Japan International Cooperation Agency

National Water Resources Board
The Republic of The Philippines

The Study on Water Resources Development for Metro Manila in the Republic of the Philippines

Final Report

Volume I
Executive Summary

March 2003

Nippon Koei Co., Ltd.

NJS Consultants

List of Volumes

Volume I	**:**	**Executive Summary**	
Volume II	**:**	**Phase 1:**	**Master Plan Study - Main Report**
Volume III	**:**	**Phase 1:**	**Master Plan Study - Supporting Report**
Volume IV	**:**	**Phase 2:**	**Feasibility Study - Main Report**
Volume V	**:**	**Phase 2:**	**Feasibility Study – Suporting Report**
Volume VI	**:**	**Phase 2:**	**Feasibility Study - Data Book**

The cost estimate is based on the price level and exchange rate of June 2002.

The exchange rate is:

US$1.00 = PHP52.0 = ¥120.0

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Study on Water Resources Development for Metro Manila in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

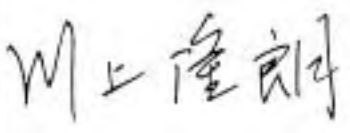
JICA selected and dispatched the study team headed by Mr. Michito Kato of Nippon Koei, Co., LTD. (consisting of Nippon Koei, Co., LTD. and NJS Consultants) to the Philippines, three times between March 2001 and February 2003. In addition, JICA set up the advisory committee headed by Mr. Takuji Oikawa, Director, Ikeda Dams and Canal Integrated Office, Water Resources Development Pubilic Corporation between March 2001 and March 2003.

The team held discussions with the officials concerned of the Government of the Republic of the Philippines, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the Study.

2003 March



Takao Kawakami
President
Japan International Cooperation Agency

March 2003

Mr. Takao Kawakami
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

Letter of Transmittal

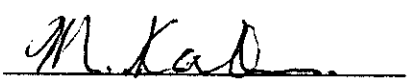
It is a great pleasure that we submit herewith the Final Report of the "Study on Water Resources Development for Metro Manila in the Republic of the Philippines".

The main objective of the Study was placed on the formulation of water supply development plan for the Metro Manila and its vicinity for meeting the water demand up to the year 2025. The Study prepared in its Phase I a master plan for the water resources development in the Agos River Basin and the associated water conveyance facilities, and successively in the Phase II a feasibility study for the priority project selected from the master plan. The Report presents the outcomes of the master plan and feasibility study.

We hope that this Report will be helpful for the realization of the project proposed in this Study. We believe that the successful undertaking of the proposed project would assure stable water supply in the Metro Manila area in the long term and thus contribute to the further socio-economic development in the region.

We wish to express our sincere gratitude to the personnel concerned of your Agency for the guidance and support given throughout the Study period. Our deep gratitude is also expressed to the National Water Resources Board and other concerned authorities of the Government of the Republic of the Philippines, JICA Philippines Office and the Embassy of Japan in the Philippines for their close cooperation and assistance extended during the course of the Study.

Very truly yours,



Michito Kato
Team Leader

The Study on Water Resources
Development for Metro Manila
in the Republic of the Philippines


PROJECT AREA
PHILIPPINES
LEGEND
River
Province Boundary
Catchment Boundary
Major Road
Road
City
N
W
E
S
Scale
0
10
20
30km
Pacific Ocean
Bulacan Province
Quezon Province
Angat Dam
Kanan River
AGOS RIVER BASIN
Agos River
Infanta
Agos Dam
Rizal Province
Kaliwa River
Metro Manila
Antipolo Service Reservoir
Kaliwa Low Dam
Taytay Service Reservoir
Morong WTP
Kaliwa-Taytay Waterway
Cavite City
Laguna de Bay
Laguna Province
LOCATION MAP

OUTLINE OF THE STUDY

CONCLUSIONS AND RECOMMENDATIONS

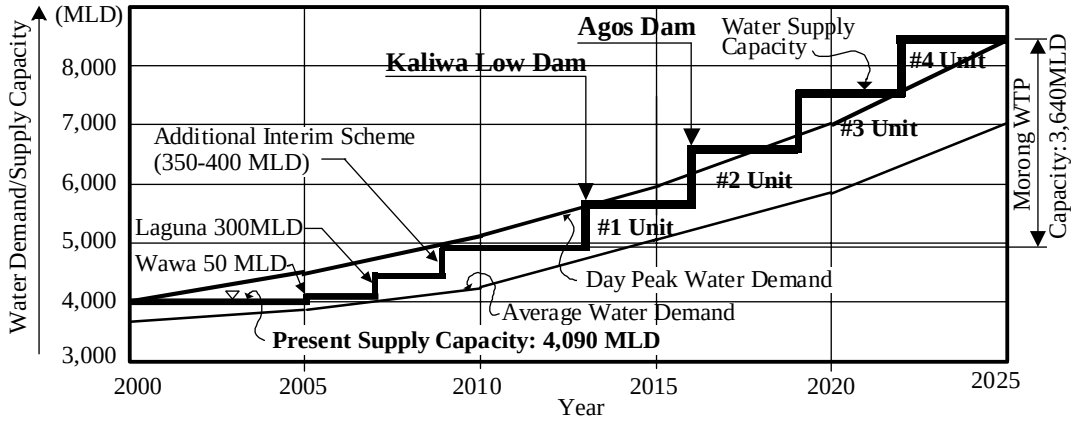
1. Necessity of Augmentation of Water Supply Capacity

Present water supply capacity in Metro Manila area is 4,090 MLD, comprising 4,000 MLD from the existing Angat system and 90 MLD from groundwater source. Present potential daily maximum demand is presumed to be larger than the supply capacity as represented by water rationing obliged in some areas. In this regard, it is deemed that the present supply capacity is already critical.

The demand is projected to increase to 8,450 MLD in terms of daily maximum demand towards Year 2025. This requires the development of new water resources of 4,360 MLD in day peak capacity or 3,600 MLD in daily average supply volume (assumed day peak factor:1.21).

2. Proposed Kaliwa Low Dam-Agos Dam Water Supply Project

The proposed project will yield 3,000 MLD in daily average quantity with the facilities capable of supplying 3,640 MLD to cope with the day peak demand. The earliest commissioning schedule of the first stage of the project is envisaged to be Year 2013.



Water Demand-Supply Balance and Project Commissioning Schedule

As shown in the figure above, the demand–supply balance will worsen year by year especially for the coming 10 years until the project is commissioned. The earliest commissioning of the proposed project is very requisite.

3. Earliest Decision of the Implementation

The project will require an 11-year lead-time towards the completion: 5.5 years for pre-construction arrangement and 5.5 years for construction of the first stage project. The schedule is tight with no time-float. In order not to allow any delay in

completion, a vital requirement for the Executing Agency (MWSS) is the earliest decision of the implementation of the project

4. Viability of the Proposed Project

The proposed water supply project is evaluated to have a favorable economic soundness and financial viability: the EIRR of overall water supply project being 16.7% and the FIRR of BOT portion of the water supply scheme being 17.6%.

MASTER PLAN STUDY

5. Comparison of Alternative Development Scenarios

Combining three (3) pre-selected dam schemes and three (3) run-of-river schemes as water sources in the Agos River Basin and three (3) waterway schemes laying out from the Agos River Basin to Taytay (off-take point for selling water to existing network), eight (8) alternative development scenarios, Scenario A to H, were formulated for comparison. The comparison was based on 'unit water cost index' (or in other terms equalizing water revenue rate) that would equalize the present worth of cost (construction and O&M costs) and assumed revenue streams.

The comparison revealed that Scenario B, comprising the Kaliwa Low Dam and Agos Dam as water sources and the Kaliwa-Taytay Waterway as water conveyance facility, would give the least cost solution

Laiban Dam is a project earlier committed by the government. However, the project has been frozen since 1984 due to difficulty of solving the relocation issue (some 3,000 households to be relocated). Laiban Dam alone cannot suffice the total demand up to Year 2025, the target year of this Study, and requires the successive commissioning of the Agos Dam after 7 years. This development scenario, Scenario F, was less favorably evaluated than the Scenario B.

6. Formulation of a Master Development Plan

Along with the Scenario B selected above, the Study formulated a master plan for the water resources development of the Agos River Basin and the associated water conveyance with a main objective of water supply to Metro Manila for a planning horizon up to Year 2025. Besides the water supply scheme, the proposed plan included also hydropower schemes identified in connection with the water supply scheme and several projects for regional development.

Among the project components formulated in the Master Plan, the Study intended to take up the first stage project of the water supply scheme for the feasibility study. However, the configuration of the project required a due study on the Agos Dam since the viability of the project was thought to depend largely on the feasibility of Agos Dam included in the second stage. Hence, the feasibility study covered almost all components included in the Scenario B scheme.

FEASIBILITY STUDY

7. Proposed Development Projects (Water Supply and Hydropower)

The projects formulated in the feasibility study are summarized in table below.

Configuration of Proposed Water Supply and Hydropower Development Projects

Proposed Facilities	1st Stage Develop.	2nd Stage Development	
	Stage 1 (Comp. Year 2013)	**Stage 2-1** (Completion Year 2016)	**Stage 2-2** (Completion Year 2019-22)
WATER SUPPLY SCHEME			
Demand to Meet	2014-2016	2016-2019	2020-2025
Water Supply Q'ty (daily average)	550 MLD initially (550 MLD)	Additional 950 MLD (total 1,500 MLD)	Additional 1,500 MLD (total 3,000 MLD)
Water Source:			
Kaliwa Low Dam	Supply of 550 MLD initially	(Supply substituted by Agos Dam)	
Agos Dam	-	Supply of 1,500 MLD, incl. 550 MLD formerly supplied by Kaliwa Low Dam	Supply of additional 1,500 MLD (total yield 3,000 MLD)
Water Conveyance Facilities:			
Kaliwa-Taytay Waterway	1st Waterway for 1,500 MLD	-	2nd Waterway for additional 1,500 MLD (total 3,000 MLD)
Morong Water Treatment Plant (WTP)	WTP #1 – 750 MLD	WTP #2 - 750 MLD (total 1,500 MLD)	WTP #3 & #4 - 1,500MLD (total 3,000 MLD)
Taytay Main Service Reservoir (SR)	SR #1- 190,000 m^3	SR #2 - 190,000 m^3 (total 380,000 m^3)	SR #3&4 - 380,000 m^3 (total 760,000 m^3)
HYDROPOWER SCHEME			
Agos Hydropower Scheme	-	51.5 MW in installed capacity	-

Note: The above figures in MLD represent daily average supply quantity. The capacity of waterway and WTP facilities is planned to be 1.21 times the daily average supply capacity to cope with the production requirement meeting the day peak demand.

