent higher than the proposed new water tariff rate of ₱ 8.78 per cu.m. As a long term objective, the water tariff should be set to equal to the AIEC.

However, if a combined project covering not only the primary distribution system, but also the secondary and tertiary distribution systems is implemented, as proposed in **Section 11.2**, the resulting AIEC would be lower. This would most likely be less than the proposed new water tariff and hence enhance the project's economic viability.

10. INITIAL ENVIRONMENT ASSESSMENT

10.1 Environmental Impacts and Mitigation Measures

The proposed project will rehabilitate and improve the existing primary distribution system. No particular environmental problems are foreseen due to the location or nature of the various project components.

The overall operation of the system upon project completion will have no adverse impacts on the environment except for a consequent increase in sewage and drainage flows. Any improvement in water supply accessibility will allow customer access to increased water usage, resulting in an increase in sewage and drainage flows. Hence, MWSS should coordinate sewerage and drainage system improvements accordingly.

Environmental problems during the construction stage will mostly be temporary in nature. They will include noise, traffic disruption, dust, debris, litter and the dangers of open trenches. Contractors must be required to undertake all necessary measures to eliminate or minimize such problems.

Potential enhancement to the environment will be improvement in health and sanitation conditions, as well as better living conditions brought about by increases in economic prosperity in the area. This will result from water being readily available to the public.

10.2 Environmental Monitoring Program

Whilst adverse impacts to the environment will occur during the construction stage only, these would need to be controlled by proper supervision of the Contractors to ensure proper compliance with design specifications, methods of construction and environmental protection requirements. Construction activities must be continually monitored to ensure that identified environmental issues are addressed and minimized.

11. LEAKAGE CONTROL STRATEGY

11.1 General Approach

In order to accurately assess leakage in the PDS, meters would be required at all off-takes to the secondary system. . In the MWSS system, there are so many off-takes from primary distribution pipelines that a metered system would require significant capital investment, a very high degree of control and continual monitoring and analysis. This approach would also take some time to implement. In Manila leakage would be better addressed through monitoring of geographic areas rather than by isolating the PDS. (see **Section 11.2**).

A simpler approach could be instigated to bring benefits almost immediately. This should include:

- **Inspection by Line Walking.** This would involve an active policy of visual inspection of the pipelines at night-time; say twice-yearly for the older lines (pre-1980) and once-yearly for newer lines. Night time inspection would be preferred due to lower traffic congestion and higher water pressure that would allow leaks to be more easily identified.

- **Effective Repair of Leaks.** Combined with this active policy is a commitment to effect permanent repairs of the leaks. The provision of management support, manpower and adequate equipment must be made a priority as an integral part of a successful leak detection and repair policy.

- **River Crossings.** There may be some merit in considering intensive metering at under-river crossing points as these seem particularly vulnerable to both leaks and illegal connections.

11.2 Total Distribution System Approach

In most major cities there is a clear interface between primary and distribution mains. Primary systems usually have a tree or ring structure with a limited number of off-takes to supply reservoirs or distribution systems. These off-take are often equipped with pressure reducing valves and/or meters. By contrast the MWSS PDS is a network of large pipes with many interconnections and off-takes, some of them direct to customers. In the MWSS network there is no definite distinction or interface between the primary system and distribution mains.

The World Bank-funded "Manila Renovation of Water Distribution Network Project" and this study are both aimed at formulating projects for upgrading the MWSS water supply network. As an alternative to proceeding with the project outlined in this report, the Bank and MWSS may wish to consider awaiting the outcome of the World Bank ongoing studies, and then creating a co-financed program to upgrade the distribution system in an integrated manner.

Because of the particular nature of the MWSS PDS, there would be technical merit in formulating an such an integrated approach to rehabilitation and reduction of leakage throughout the total distribution system. This would allow a more practical technical and commercial boundary to be developed between the primary distribution pipelines and the secondary and tertiary networks. It may be possible in some areas to set up metering into the secondary and tertiary systems from the primary system. This together with the flowmeters being installed under the ongoing Telemetry Contract (AWSOP) will enable metering data to be used to monitor leakage in all systems.

The review of past system rehabilitation projects has indicated that the secondary mains have often been omitted from leakage/rehabilitation blocks. The modelling work carried out for this study has also indicated that some mains defined as secondary were actually hydraulically important to enable transfer of bulk water and are acting as primary distribution mains. An integrated approach to system leakage would allow all pipelines to be evaluated together and network components classified by their function rather than size.

Further justification of the benefit of an integrated approach is demonstrated by the severe impact on financial and economic indicators of the Project (see **Sections 8 and 9**), if NRW is not reduced in the secondary and tertiary systems by a similar quantum.