A hydropower scheme earlier envisaged in the master plan at Lagundi (at downstream end of the waterway tunnel) was finally ruled out due to the low financial viability.

8. Measures for Mitigating Environmental Impacts

The project involves no serious natural environmental problem that would adversely affect the implementation of the project. Nevertheless, several items of mitigation measures are proposed to minimize the impacts arising from the project. They include (i) protection of eco-system, (ii) collaboration to the on-going watershed management project and (iii) measures for mitigating the water pollution in the upstream basin especially the Kaliwa River basin.

Reduction of sediment yields due to trapping by the Agos reservoir may cause the change of shape of coastlines in the Infanta Plain in a long range. The Study proposed a monitoring program of the coastlines in the future and countermeasures to be taken in the case adverse impact should arise.

9. Resettlement Plan

Agos reservoir will inundate 174 households. This relocation quantity is deemed to be within a manageable extent if a proper resettlement plan (RP) is implemented. The majority of affected people showed presently an attitude of reluctance to the relocation. People's general attitude is that they would like to have 'conditions' and 'promised benefits' in place first before their agreement to the relocation.

Two (2) resettlement sites were identified along the Kaliwa River. The sites are intended to house the affected people from the same barangays. In this way, social displacement and institutional adjustments are kept to a minimum.

Another 222 households will be relocated in the proposed waterway area. The majority of affected households expressed no strong opposition to the relocation. The resettlement will be made to the nearby areas so as to minimize the change of livelihood of the relocated people.

10. Associated Works for Regional Development

The implementation of the proposed project, particularly Agos dam, will bring about a certain extent of inconveniences to the people in the project area. For compensation to those inconveniences, the project will contain several works aiming at improvement of people's livelihood and enhancement of regional economic activities.

Associated Works Proposed for Regional Development

	Description	Objective
1	Bank erosion protection works at General Nakar and Infanta	Collaboration to solving the present difficulty in project affected area
2	Flood protection work at General Nakar	- do above -
3	Provision of river use facility at 21 places in the Agos downstream reach	For facilitating the people's river use (for change of water level regime)
4	Provision of access roads and footpaths along the perimeter of proposed Agos reservoir, including a permanent access road to Barangay Daraitan	For facilitating the people's traffic between the communities in the area
5	Flood protection bund at Barangay Daraitan	For prevention of flooding in low-lying area due to rise of flood water level
6	Establishment of a manpower training center either at Barangay Daraitan or new resettlement site	For supporting income restoration program for the relocated people
7	Establishment of a health center either at Barangay Daraitan or new resettlement site	For benefit to the relocated people

The cost of the above works, estimated at US$ 5.75 million equivalent, was included as a part of the construction cost of Agos Dam.

In addition to the above, a drainage improvement work for Infanta town was also examined in the Study. The work will be mobilized as a separate project since it is not directly related to the proposed Agos Dam project (no adverse effect by the dam). The cost is estimated roughly to be US$ 2.4 million.

11. Project Implementation Cost

The total construction cost of the whole project is estimated as US$ 1.73 billion equivalent at 2002 price. The fund requirement inclusive of price contingency and tax (VAT) is US$ 2.54 billion equivalent.

The project will be divided into three components for implementation; (i) water source facilities (Kaliwa Low Dam and Agos Dam) and water conveyance tunnel up to water treatment plant to be implemented as the government project (GOVw, see table below), (ii) water treatment plant and transmission facilities as BOT project (BOTw) and (iii) Agos power station also as BOT project (BOTa).

The project cost estimated for respective projects is summarized in the table below.

Summary of Estimated Project Cost (Million US$ equivalent)

Stage	Main Works	GOVw	BOTw	BOTa	Total
1	Kaliwa Low Dam + 1st Waterway	252.1			
	Morong WTP-Taytay 1st Waterway + WTP #1		258.3		510.4
2-1	Agos Dam	503.2			
	WTP #2 Unit		91.3		
	Agos Power Station			80.8	675.3
2-2	Kaliwa-Morong WTP 2nd Waterway	176.3			
	Moron-Taytay 1st Waterway+WTP #3 and #4		368.5		544.8
	Project Cost at 2002 Price (*)	931.6	718.1	80.8	1,730.5
	Price Contingency				639.7
	Taxes (VAT)				173.1
	Fund requirement （excluding IDC）				2,543.3

Note: 1. (*)Base construction cost at 2002 price + Engineering Services + Administration Cost + Physical Contingency

2. In this report, water conveyance and transmission facilities from Intake and Service Reservoirs are generically called ‘waterway’ or ‘waterway facilities’.

3. WTP: Water treatment plant at Lagundi, Morong
GOVw: Government project for water supply development
BOTw: BOT project for water supply development
BOTa: BOT project for Agos Hydropower Development

12. Evaluation of Proposed Project

The feasibility of the project was evaluated from the five (5) aspects stated below. The conclusion of the evaluation is as follows:

Summary of Project Evaluation

Item	Description of Evaluated Results
Economic Evaluation	Water Supply Scheme (GOVw+BOTw): EIRR 16.7% Agos Hydropower Scheme (BOTa): EIRR 14.4 %
Financial Analysis	BOTw: FIRR 17.6 % and ROE 15.0 % BOTa: FIRR 25.6 % and ROE 38.4 % Water Rates: Peso 7.3 per m^3 at off-take point of GOVw Peso 15.9per m^3 at off-take point of BOTw
Technical Aspect	The project involves several technical difficulties, but all are of technically solvable nature by proper planning of preventive measures and proper design of structures
Social Aspect	Relocation quantity, about 400 households in total, is of a manageable extent by deploying a proper resettlement plan
Natural Environmental Aspect	The project will cause a certain extent of environmental problems. However, they are mostly of the nature for which mitigation measure can be applied. Several protection measures are proposed as a component of the project

PRINCIPAL FEATURES OF PROPOSED PROJECT (MAIN WORKS)

Objective of Project:				
- Water Supply	Supply of water to Metro Manila and its vicinity for meeting demand up to Year 2025			
- Hydropower	Supply of power to the existing Luzon grid and Quezelco grid (Infanta) by harnessing hydropower potential available at Agos Dam			
		Stage 1	Stage 2	
Development Scale:			Stage 2-1	Stage 2-2
- Water Supply (Accumulated)	Day average supply volume	550 MLD	1,500 MLD	3,000 MLD
	Day peak supply capacity	660 MLD	1,820 MLD	3,640 MLD
- Hydropower	Installed capacity		51.5 MW	

Description	Proposed Plan
Agos River Basin:	
Drainage area	
- at Agos damsite	860 km^2
- at river mouth	940 km^2
Mean discharge	
- at Agos damsite	113.3 m^3/sec
- at river mouth (Banugao)	120.6 m^3/sec
Agos Reservoir:	
Full Supply Level (FSL)	EL.159 m
Minimum Operating Level (MOL)	EL.133 m
Gross storage capacity	886 x$10^6 m^3$
Effective storage capacity	409 x$10^6 m^3$
Reservoir area at FSL	19.1 km^2
Exploitable water	61.0 m3/sec
Agos Dam:	
Type	CFRD
Crest elevation	EL.165.2 m
Crest length	780 m
Height above foundation rock	165 m
Dam embankment volume	13.4 x$10^6 m^3$
Spillway discharge capacity	
- Design flood	9,600 m^3/sec
- Probable maximum flood	17,100 m^3/sec
Kaliwa Low Dam:	
Type	Random fill
Operating water level	EL.125.0 m
Crest elevation	El.129.0 m
Height	36.0 m
Waterway Intake:	
Type	Inclined type
No. of intake mouth	2 nos.
Intake discharge (by 2 intakes)	42.0 m^3/sec
Tunnel No.1:	
Type	Pressure tunnel
No. of tunnels	2 lines
Discharge capacity (by 2 tunnels)	42.0 m^3/sec
Diameter	3.5 m, circular
Length	27.5 km

Description	Proposed Plan
Morong Water Treatment Plant:	
Type	Rapid filtering
Plant yard net area	96 ha
No. of plant units	4 units
Capacity	910MLD/unit
Pipeline No.1:	
(WTP-Tunnel No.2)	
Type	Buried steel pipe
No. of pipelines	2 lines
Diameter	3.4 - 3.3 m
Length	4.9 km
Pipeline No.2:	
(Valve house-Antipolo SR)	
Type	Buried steel pipe
No. of pipelines	2 lines
Diameter	1.6 m
Length	4.1 km
Antipolo Pump Station:	
Type of Pumps	Multi. centrifugal
Plant yard net area	0.9 ha
No. of plant units	10 units
Capacity per pump unit	59m^3/min/unit
Antipolo Service Reservoir:	
Type	Concrete tank
Plant yard net area	6.5 ha
No. of reservoir tanks	6 tanks
Storage capacity per tank	30,000m^3/tank
Tunnel No.2:	
Type	Pressure tunnel
No. of tunnels	2 lines
Discharge capacity (by 2 tunnels)	42.0 m^3/sec
Diameter	3.3 m, circular
Length	5.4 km
Taytay Service Reservoir:	
Type	Concrete tank
Plant yard net area	20 ha
No. of reservoir tanks	4 tanks
Storage capacity per tank	180,000m^3/tank

Agos Damsite (Looking Upstream)

Proposed Facilities in the Project Area

THE STUDY
ON
WATER RESOURCES DEVELOPMENT
FOR
METRO MANILA
IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

Table of Contents

List of Figures

ABBREVIATION

Organizations:

DENR	:	Department of Environment and Natural Resources
DFI	:	Development Financing Institutes
DILG	:	Department of Interior and Local Government
DOE	:	Department Energy
DOH	:	Department of Health
DPWH	:	Department of Public Works and Highways
DTI	:	Department of Trade and Industry
GOJ	:	Government of Japan
GOP	:	Government of the Republic of the Philippines
JICA	:	Japan International Cooperation Agency
LGU	:	Local Government Unit
Meralco	:	Manila Electric Company
MWCI	:	Manila Water Company Inc.
MWSI	:	Maynilad Water Services Inc.
MWSS	:	Metropolitan Waterworks and Sewerage System
NAMRIA	:	National Mapping and Resource Information Authority
NEDA	:	National Economic and Development Authority
NIA	:	National Irrigation Administration
NPC	:	National Power Corporation
NSO	:	National Statistical Office
NWRB	:	National Water Resources Board
OP	:	Office of the President
PHILVOLCS	:	Philippine Institute of Volcanology and Seismology
Quezelco	:	Quezon Electric Company

Technical Terms:

Barangay	:	Village (administration unit within Municipality)
BOT	:	Build-Operate-and-Transfer
CFRD	:	Concrete Face Rockfill Dam
DSCR	:	Debt Service Coverage Ratio
ECRD	:	Earth Core Rockfill Dam
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EO	:	Executive Order
EVAT	:	Expanded Value Added Tax
EWR	:	Equalizing Water Rate
FC	:	Foreign Currency
FGD	:	Focus Group Discussion
FIRR	:	Financial Internal Rate or Return
F/S	:	Feasibility Study
FSL	:	Full Supply Level
GDP	:	Gross Domestic Products
GRDP	:	Gross Regional Domestic Products
IEE	:	Initial Environmental Examination
IPs	:	Indigenous Peoples

JVC	:	Joint Venture Company
LC	:	Local Currency
LCB	:	Local Competitive Bidding
LWL	:	Low Water Level
M/P	:	Master Plan Study
MOL	:	Minimum Operation Level
NATM	:	New Austrian Tunneling Method
NCR	:	National Capital Region
NRW	:	Non-Revenue Water
O&M	:	Operation and Maintenance
ODA	:	Official Development Assistance
PAF	:	Project Affected Family
PAP	:	Project Affected People
PD	:	Presidential Decree
PMF	:	Probable maximum flood
PROC	:	Proclamation
P/S	:	Power Station
RP	:	Resettlement Plan
PHP	:	Philippine Peso
ROE	:	Return on Equity
SES	:	Socio-Economic Survey
Sitio	:	Hamlet (settlement within Barangay)
SR	:	Service Reservoir
TBM	:	Tunnel Boring Machine
TOR	:	Terms of Reference
TRANSCO	:	National Transmission Company
WACC	:	Weighted Average Cost of Capital
WRAP	:	Water Resources Authority of the Philippines
WTP	:	Water Treatment Plant
WtP	:	Willingness to Pay

Units:

GWh	:	Gigawatt-hour
KWh	:	kilowatt-hour
EL.	:	Elevation
ha	:	Hectare
km	:	Kilometer
m	:	Meter
m^2	:	Square meter
m^3	:	Cubic meter
m^3/sec	:	Cubic meter per second
MLD	:	Million Litter per Day
MW	:	Megawatt

THE STUDY

S1 Background of the Study (Chapter I of Volume II and IV)

One of long outstanding problems in Metro Manila is chronic shortage of water resources for stable water supply, which constitutes one of factors of hampering the economic and social development in the area. Since water demand in the Metro Manila is increasing year by year, the expansion of water supply capacity is an impending need to be tackled. Further, the present water supply depends almost on a single water source, Angat Dam, which supplies 97 % of the total water. In order to establish a stable and reliable water supply system, there is a great need of exploiting another bulk water source.

With these background, the Government of the Republic of the Philippines (GOP) requested the Government of Japan (GOJ) in January 2000 to conduct a master plan study on the water resources development in the Agos River Basin and a feasibility study on the selected project. The main objective of the Study is placed on the formulation of a plan for augmenting the water supply capacity in the Metro Manila area.

In response to the request from the GOP, the GOJ agreed to carry out this "Study on Water Resources Development for Metro Manila in the Republic of the Philippines", as a program of technical cooperation between the two countries. For the implementation of the Study, the Japan International Cooperation Agency (JICA), responsible for the implementation of technical cooperation activities of the GOJ, dispatched a Study Team to commence the Study in March 2001.

On the part of the GOP, National Water Resources Board (NWRB) acts as the counterpart agency for the JICA Study Team and also as a coordinating body for the smooth implementation of the Study. The NWRB has organized a Steering Committee and a Technical Committee for supervising the study activities, both of which are composed of representatives from the concerned agencies. NWRB has also nominated counterpart personnel to coordinate closely with the JICA Study Team.

S2 Objectives of the Study (Chapter I of Volume II and IV)

The objectives of the Study are threefold:

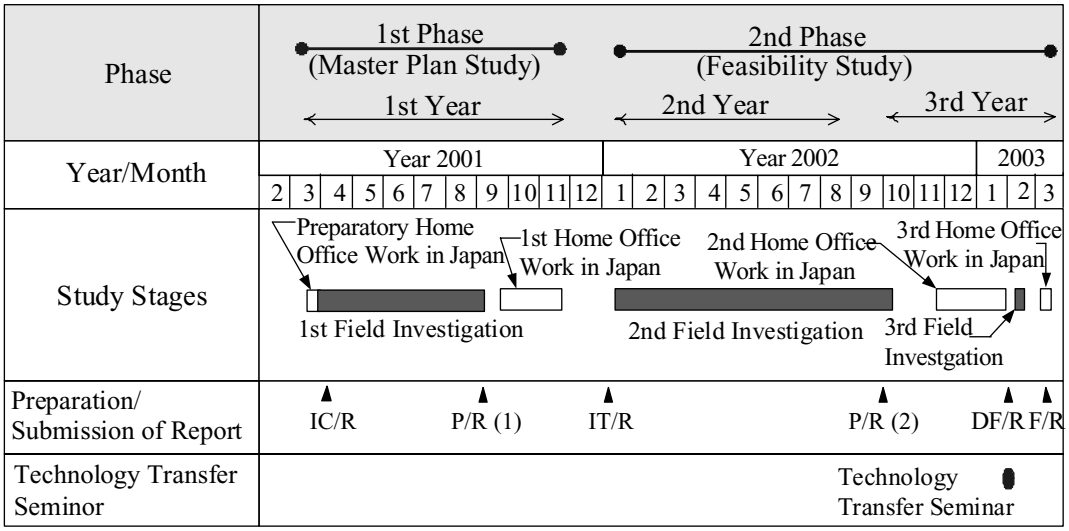
- To formulate a master plan on water resources development in the Agos River Basin (including Kanan and Kaliwa River Basins) to supply domestic, municipal and industrial water to Metro Manila (Phase 1 Study)
- To conduct a feasibility study on the priority project(s) which will be selected from the master plan (Phase 2 Study)
- To carry out technology transfer to the Philippine counterpart personnel in the course of the Study.

S3 **Study Area** (Chapter I of Volume II and IV)

The Study area covers the Agos River Basin including the Kanan and Kaliwa River Basins, as well as the MWSS water supply service areas in and around Metro Manila.

S4 **Overall Work Schedule of the Study** (Chapter I of Volume IV)

The Study was carried out dividing the work period into two phases, namely Phase I: the Master Plan Study (M/P) spanning between March 2001and November 2001, and Phase II: the Feasibility Study (F/S) on the selected priority project spanning between January 2002 and March 2003.



IC/R: Inception Report P/R: Progress Report IT/R: Interim Report
DF/R: Draft Final Report F/R: Final Report

Overall Work Schedule of the Study

Originally, the Study was scheduled to be completed by November 2002. However, this has been extended by four months to March 2003 due to additional time required to complete the Second Field Investigation Work in the Phase 2 stage, related to security problems and adverse weather condition encountered on the site.

S5 **Reports** (Chapter I of Volume IV)

Reports produced from the Study cover two components; i.e., Master Plan Study (M/P) and Feasibility Study (F/S). The Reports are presented in the following six (6) volumes:

Volume I	Executive Summary (this Report)
Volume II	Phase 1: Master Plan Study – Main Report
Volume III	Phase 1: Master Plan Study – Supporting Report
Volume IV	Phase 2: Feasibility Study – Main Report
Volume V	Phase 2: Feasibility Study – Supporting Report
Volume VI	Phase 2: Feasibility Study – Data Book

The F/S has refined and updated various data presented earlier in the M/P, based on new findings from the Second Field Investigation conducted after the M/P. Hence, there are some differences in the presented figures between M/P and F/S. The refinement and updating in the F/S relate to the following study items:

(a) Assessment of in-situ field conditions based on the results of field investigations

(b) Preparation of layout plans of the proposed facilities based on the findings from (a) above

(c) Assessment of socio-environmental conditions based on EIA

(d) Construction cost estimate based on changes in (a) to (c) above

(e) Economic and financial evaluations of the project incorporating the revision in (d) above

It is noted that the concept of plan formulation has been kept consistent throughout the course of the studies. The revision of plans and figures made in F/S is not of such a major extent as affecting the logic and result of comparative studies presented in the M/P. Hence, the conclusion and recommendation in the M/P and F/S still remain consistent.

PHASE 1 MASTER PLAN

M1 Socio-Economic Framework (Chapter II of Volume II)

M1.1 Population Projection (Chapter II)

The Study area in terms of the proposed water supply area covers the National Capital Region (NCR) and partial areas of Rizal Province and Cavite Province, which is identical to the MWSS service area designated in the Concession Agreement with the two concessionaires (MWCI/MWSI). (See Figure M1.1)

Future population in the Study area was projected for the period up to year 2025, the planning period of the Study. The population projection aims at providing data for the estimate of future water demand in the Study area at city/municipality level. The population projection so derived is summarized below:

Population Projection up to 2025

(Unit: 1,000)

Description	Population 2000 (Census)	Projected Population					Growth Rate
		2005	2010	2015	2020	2025	2000-2025
The Philippines	76,499	84,241	91,868	99,016	105,507	113,661	1.6 %
NCR *1	9,933	10,680	11,291	12,434	12,854	13,241	1.2 %
Cavite Province *2	2,063	2,357	2,411	2,715	2,987	3,250	1.8 %
Rizal Province *3	1,707	2,152	2,681	3,409	4,222	5,139	4.5 %
Study Area Total	13,073	15,189	16,383	18,558	20,063	21,630	2.0 %

Notes: *1 12 cities and 5 municipalities
*2 1 city (Cavite) and 5 municipalities
*3 1 city (Antipolo) and 13 municipalities

As shown above, the population of the Study area is projected to increase at 2.0 % per annum for the period of 2000-2025.