In previous rehabilitation and leakage control projects, there has been some success in reducing leakage levels, however there have been problems with sustaining the reduced levels. If the Bank and MWSS choose to formulate an integrated project, care should be taken that the project includes initiatives to ensure the long-term sustainability of the program.

11.3 Provision of Equipment

The condition and suitability of existing leakage detection equipment is poor. However within the Angat Water Supply Optimization Project, there is an Accelerated Non-Revenue Water Project component. MWSS proposes to purchase an extensive range of leak detection and repair equipment to meet their needs. The list of equipment is comprehensive and will satisfy the current equipment requirements of staff working on the primary distribution pipelines. Intensive training courses are also being arranged for the relevant MWSS staff within the program .

12. WATER SUPPLY SECTOR POLICY ISSUES

12.1 Introduction

The development of policies, plans and programs for the water sector involves a number of government bodies and agencies. Congress enacts the necessary legislation, National Economic Development Authority (NEDA) formulates the long-term plans, Department of Finance (DOF) identifies the sources of financing and Department of Budget Management (DBM) provides budgetary allocations for the projects. The Director of Public Works and Highways (DPWH) and Department of Interior and Local Government (DILG), due to their functional supervision over rural water utilities and local governments, also provide policy guidelines.

At the operational level, MWSS and Local Water Utilities Administration (LWUA), through the various Water Districts, are the agencies involved in the construction, operation and maintenance of water supply facilities. They also initiate and develop their own plans and programs based on the general policies laid down by the government. Water supply agencies are regulated and monitored by the National Water Resources Board (NWRB), Department of Environment and Natural Resources (DENR) and Department of Health (DOH) in areas of water resource management, water quality, and health and sanitation, respectively.

The MWSS has responsibility for the whole of Metro-Manila including some parts of Cavite and Rizal Provinces. Its corporate mission is to provide the people in its service area with adequate supply of potable water at fair and affordable prices. To achieve this, it performs the key functions of planning, infrastructure development, operations, and customer services, with support functions in finance, general administration, human resources management and information systems. As a public service organization, MWSS not only has to implement its own internal plans and program s but also has to align its operations to the policies and thrusts of the government.

The conclusions and recommendations on water supply sector policies and MWSS operations are summarized in the following sections.

12.2 On the Water Supply Sector

(a) A review of the membership composition of the National Water Resources Board should be conducted to determine whether some members should be on full-time basis and whether there is a need to change the Board composition. To provide better and effective management the Chairman, at least, should be on full time basis.

(b) There is a need to review the existing arrangements for sharing Angat water due to the changing requirements of users. This should involve the review of present operating rules and the adoption of new dynamic rule curves to optimize the use of Angat reservoir. New developments, such as the implementation of the Umiray-Angat Transbasin Project, should be fully reflected in the sharing arrangement.

(c) Future multi-purpose water supply projects should be developed based on equitable project cost sharing by users. If a project will be for the benefit of two users, the cost to implement the project should be shared by both parties.

(d) A water regulatory board should be established to facilitate rate increase implementation. With a regular tariff board, both rate proponents and oppositions are given equal chance to state their case, after which the board decides based on its independent review of the issues. Changes to tariff are more widely accepted and easier to implement if proposed and endorsed by an independent body.

12.3 On MWSS Operations

(a) There is a need to undertake a comprehensive review of the service coverage of MWSS due to the rapid urbanization of the areas around its present service area. The study should:

- identify which of the growth areas in Calabarzon and other industrial and economic zones should be under MWSS service coverage;
- determine the resources necessary to provide acceptable water supply and sewerage services; and
- recommend the type of institution required to manage and operate the services.

(b) MWSS should continue with its efforts to properly and effectively manage its non-revenue water. MWSS should give the highest priority for non-revenue water reduction programs.

(c) The new water rates as approved by the MWSS Board should be implemented as soon as practicable. The nature of MWSS operations requires adequate funds for effective repairs and maintenance work.

12.4 Privatization

The President of the Republic of the Philippines has issued an Executive Decree which authorizes the privatization of the MWSS as soon as possible. International Finance Corporation (IFC) is currently assisting the MWSS to review options for privatization.

The PDS rehabilitation project alone, as proposed by this study, is unlikely to generate sufficiently high returns for a privatized company; which may choose a total system approach covering the PDS, secondary and tertiary systems to generate more attractive returns.

If it is the Government's intention to burden the privatized water company with MWSS' outstanding debt, then the Government and the MWSS need to consider the impact on the MWSS balance sheet of the increase in indebtedness that will result from this project.