M1.2 GRDP Projection (Chapter II)

Gross Regional Domestic Product (GRDP) in the Study area was projected for the three major sectors of agriculture, industry and service up to the year 2025, by referring to the indices contained in the Long-Term Philippine Development Plan (LTPDP) and the Medium-Term Philippine Development Plan (MLTPDP). The GRDP projection is needed to provide basic data for the estimate of future municipal and industrial water demands in the Study area. The projected GDP/GRDP are summarized below:

GDP/GRDP Projections for 2000-2025

(Unit: Billion Pesos)

Description	2000	2005	2010	2015	2020	2025	Growth 2000-25	Share to Nation 2025
Philippines (GDP)	962	1,236	1,604	2,097	2,760	3,652	5.5%	
NCR	294	388	520	696	933	1,250	6.0%	34.2%
- Agriculture Sector	0	0	0	0	0	0	0%	0%
- Industrial Sector	112	144	192	254	339	450	5.7%	28.0%
- Service Sector	182	244	328	441	594	800	6.1%	44.7%
Region IV	148	191	249	328	435	582	5.6%	15.9%
- Agriculture Sector	34	37	38	39	40	41	0.7%	16.1%
- Industrial Sector	64	86	119	164	225	310	6.5%	19.3%
- Service Sector	50	68	92	125	170	231	6.3%	12.9%

As shown above, the GRDP of NCR and Region IV is projected to grow at 6.0% and 5.6% per annum, respectively, for the period of 2000-2025, both of which are higher than the GDP growth rate of the whole country (5.5%).

M2 Water Demand Projection (Chapter II of Volume II)

Water demand consists of billed water (domestic + commercial + industrial) and non-revenue water (NRW). The demand projection takes into account the growth of population and GRDP and also the improvement of billed water ratio (decrease of NRW ratio). The projected water demand is summarized in the table below, together with the projection of per capita consumption, service coverage and NRW ratio:

Water Demand Projection up to Year 2025

Description	2000	2005	2010	2015	2020	2025	Growth Rate
Projected Water Demand: (MLD) *1							
Day average demand	3,663	3,783	4,250	5,033	5,866	6,980	2.6 %
Day peak demand *2	(4,400)	4,577	5,143	6,090	7,097	8,446	2.9 %
Present Supply Capacity *3	4,090						
Per capita consumption (Lpcd)	119	125	139	153	170	188	1.8 %
Service coverage (%)	69	71	75	81	88	97	1.4 %
Served population (1000)	8,120	9,703	11,286	13,785	16,147	19,109	2.4 %
Billed water ratio (%)	39.1	46	52	58	64	70	2.4 %
NRW ratio (%)	60.9	54	48	42	36	30	- 2.8 %
of which, - Physical loss (%)	33.5	30	28	26	23	20	- 2.1 %
- Commercial Loss (%)	27.4	24	20	16	13	10	-4.1 %

Note: *1 Water demand in the Study Objective Area (See Figure M1.1)

*2 Day peak demand is assumed as 1.21 times the average demand. The figure of 4,400 MLD in year 2000 is deemed as 'potential day peak demand' estimated to be 1.21 times the day average demand.

*3 Present supply capacity: Angat supply system 4,000 MLD + Groundwater 90 MLD

The water demand projected above is similar to the projections made in the previous studies, such as the Water Supply and Sewerage Master Plan Study (JICA, 1995), Water Resources Master Plan Study (JICA, 1998) and the latest MWSS projection (2001), being only about 3-4 % different. (See a figure in Subsection 2.5.5 of Volume II for the comparison among the various projections).

M3 Water Resources to be Developed towards Year 2025 (Chapter II & V of Volume II)

M3.1 Interim Schemes Assumed in Master Plan (Chapter II and V)

As indicated in the table above, water supply capacity in the year 2000 (4,090 MLD) is already critical, if potential day peak demand is deemed to be 1.21 times the average daily demand, i.e. 4,400 MLD (3,663 MLD x 1.21 = 4,400 MLD). In order to cope with the growing demand, MWSS and two water companies (MWCI and MWSI) contemplate the augmentation of water supply capacity by implementing several projects. The schemes envisaged at the stage of M/P in 2001 were Wawa Water Supply Project (50 MLD), Laguna Lake Bulk Water Supply Project (300 MLD) and Angat Aqueduct Rehabilitation Project (350 MLD)*, giving a total of 700 MLD in supply capacity. These schemes are referred to as the "Interim Schemes".

Notes: *Day peak demand factor assessed in the latest MWSP III Project Review Study in 1997, which was adopted in this Study as well

** Of the three schemes, Angat Aqueduct Rehabilitation Project (350 MLD) was later deleted from the Interim Schemes in terms of the augmentation of water resources. Instead, the installation of a by-pass aqueduct (AQ6) is under planning in 2002. See Section F8.1 hereinafter for the interim schemes finally assumed in the F/S.

M3.2 Development Scale of New Water Resources in the Agos River Basin (Chapter II and V)

After the three Interim Schemes are added, the total supply capacity becomes 4,790 MLD in terms of day peak supply capacity. This affords the stable supply of 3,960 MLD in terms of daily average supply quantity if a day peak factor of 1.21 is assumed (4,790 MLD/1.21=3,960 MLD). The need for further development of water resources towards the year 2025 is then estimated as 3,020 MLD in terms of daily average supply quantity (6,980 MLD-3,960 MLD=3,020 MLD).

Note: In the Study, water resources development is planned for the daily average supply requirement, while the proposed water conveyance and treatment facilities are planned to have the capacity meeting the day peak demand, i.e., 1.21 times the daily average demand.

In consideration of the figure derived above (3,020 MLD), the Study has determined that the development requirement of water resources in the Agos River Basin is 3,000 MLD in daily average supply quantity (3,640 MLD in day maximum supply quantity).

M3.3 Development Plans to Meet the Growing Water Demand (Chapter II and V)

The planning concept set forth in Section M3.2 above is that water demand growth up to the year 2025 would be met by the combination of Interim Schemes (700 MLD) and the water resource development in the Agos River Basin (3,640 MLD in day peak supply capacity). The Interim Schemes are to meet the short-term demand and the Agos scheme is to meet the long-term demand.

In the context of demand-supply capacity gap foreseen to worsen year by year in the coming several years, a very urgent need is the earliest implementation of the

Interim Schemes. It is strongly recommended that MWSS should mobilize the implementation as early as possible.

M4 Exploitable Water Resources (Chapter V of Volume II)

Low flow analysis for the Kaliwa River was based on the runoff data at the Laiban damsite which were collected in the previous study (MWSP III). In the present Study, the runoff of the Kaliwa River was re-estimated using tank model method. The runoff of the Agos River was estimated from runoff records at Banugao Station and the Kanan River runoff by deducting the Kaliwa runoff from the Agos runoff.

The exploitable water resources at selected source development sites were then assessed based on the runoff data so derived and through reservoir operation studies. The results are summarized below:

Exploitable Water Resources at Development Sites

Water Resources Development Scheme	Reservoir Water Level (EL. m)		Exploitable Water Resources		Figures Assessed in Previous Study
	FSL	MOL	(MLD)	(m^3/sec)	
Reservoir Scheme:					
Laiban Dam	270	237	1,830	21.2	1,900 MLD at FSL 270 *1
Kanan No.2 Dam	310	278	3,310	38.3	3,170 MLD at FSL 295 *1
	310	225	3,770	43.6	
Agos Dam	159	133	* 5,210	* 60.2	6,740 MLD at FSL 159 *2
Run-of-River Scheme:					
Kaliwa Low Dam	-		550	6.4	8.6 m^3/sec *2
Laiban Low Dam	-		340	3.9	
Kanan Low Dam			770	8.9	

Notes: (1) Reservoir Scheme: Design year is regarded to be a dry year occurring once in 10 years
(2) Run-of-River Scheme: 90 % dependable discharge, after releasing river maintenance discharge
(3) Exploitable water at Agos Dam represents the total yield usable for water supply and hydropower
* In F/S, re-evaluated to be 5,270 MLD and 61.0 m^3/sec, respectively
*1 MWSP III Study for Laiban Dam *2 EDCOP Study for Kaliwa Low Dam-Agos Dam

M5 Geological Assessment (Chapter III of Volume II)

M/P identified potential geological problems. Among others, the major concerns needing the attention were regarded as follows:

(a) Seismicity risk

Risk to earthquakes is high due to proximity to the active Philippine Fault (Infanta Fault). This issue is common to all dam schemes in the Agos River Basin.

(b) Faults

PHILVOLCS assesses the existence of faults around the proposed damsites and along waterways, some of which are categorized as 'assumed active fault'. This issue is also common to all dam and waterway schemes, although the extent varies by scheme.

(c) Existence of limestone masses

There is concern for reservoir watertightness due to limestone masses occurring in the proposed reservoir areas, for both the Laiban Dam and Agos Dam.

(d) Agos damsite geology

Specific attention needs to be paid to the thick riverbed deposit at Agos damsite and potential landslide problems at both the Agos and Kanan No.2 damsites

The plan formulation studies duly took into account these problems and also other geological aspects peculiar to the respective sites, though the latter is mostly of less serious natures.

M6 Initial Environmental Examination (Chapter IV of Volume II)

Initial Environmental Examination (IEE) conducted in M/P identified varying degree of socio-environmental impacts that may arise due to the proposed projects. The major issues noted were as follows:

(a) Reduction of river flows in the Agos River downstream reaches

An impact to the riverine environment in the downstream reaches is the reduction of flow due to water transfer to Metro Manila. The change of flow regime will force local people to change the way of river use.

(b) Reduction of sediment yields in the Agos River downstream reaches

The dam, once built, will tarp most of sediment loads yielded from the upper basins. This will cause the reduction of sediment yields in the Agos River downstream reaches. The reduced sediment yields may cause a change of morphology of the river mouth and coastlines in the lowermost Infanta-General Nakar alluvial plain, which would be especially serious in the case of Agos Dam.

(c) Necessity of watershed management

There is a need for watershed management, especially for the Kaliwa River basin, in view of active human activities in the area.

(d) Need for protection of ecosystems

There is a need for protection of ecosystems, which are already being affected by illegal logging and human encroachment. This issue is particularly important in the Kanan-Agos watersheds.

(e) Resettlement Plan

There is a need for preparation of a feasible Resettlement Plan (RP) for relocating the affected families. The number varies by scheme and is most serious in the case of Laiban Dam (3,000 families to be relocated) and Agos Dam (300 families*).

Note: * Modified to 174 families in the F/S based on EIA

M7 Formulation of Alternative Water Resources Development Plans
(Chapter V of Volume II)

In order to find the least cost development plan, eight alternative development scenarios were formulated for comparison. The plans were derived from reviews of previous studies and also through a map study and reconnaissance survey conducted under this Study.

The map study identified five (5) dam schemes and three (3) run-of-river schemes. A comparative study examined the optimum dam height for five (5) dam schemes identified (Laiban, Kanan No.1, Kanan No.2, Kanan B1 and Agos) and selected three (3) dam schemes (Laiban, Kanan No.2 and Agos) for further study. As a result, development scenarios were formulated by combination of three (3) selected dam schemes, three (3) run-of-river schemes for water source development and three (3) waterway schemes for water conveyance to the Metro Manila area. The formulated scenarios are shown in the table below:

Alternative Development Scenarios

Develop. Scenario	Ultimate Supply Volume (MLD)	First Stage Development	Second Stage Development		Water-way Scheme
			Stage 2-1	Stage 2-2	
A	5,110	Laiban Dam + 1st Waterway	Kanan No.2 Dam + 2nd Waterway	-	*1
B	3,000	Kaliwa Low Dam + 1st Waterway	Agos Dam	2nd Waterway	*2
C	3,000	Agos Dam + 1st Waterway	2nd Waterway	-	*2
D	3,600	Kaliwa Low Dam + 1st Waterway	Kana No.2 Dam	2nd Waterway	*2
E	4,060	Kaliwa Low Dam + 1st Waterway	Kanan Low Dam	Kanan No.2 Dam + 2nd Waterway	*2
F	3,330	Laiban Dam + 1st Waterway (*1)	Agos Dam + 2nd Waterway (*2)		*1 *2
G	3,430	Kaliwa Low Dam + 1st Waterway	Laiban Dam	Agos Dam + 2nd Waterway	*2
H	3,420	Laiban Low Dam + 1st Waterway	Kanan No.2 Dam	2nd Waterway	*3

Notes: 1. Supply Volume: Daily average supply quantity

2. In this Report, water conveyance and transmission facilities from Intake to Service Reservoirs are generically called 'waterway' or 'waterway facilities'.
   *1 Laiban~Pantay~Taytay *2 Kaliwa~Abuyod (Lagundi) ~Taytay
   *3 Laiban~Karan Batu~Taytay
3. Layout plan of Kaliwa~Abuyod~Taytay waterway (*2 above) was slightly modified in F/S incorporating new findings from field investigations. The revised layout takes a route of Kaliwa~ Morong (Lagundi)~Taytay.

The proposed layout plan of the alternative development scenarios is shown in Figure M7.1.

M8 Comparison of Alternative Development Plans (Chapter VII of Volume II)

M8.1 Unit Water Cost for Comparison (Chapter VII)

The relative attractiveness of the eight (8) alternative development scenarios was evaluated through comparison of 'unit water cost' per m^3 of water supply. The project cost estimated for this comparative study included water source facilities (dam and run-of-river schemes), water treatment plant and water conveyance facilities up to a main service reservoir at Taytay. The water cost represents the cost at the main service reservoir, which is regarded as the off-take point for distribution to the supply network.

Since the proposed development scenarios are formulated to differ in their development scales and commissioning timing, the comparison should take into account not only cost factor but also time factor. Hence, the 'unit water cost' is calculated by comparing the present worth of invested cost and expected revenue (unit water cost multiplied by water quantity) by discounting to 2001 price at a discount rate of 12 % per annum.

In the analysis of cost and revenue streams, it was assumed that part of the invested cost would be recovered by electricity energy revenue and the remainder by water revenue. On this basis, a trial calculation was made to find a 'unit water cost' that would equalize the present worth of the cost and the present worth of the assumed water revenue.

Note: Unit water cost assessed herein represents the water cost derived on the basis of a preliminarily assumed financial condition (interest rate, etc.). It should be regarded as a cost index value just for comparison of alternative development scenarios. It does not represent a water-selling rate in real term.

M8.2 Comparison of Unit Water Cost (Chapter VII)

The evaluation horizon is set at 40 years after the commissioning of the first stage project. For comparison of the Scenarios within the same time frame, the Study assumed that the first stage project of all the Scenarios would be completed in year 2010. Therefore, the evaluation horizon assumed is from 2011 to 2050 in this comparative study.

The results of 'unit water cost' comparison are summarized in the table below:

Summary of Comparison of Unit Water Cost Index

Scenario	Proposed Scheme	Project Cost *1 (US$ Mil.)	Present Worth		Equalizing Unit Water Cost *2 (US$/ m^3)
			Water Volume Supplied (Mil. m^3)	Cost to be Recovered (US$ Mil.)	
A	Laiban + Kanan No.2 Dam	2,256	1,650	1,429	0.400
B	Kaliwa Low Dam + Agos Dam	1,826	1,449	1,129	0.379
C	Agos Dam	1,820	1,449	1,171	0.391
D	Kaliwa Low Dam + Kanan No.2 Dam	1,884	1,531	1,248	0.389
E	Kaliwa Low Dam + Kanan Low Dam + Kanan No.2 Dam	2,200	1,580	1,411	0.421
F	Laiban Dam + Agos Dam	2,064	1,498	1,236	0.390
G	Kaliwa Low Dam + Laiban Dam + Agos Dam	2,284	1,513	1,337	0.424
H	Laiban Low Dam + Kanan No.2 Dam	1,778	1,511	1,254	0.398
(For Reference)					
-	Laiban Dam only *3	871	1,166	868	0.380

Notes: *1 Base cost estimate at 2001 price, comprising construction cost, land acquisition/resettlement cost, engineering/administration cost (7%) and physical contingency (15%)

*2 Unit water cost at 2001 price, which equalizes the present worth of costs and the present worth of revenues, discounted at 12% per annum. Both the water and energy sale prices are escalated at 3% per annum.

*3 Laiban Dam will supply only 1,830 MLD (day average). Laiban dam alone cannot suffice the water demand up to 2025 (3,000 MLD).

M8.3 Evaluation of Comparison Results (Chapter VII)

As indicated in the table in Section M8.2 above, the unit water cost index is evaluated to be least in Scenario B, followed by Scenarios D, F and C with only marginal differences. The favorable index of Scenario B can be explained by the larger quantity of water exploitable at the Agos Reservoir, which is usable both for water supply and hydropower. Other technical aspects relevant to Scenario B are described in Section 7.5 of Volume II in the form of comparisons with the other Scenarios.

The unit water cost index of the Laiban Dam project showed a favorable index value almost comparable to that of Scenario B. Hence, the possibility of Laiban Dam would also be retained in the formulation of a master plan of the Agos River Basin. It is noted, however, that the selection of Laiban Dam as the first project means the adoption of Scenario F in order to cope with the demand growth up to Year 2025.

M9 Proposed Master Plan (Chapter VIII of Volume II)

M9.1 Formulation of Master Plan (Chapter VIII)

The proposed master plan of the Agos River Basin water resources development is presented in two parts:

(a) Master Development Plan towards the Year 2025:

This constitutes mainly the water supply development plan for meeting water demand up to the year 2025. The plan also includes hydropower projects associated with the water supply projects, and several works proposed for regional development of the basin.

(b) Optional Development Plan:

This includes the development option of the Laiban Dam for water supply as an alternative to the Scenario B development or otherwise as a development potential for meeting the demand after year 2025 (after Agos Dam). The main reason for retaining the Laiban Dam in M/P is that the project is on a state of 'approved by the government' although the actual implementation is suspended due to relocation problems.

Hydropower development at the Kanan No.2 Dam is included in this optional development plan, since the scheme is independent of the water supply development towards 2025 and can be implemented at any period, not limited to the period up to 2025.

The configuration of the proposed master plan is shown in Figure M9.1.

M9.2 Master Development Plan towards the Year 2025 (Chapter VIII)

The master development plan was formulated basically in line with the plans proposed in Development Scenario B selected in Section M8.3 above.

M9.2.1 Water Supply Development Plan

Scenario B envisages the development of Kaliwa Low Dam in the first stage and Agos Dam in the second stage for meeting water demand up to the year 2025 (3,000 MLD in daily average supply quantity). The sequence of proposed development is shown in the table below:

Sequence of Proposed Water Supply Development (Scenario B)

Proposed Facilities	1st Stage Development	2nd Stage Development	
	Stage 1 (Completion Year 2013)	Stage 2-1 (Completion Year 2016)	Stage 2-2 (Completion Year 2019-2022)
Water Supply Q'ty (daily average)	550 MLD initially (550 MLD)	Additional 950 MLD (1,500 MLD in total)	Additional 1,500 MLD (3,000 MLD in total)
Water Source:			-
Kaliwa Low Dam	Supply of 550 MLD initially	(Supply substituted by Agos Dam)	
Agos Dam	-	Supply of 1,500 MLD, incl. 550 MLD formerly supplied by Kaliwa Low Dam	Supply of additional 1,500 MLD (3,000 MLD in total)
Waterway	1st Waterway for 1,500 MLD	-	2nd Waterway for additional 1,500 MLD (3,000 MLD in total)
Water Treatment Plant (WTP)	WTP #1 - 750 MLD	WTP #2 - 750 MLD	WTP #3 & #4 - 1,500 MLD in total (3,000 MLD in total)
Main Service Reservoir (SR)	SR #1 - 190,000 m^3	SR #2-190,000 m^3	SR #3&4 - 380,000 m^3 (780,000 in total)

Note: The above figures in MLD represent daily average supply quantity. The capacity of waterway and WTP is planned to be 1.21 times the daily average supply capacity to meet the day peak demand.

M9.2.2 Hydropower Development

Scenario B involves the potential development of two hydropower schemes associated with water supply development: (i) Abuyod power station (P/S) at the downstream end of the water conveyance tunnel and (ii) Agos power station at the toe of Agos Dam. The features of the proposed hydropower development identified in M/P are summarized in the table below:

Hydropower Development Associated with Water Supply Development

Scheme	Power Output (MW)		Annual Energy Production (GWh)		
	Installed Capacity	95 % Guaranteed	Primary Energy	Secondary Energy	Total
Abuyod P/S *1	12.5	7.0	98.6	-	98.6
Agos P/S *2	85.6	71.3	178.0	240.9	418.9

Notes: *1 Called in F/S as 'Lagundi Power Station' due to change of location. Power output was also modified.

*2 Planned as a 6-hr peaking plant at the M/P stage. Modified to a semi-peak plant in F/S through an optimization study.

M9.2.3 Projects for Enhancement of Regional Development

The implementation of the proposed water resources development project would cause various inconveniences to people in the project area, such as the relocation of settlements, change of river environments, disconnection of local communities due to reservoir impoundment, etc. For compensation for those inconveniences, the following projects were proposed in M/P:

(a) Bank erosion protection work at Infanta-General Nakar

(b) Provision of riverbank structures for facilitating the people's use of the river

(c) Provision of access roads/footpaths along the perimeters of the Agos Reservoir

(d) Establishment of a manpower training center for the relocatees

(e) Establishment of a medical clinic for the people affected by the Agos Reservoir

These regional enhancement projects were formulated in the F/S (see Sections F6.2 and F6.3 hereinafter).

M9.3 Optional Development Plan (Chapter VIII)

M9.3.1 Optional Water Supply Development Plan – Laiban Dam

Laiban Dam project was conceived as an alternative development plan to the proposed Scenario B Scheme. Laiban Dam project is a "committed project" already authorized by the Government through the Memorandum Order No.10 of August 5, 1998, which mandated the MWSS to resume the implementation of the project.

However, there remain two hurdles for the implementation of Laiban Dam. One is a large social impact due to the relocation of about 3,000 households, which has been a long outstanding issue left unsolved since 1984. A continuing concern is the failure of solving this issue at all, or the possibility of a long time requirement for formulation of public acceptance, even if the dialogue with people is resumed. The second is another concern for delay in completion of the construction works, since many associated problems may arise during the implementation in view of the size of resettlement work. The implementation of Laiban Dam depends on MWSS's decision and the prospect of how quickly the resettlement issue could be solved and how quickly the project could be commissioned.

In the case MWSS foresees that the development of Laiban Dam in the immediate stage is not practicable due to the difficulty of solving the resettlement issue, the development potential of the Laiban Dam should be preserved for future water supply needs after the year 2025.

M9.3.2 Optional Hydropower Development Plan

In addition to the two hydropower schemes mentioned in Subsection M9.2.2 above, there are two other hydropower development potentials: one is a scheme at Kanan No.2 Dam and the other the Pantay power scheme associated with Laiban Dam water supply project. The features of the two schemes are summarized below:

Optional Hydropower Development Plans

Scheme	Power Output (MW)		Annual Energy Production (GWh)		
	Installed Capacity	95 % Guaranteed	Primary Energy	Secondary Energy	Total
Kanan No.2 P/S	209.5	135.3	406.4	97.2	503.6
Pantay P/S	22.6	17.8	179.0	-	179.0

(1) Kanan No.2 Hydropower Scheme

Kanan No.2 Dam will be developed solely for hydropower development, and is independent from the water supply development mentioned in Section M9.2.1 above. Timing of the implementation of Kanan No.2 Scheme is entirely dependent on the interest expressed by BOT proponents. Power demand of the Luzon grid is already large enough to accommodate the power from Kanan No.2 Scheme at any time.

(2) Pantay Hydropower Scheme associated with Laiban Dam

This scheme is an optional plan, only be implemented in the case Laiban Dam is developed for water supply. Under this plan, a power plant will be built at Pantay at the downstream end of the conveyance waterway tunnel from the Laiban Dam.

M10 Economic Evaluation of Proposed Schemes (Chapter VIII of Volume II)

An economic evaluation in the M/P was made for two major schemes proposed in the Master Plan (See Section M9.2 and M9.3). One is the Scenario B Scheme for water supply development associated with two hydropower schemes (Abuyod P/S and Agos P/S). The other is Kanan No.2 hydropower as an optional development. The economic benefit of water supply is regarded to be the willingness-to-pay for water. The hydropower benefit is regarded as the cost of alternative thermal power plant.

Analysis of the cost and benefit streams revealed that the economic internal rate of return (EIRR) is 13.5 % for the Scenario B Scheme and 5.4 % for the Kanan No.2 hydropower scheme. The EIRR evaluated for the Scenario B Scheme seems acceptable, since it is more than the opportunity cost of capital (12.0 %). However, the EIRR of the Kanan No. 2 hydropower scheme is relatively low. The scheme could only be justified under the condition of increased power benefit.

M11 Selection of Project for Subsequent Feasibility Study (Chapter IX of Volume II)

The most urgent project is a water supply development for attaining the earliest supply of water to Metro Manila. Hence, the feasibility study took up the first stage development of the Scenario B Scheme selected in the M/P. The reason for the selection of Scenario B is twofold:

- Evaluated as the least cost development scenario in terms of unit water cost index (Section M8.3)
- Need for formulation of a new water source development project substituting the Laiban Dam project which has been suspended for 18 years since 1984 due to social problems

The 1st stage project consists of the Kaliwa Low Dam with the Kaliwa-Taytay 1st Waterway. It should be noted that the viability of the 1st stage project relies largely on the feasibility of the Agos Dam scheduled in the 2nd stage project. Therefore, the feasibility study should include the investigations and studies of the Agos Dam as

well. This resulted in the feasibility study to cover almost all components of the Scenario B development.

The F/S will cover the following schemes (see Section M9.2 for the outlined features):

- Water source development in the Agos River Basin (Kaliwa Low Dam and Agos Dam)
- Water conveyance, treatment and transmission facilities between Kaliwa Intake (at Kaliwa Low Dam site) and Taytay Service Reservoir
- Hydropower scheme associated with the above water supply scheme (Abuyod (Lagundi) P/S and Agos P/S)
- Other associated schemes such as the projects for enhancement of regional development

The layout plan of the schemes covered by the feasibility study is shown in Figure M9.1.

PHASE 2 FEASIBILITY STUDY

F1 General (Chapter I of Volume IV)

With the consent of the Steering Committee at a meeting held on January 16, 2002, the projects proposed as Development Scenario B were agreed for the feasibility study. The proposed projects consist of Kaliwa Low Dam and Agos Dam as water sources and Kaliwa-Taytay Waterway as water conveyance facility. The Feasibility Study also examined the viability of two hydropower schemes: Agos power scheme and Lagundi (Abuyod in M/P) power scheme.

The Feasibility Study consisted of field investigations involving socio-environmental aspects, plan formulation studies in the form of detailing the plans proposed in M/P, preliminary design, cost estimate and the evaluation of the projects.

F2 Findings from Field Investigations (Chapters II and IV of Volume IV)

F2.1 Topographic Survey (Chapter II)

The Study produced topographic maps principally by photographic mapping methods. The survey, however, could not accomplish the aerial-photo shooting for the whole area since unfavorable weather conditions prevailed throughout the dry season (February-June 2002),.

This required that partial areas had to be mapped using the existing photos available from NAMRIA (1995-2000). Topographic information regarding the proposed Agos Reservoir area had to be obtained from the existing maps prepared in the earlier studies (1980-1992) due to unavailability of photos in recent years.

Topographic maps produced during this Study are of 1:5,000 scale covering the whole project area and 1:2,000 scale for six (6) major structure sites and pipeline route.

F2.2 Hydrological Investigation (Chapter II and IV)

During the field investigation in 2001 and 2002, four stream gauging stations were installed for water level recording and discharge measurement. At the end of the Study, the gauges remained for the continuation of the measurements by the Philippines authorities.

As a part of hydrological survey, spot discharge measurement was carried out at eight points on the Kaliwa River. The objective was to investigate the distribution of flows in limestone areas, through which the Study had intended to assess the possibility of water loss in the Daraitan limestone area. The results showed that water once infiltrating into the limestone mass returns back at the downstream

reach. This suggests that there is no possibility for the loss of reservoir water leaking to the outside of the basin. (See also Subsection F2.3.3 below).

F2.3 Geological Investigation (Chapter IV)

F2.3.1 Active Fault and Seismic Risk at Agos Damsite

The project area is situated within a zone of active tectonics represented by the Philippine Fault (Philippine Fault Zone: PFZ) and the Valley Fault System. These faults have potential for very high earthquake activity and hence the project area is situated within a zone having a high seismic risk.

Particularly, the Agos damsite is located only 7-8 km distant from the Philippine Fault Zone (Infanta Fault). Therefore, high seismic risk should be taken into account in the preparation of design. The peak acceleration at a100-year probability is assessed at 0.58g.

To confirm the distribution and certainty of active faults, photographic analysis was conducted in an area of 10 km radius around the Agos damsite. As a result, a fault 500 m upstream from the Agos Dam axis, which is indicated as an 'assumed active fault' by PHILVOLCS, was classified as a Class III* fault. Therefore, it can be said that "active fault that would need careful attention" does not exist nearby the Agos damsite.

Note: * Class III is categorized, according to the Japanese standards, as the fault having no specific factors indicating a suspected active fault.

F2.3.2 Agos Damsite Geology

The proposed dam axis is almost identical to that selected in the previous study conducted by JICA in 1981 (called herein 'upstream site'). The investigation also examined an alternative dam axis (called herein 'downstream site') located about 700 m downstream from the upstream site. Geotechnical investigations were carried out for the both dam axes. As the result of comparison, the upstream site was finally selected (see Section F3.2 below for detail).

The foundation of the selected upstream damsite is generally hard and impervious, which was assessed suitable for the foundation of a fill type dam. Nevertheless, it has the following problems:

(a) Thick Riverbed Deposit

The river deposit of sand and gravel layer has a thickness of 30 to 40 m at the dam axis. The large thickness of the river deposit can be explained by valley incision associated with marine transgression in the past and subsequent deposition of sediments in the valley, according to the geo-morphological analysis conducted under the Study.

(b) Landslide on the Abutments

Several landslide blocks are observed around the damsite (Figure F2.1). The blocks may lose stability and slide during the construction work and after the impoundment of reservoir. Most of landslide blocks will be removed

during the excavation of main dam and spillway. The blocks outside the main excavation area, estimated at about one million m^3, will also be removed.

(c) Distribution of Low Velocity Zones

Five (5) low velocity zones were identified at the damsite by seismic exploration survey (Figure F2.1). These are possibly the extension of faults running in a E-W direction. The partial removal of fractured zones and grouting work will be required in order to assure the watertightness of the zones. The detailed condition of these zones should be confirmed by core drilling in the next detailed investigation stage.

F2.3.3 Water Leakage from Daraitan Limestone in Agos Reservoir Area

In the Agos Reservoir area, the possibility of water leakage from Daraitan limestone mass towards south was one of the subjects to be investigated. Daraitan limestone mass is situated at the upstream part of the Kaliwa River in the Agos Reservoir area with a width of 1.5 km, distributing in a N-S direction. Many cavities, holes, and water-springs are observed in the Daraitan limestone area.

Two core-drillings (350m in total depth) and two lines of electric prospecting (5 km in total length) were carried out to confirm the continuity of Daraitan limestone mass toward the south direction. The investigation revealed that the problem of water leakage from the limestone mass would possibly be negligible judging from the following facts: (See Figure F2.2)

(a) Towards the south, the permeable limestone mass wedges out around the Makmira village at the 3-km southern point from the Kaliwa River. Drilling investigation conducted in the southern area did not find the limestone.

(b) Groundwater level seems shallow around Makmira to Santiago village area, represented by constant surface flows observed at streams in the vicinity.

(c) No loss of the river water flow was observed in the sections of limestone area, according to the result of spot discharge measurement (See Section F2.2 above)

F2.3.4 Waterway Geology

The proposed waterway facilities, consisting of two tunnels, a water treatment plant, pipelines, a pump station and two service reservoirs, are located in mountainous to gentle-hilly areas. In the area, firm rocks in old age and/or compacted Quaternary deposits (Guadalupe Formation) are available for foundation construction at respective sites. The tunnel construction in the Quaternary deposit layers, however, will need to take account of the change of geological conditions as the rock condition is not thought to be homogeneous.

The field investigation identified the following problems for the waterway construction: (See Figure F4.5 for the layout of waterway)

(a) Tunnel No.1 has a 27.5-km length in total. It is presumed that tunneling by TBM may possibly be effective in the most part where favorable geology

exists. However, the tunneling will encounter a major fault designated as an 'assumed active fault' by PHILVOLCS (2000) at the point of 25 km from the intake (see Figure F2.3). The tunnel should cross the fault at a right angle so as to decrease the length of tunneling in the fault zone. NATM should be planned for the excavation of this fault zone.

(b) Tunnel No.2 is laid out beneath the Antipolo plateau. In the 1.3-3.3 km section, there is a possibility of encountering the Guadalupe Formation. The lowest layer of Guadalupe Formation is supposed to be a confined aquifer, which supplies water to the deep wells in the Antipolo plateau. In the next stage, detailed geotechnical investigations will be required to confirm the geological condition for tunneling and evaluate the influence to the wells.

(c) Valve House No.2 at Teresa and partial area of Antipolo pump station are proposed in the low-flat area possibly formed by alluvial deposits such as soft clay, silt or sand materials. Pile foundation is recommended for the proposed structures.

(d) Partial sections of the pipeline route (37 % of the total length) pass through the alluvial deposit area. During the construction of this pipeline section, excavation with sheet-pile walling will be required.

F3 Formulation of Optimum Development Plan (Chapter VI of Volume IV)

The Study attempted to formulate the most optimum development plan through comparative studies. The major findings are described below.

F3.1 Development Scale of Agos Dam (FSL of Agos Dam/Reservoir) (Chapter VI)

In order to find the optimum development scale of Agos Dam, six alternative development scales were examined by varying the full supply level (FSL) from El. 145 m to 195 m. The comparison was based on a 'unit water cost' index expressed as construction cost divided by the exploitable discharge. The minimum operating level (MOL) is set at EL.133 m for every case. The comparison study showed that the unit water cost is generally lesser at higher FSLs, with the least-cost case being FSL 185 m.

On the other hand, however, topographic map indicates that the FSL higher than EL.159 m would submerge the residential area of Barangay Daraitan where about 500 households exist. Barangay Daraitan is the core village in the vicinity and its submergence would bring about a large social problem to the extent hampering the smooth implementation of the project. From this social aspect, the highest practical FSL of the Agos Reservoir was regarded to be EL. 159 m.

The Agos Dam with FSL 159 can yield a discharge of about 61.0 /m^3sec, which suffices the required water exploitation of 34.7m^3/sec or 3,000 MLD for meeting the water demand in Metro Manila up to 2025. The Study proposes to utilize the remaining water (26.3 m^3/sec) for hydropower development, which has a high

economic viability. Part of this extra water resource of 26.3 m^3/sec could be utilized as an emergency water source in the case of extraordinary droughts.

F3.2 Selection of Dam Axis (Chapter VI)

As stated in Subsection F2.3.2 before, two alternative dam axes were examined in the Study (See Figure F2.1): an upstream axis, which is identical to the site contemplated in the M/P, and a downstream axis, which was proposed as an alternative plan for comparison.

Geological investigation revealed that the downstream axis would require extra costs for removal of landslide blocks lying between the two dam axes. Cost comparison indicated that the upstream site is less costly by about US$ 44 million equivalent. Therefore, the upstream axis was selected as the preferable dam axis for the Agos Dam.

F3.3 Selection of Dam Type (Chapter VI)

Two dam types, concrete face rockfill dam (CFRD) and earth core rockfill dam (ECRD), are retained as possible dam type for the Agos Dam. Comparing the two, the CFRD type is assessed to have the following advantages:

- ECRD type takes a longer construction period than CFRD type on account of high annual rainfall in the Agos River Basin, since the earthfill of the center core in ECRD cannot be carried out during the wet season. The main work in the CFRD is rock embankment, which could be carried out throughout year.
- CFRD is more resistant to overtopping of flow in the case of extraordinary flood than ECRD and is therefore safer in terms of flood risks during the construction period.

In addition to these technical advantages of the CFRD type, a cost comparison showed that CFRD is less costly than the ECRD by about US$ 27 million equivalent. Accordingly, CFRD was adopted as the dam type of Agos Dam.

F3.4 Economic Diameter of Tunnel No.1 of Kaliwa-Taytay Waterway (Chapter VI)

The diameter of Waterway Tunnel No.1, which connects an intake structure at Kaliwa Low damsite and Valve House No.1, is one of important factors dominating the project cost due to its long distance (27.5 km long).

For the cases of varying diameter, a comparative study was carried out to compare the total cost of tunnel and dam. As the result, the cost would be minimized in the case of the tunnel diameter being in a range of 3.3 to 3.5 m with only a marginal difference between them. A diameter of 3.5m was finally selected in view of little difference in the cost and larger water exploitation potential preserved in the reservoir below FSL 159 m.

F3.5 **Hydropower Development** (Chapter VI)

F3.5.1 Agos Power Scheme

(1) Formulation of Alternative Development Plans

In order to determine the most optimum development scale, the following four (4) alternative plans were compared:

Alternative Development Plans

Alter-native	Installed Capacity (MW)	Dependable Power Output (MW)	Max. Plant Discharge (m^3/sec)	Energy Generation (GWh)			Annual Plant Factor
				Primary	Secondary	Total	
A	103.4	85.9	110.8	216.1	253.3	469.4	0.52
B	77.5	64.4	83.1	216.0	186.8	402.8	0.59
C	51.5	42.7	55.4	215.3	102.9	318.2	0.71
D	25.6	21.1	27.7	213.3	-	213.3	0.95

Notes: (1) Annual Plant Factor: Total Energy/(Installed Capacity x 24 hrs x 365 days)
(2) Dependable Power Output: 90% guaranteed power

(2) Selection of Development Scale

Comparison of four (4) alternative development plans was based on economic evaluation. Economic benefit was taken from alternative thermal power cost. The result is summarized below:

Comparison of Economic Viability of Alternative Plans

Alternative	Construction Cost	Present Worth at Discount Rate of 12 %			EIRR (%)
		Cost (C)	Benefit (B)	B-C	
A	159.0	120.9	120.0	-0.9	11.8
B	139.4	98.6	98.6	-7.3	10.3
C	81.2	68.8	68.8	6.3	14.6
D	58.5	40.1	40.1	-4.9	9.6

Notes: 1. Construction cost is expressed in terms of economic cost at 2002 price. The cost covers power intake, waterway, powerhouse, generating equipment, switchyard, afterbay weir (for Alt. A and B), transmission line and substation
2. Shadow pricing was applied for foreign exchange rate and unskilled labor.
3. Evaluation period: 50 years from commissioning

As indicated in the table above, Alternative Plan C was evaluated to be most attractive from the national economic development viewpoint. A preliminary financial analysis also revealed the Plan C would be most viable. Thus, the Agos hydropower scheme is proposed to be 51.5 MW in installed capacity.

F3.5.2 Lagundi Power Scheme

There are two (2) alternative plans with regard to the alignment of the downstream part of Tunnel No.1. One is with the Lagundi power plant and the other without the plant. Selection of the plan entirely depends on the viability of the proposed Lagundi hydropower scheme.

For the given conditions of plant discharge (34.7 m^3/sec in average) and available head between the Agos Reservoir and the powerhouse, the power output of the scheme was calculated as follows:

- Installed capacity: 10.61 MW
- 90% dependable power: 5.65 MW
- Annual Energy Production: 78.1 GWh

The viability of the scheme was evaluated through a financial analysis in the context that the scheme is proposed as a BOT scheme. The analysis revealed that the FIRR is only 5.3 %, which would not be a level of justifying as a BOT project. Hence, the scheme was ruled out from further study.

Accordingly, the waterway is aligned so as to connect the Tunnel No.1 directly to Valve House No.1 at the water treatment plant.

F4 Preliminary Design of the Proposed Project (Chapter VII and VIII of Volume IV)

F4.1 Water Source Development (Chapter VII and VIII)

F4.1.1 Kaliwa Low Dam

Kaliwa Low Dam will be constructed with random fill materials produced from the excavation of the intake and waterway tunnel. The upstream face of the dam will be covered with dumped impervious fill to minimize the water seepage through the dam body. The downstream face will be protected with wood cribs filled with rocks to allow the overtopping of flood flow. The layout plan and structural design of the Kaliwa Low Dam are shown in Figure F4.1.

Kaliwa Low Dam is constructed as a temporary structure with a life of three years until it is submerged by the Agos Reservoir that will be built in the second stage (Stage 2-1).

F4.1.2 Agos Dam

(1) Main Dam

The crest level of Agos Dam is set at El. 165.2 m securing a required freeboard of 6.2 m to ensure the dam to be safe against the design flood (1.2 times 200-year probable flood) and the probable maximum flood (PMF). The dam height is 165 m above the foundation rock at the plinth. The crest length at El. 165.2 m is 780 m, which gives a ratio of dam height to dam crest length (V:L) to be about 1:4.8.

The dam embankment is designed to have a slope of 1V:1.5H for both the upstream and downstream slopes (V: vertical, H: Horizontal). The upstream surface is covered with face slab concrete with a plinth structure at the bottom. Curtain grouting is provided at the plinth to prevent the water seepage through the dam foundation. Preliminary design of the Agos Dam is shown in Figures F4.2 and F4.3.

(2) River Diversion Work

A conventional river diversion comprising two diversion tunnels, two upstream cofferdams and a downstream cofferdam is proposed to divert the river flow to make the dam foundation area dry during the construction period. A concern held in the planning was the possibility of excessive water seepage through the thick riverbed deposit layer. To eliminate this concern, the upstream cofferdams are

planned sufficiently apart from the dam foundation area, one each on the Kaliwa and Kanan Rivers. The upstream cofferdams are provided with a slurry-trench impervious curtain wall at the foundation to shut off the water seepage. The alignment of the river diversion works is shown in Figure F4.2.

(3) Spillway

Spillway is aligned on the left bank from the topographic and geological viewpoints. The spillway has a capacity to discharge the design flood of 9,600 m^3/sec, which is equivalent to 1.2 times the 200-year probable flood at the Agos damsite. The spillway can also pass a probable maximum flood (PMF) of 17,100 m^3/sec without endangering the Agos Dam.

The spillway consists of two non-gated overflow weirs and four gated sluices. The non-gated overflow weirs, provided each on both sides of the forebay portion, can release ordinary floods of less than 5-year recurrence probability without the operation of gates. In the gated sluices, 4 radial gates, each having a dimension of 11 m high and 14 m wide, are provided.

F4.2 Agos Hydropower Station (Chapter VIII)

The facilities for the Agos power station, comprised of a power intake, a headrace-penstock tunnel and a powerhouse with tailrace, will be constructed on the left bank. The total length of the power waterway will be 755 m from the power intake to the powerhouse. The powerhouse will be provided at the downstream toe of the dam. It will accommodate two units of generating equipment. The installed capacity will be 51.5 MW and the maximum plant discharge will be 55.4 m^3/sec. Annual energy production will be 318.2 GWh. Preliminary design of the power waterway and powerhouse is shown in Figure F4.4.

The generated power will be sent to the existing Dolores Substation in Taytay and partly to a Quezelco Substation in Infanta.

F4.3 Water Treatment and Conveyance Facilities (Chapter VII and VIII)

Waterway is laid out between Kaliwa Low Dam and Taytay Service Reservoir for a total length of about 38 km. Figure F4.5 shows the general plan and profile of the waterway.

F4.3.1 Waterway Intake

A waterway intake will be adjacent to the Kaliwa Low Dam. The structure will consist of two intakes: one for each waterway. In the initial stage (Stage 1), the first intake will be constructed with full facilities, while the works for the second intake will be limited to the construction of the main-frame structure of intake and the excavation of a part of Tunnel No.1 (about 30 m in length). The second intake will be completed under the Stage 2-2 project. (See Figure F4.1)

Each intake will have a capacity of 21.0 m^3/sec for meeting the maximum water conveyance requirement of 1,820 MLD (1,500 MLDx1.21).

F4.3.2 Tunnel No.1

Tunnel No.1 is designed to convey the water from the intake to a water treatment plant. The tunnel route is 27.5 km long and the tunnel will have a circular section of 3.5-m diameter. Of the two lines of tunnels, one will be constructed under the Stage 1 project and the second under the Stage 2-2 project.

The tunneling will be done with a tunnel boring machine (TBM) in the upstream part where relatively favorable geology is expected, and with the New Austrian Tunneling Method (NATM) in the downstream part where Quaternary deposit layer of non-homogeneous geology is dominant.

At the downstream end of the tunnels, Valve House No.1 is to be provided to accommodate five regulating valves including one standby unit for controlling the flow into the water treatment plant.

F4.3.3 Morong Water Treatment Plant

A water treatment plant (WTP) will be built at Barangay Lagundi, Morong. The net area of the plant yard is about 96 ha (640 m x 1,500 m). The production capacity of the WTP is 3,640 MLD at the ultimate stage. The WTP will have four units of plant facilities, each 910 MLD in production capacity. They are installed one by one in four stages in accordance with the increase of water demand. The general layout plan and hydraulic profile of the WTP are shown in Figures F4.6 and F4.7, respectively.

The plant is designed to minimize water losses within the yard of the WTP. Wash water from the filters will be returned to the receiving well and sludge from the sedimentation basin will be de-watered, with the supernatant water also being returned to the receiving well through a backwash wastes returning tank. By these measures, the water loss at the plant could be reduced to 0.08% of the processed water volume. This allows the design capacity of WTP to be same as the maximum day peak demand (no extra capacity is planned).

Since the comparison of water quality of the Agos River Basin and the existing La Mesa Dam shows no significant difference, the conventional water treatment process as adopted at the existing La Mesa No.1 and Balara No.2 WTP will be employed in the proposed Morong WTP. The design of major facilities of the WTP, including layout, electricity saving and environmental aspects, has been prepared by referring to the design criteria of JWWA and AWWA.

Poly aluminum chloride (PAC) is recommended as the primary coagulant since its performance shows many advantages in floc formation as well as pH adaptability when compared with aluminum sulfate. Adopting intermediate chlorination aiming at manganese removal will be further studied through confirming the type of manganese and its concentration.

F4.3.4 Transmission Pipelines

Water treated at the WTP is further conveyed by pipelines to service reservoirs at Taytay and Antipolo (see Figure F4.5-General Plan of Waterway). The pipelines

comprise two trunk lines to Taytay (Pipeline No.1) and two branch lines to Antipolo (Pipeline No.2).

(1) Pipeline No.1

The two lines of Pipeline No.1 are laid out between the WTP and the portal of Tunnel No.2 for a length of 4.9 km (1st line at Stage 1 and 2nd line at Stage 2-2). The pipeline is divided into two sections: 4.0 km long pipeline of 3.4 m diameter (Pipeline No.1-1) from WTP to Valve House No.2 at the Taytay-Antipolo bifurcation point and 0.9 km long pipeline of 3.3 m diameter (Pipeline No.1-2) from the Valve House No.2 to the Tunnel No.2 portal.

The required thickness of steel pipe is determined based on the internal and external pressures. Water hammer pressure is set at 5.5 kg/cm^2 for the pipeline design. As the result, the required thickness of steel pipe is determined to be 28 mm for Pipeline No.1-1 and 26 mm for Pipeline No.1-2.

Various types of valves are planned to be provided at the required points, such as air valves with manholes at elevated points, stop valves at some 1- 2 km interval and blow-off valves at depressed points.

(2) Pipeline No.2

The two lines of Pipeline No.2, 1.6 m in diameter, are installed for water supply to the Antipolo area (1st line at Stage 1 and 2nd line at Stage 2-2). The total length is 4.1 km between the Valve House No.2 and a service reservoir at Antipolo.

The pipeline between the Antipolo Pump Station and Antipolo Service Reservoir would be subject to water hammer phenomena in the case of sudden shut-down of the pumps. To prevent the occurrence of hazardous negative pressure inside the pipe, a surge tank is provided at the midway point of the pipeline.

F4.3.5 Tunnel No.2

Two lines of 5.3 km long Tunnel No.2, 3.3 m in internal diameter, are aligned to connect the Pipeline No.1-2 and Taytay Service Reservoir.

The tunnel passes through the Antipolo plateau where many deep wells exist. Since the groundwater level is higher than the tunnel inner water head, there is a concern for high groundwater level even after the completion of the tunnel if excessive intrusion of water into the tunnel takes place during the tunneling. Hence, the tunnel is designed to be steel-lined in the sections where such concern is observed. The thickness of steel lining is 19 mm.

F4.3.6 Antipolo Pump Station and Service Reservoir

The service area of Antipolo City is situated at a high altitude, generally higher than EL.200 m. This necessitates the pump-up of water by installing a pump station. A service reservoir is planned at a highest point (EL.260m) in the northern part of Antipolo City so that water could be distributed by gravity to the service area. The general layout plans of the proposed Antipolo Pump Station and Antipolo Service Reservoir are contained in Volume IV.

MWSS/MWCI contemplate the implementation of the Antipolo Water Supply Project (Phase II, 120 MLD from Balara WTP) for completion in 2006. Aside from this scheme, the required water supply from the Kaliwa-Agos project is estimated to be 43 MLD in 2010 and 680 MLD in 2025. In particular, the increase in the period from 2020 to 2025 is projected to be dominant (340 MLD).

In order to meet this supply requirement, Antipolo Pump Station is planned to have 10 units of pumps (including two standby units), each 59 m^3/min (0.99 m^3/sec or 85 MLD) in capacity, at the ultimate stage (Stage 2-2). Storage capacity of the Antipolo Service Reservoir is 180,000 m^3 with six units of reservoir tanks, each having 30,000-m^3 capacity. Both the pumps and reservoirs are planned to be installed in three stages towards 2025.

Present demand projection assumes that population of Antipolo City in 2025 would be about 2.5 million, which is based on the population projected by NSO. Aside from this demand projection, the Study also determined a low demand scenario (1.7 million in 2025) on an assumption of reduced population increase. In this case, the water supply requirement would be 70 % of the figures stated above. As the water demand growth varies by actual population, the schedule of installation of pumps and reservoirs is subject to alteration by monitoring the actual population increase in the subsequent stages.

F4.3.7 Taytay Service Reservoir

The majority of treated water conveyed from the Morong WTP is delivered to the Taytay Service Reservoir which is a main facility to distribute water to the main service areas of the proposed project; i.e., south-western part (Cavite area), southern part (Muntinlupa area) and south-eastern part (towns in Rizal Province). This reservoir is the off-take point for delivering water to the two Concessionaires. Another off-take point is the Antipolo Service Reservoir mentioned above. The general layout plan of the proposed Taytay Service Reservoir is contained in Volume IV.

HWL and LWL of the service reservoir are set at EL. 72 m and 66 m, respectively, taking account of the altitudes of the service area ranging between EL.5 and 50 m by NAMRIA datum. It is noted that the benchmark being used by MWSS is 10 m higher than that of the NAMRIA. This means that the HWL and LWL mentioned above correspond to EL.82 m and 76 m, respectively, in terms of the MWSS datum.

A simulation analysis conducted in this Study revealed that the storage capacity equivalent to 6-hour supply volume could cope with the daily fluctuation of supply requirement. Hence, this Study proposes the effective storage volume of Taytay reservoir to be equivalent to 6-hour supply volume, i.e. 720,000 m^3 at the ultimate stage. The Service Reservoir, consisting of four units of reservoir tanks, will be developed in four stages, 180,000 m^3 at each stage, in conjunction with the expansion of the Morong WTP.

F5 Environmental Impact Assessment (Chapter V of Volume IV)

F5.1 Natural Environment (Chapter V)

F5.1.1 Anticipated Environmental Impacts

Varying degrees of physical and biological impacts are expected to occur as a result of the development project. Major issues identified in the course of the EIA study are:

i) Impact on rare and endangered flora and faunal species both terrestrial and aquatic due to inundation,

ii) Need of watershed management in the Kaliwa River Basin to reduce sediment deposit in the proposed reservoir,

iii) Reduction of sediment release, which may cause lowering of the downstream river bed level and change of shape of lower alluvial plains/delta and coastal lines, especially the sand dunes in the Agos River estuary,

iv) Reduction of river flow in the lower Agos due to water supply for Metro Manila, and

v) Need of monitoring for pollution of the reservoir water due to effluent from households and agro-industries in the upper Kaliwa River Basin.

F5.1.2 Need for Environmental Protection

(1) Protection of Ecosystems in the Kanan-Agos Watersheds

The Kanan-Agos River Watershed system in a recent biodiversity study is declared as a "biologically hot spot" area. It is home to a number of species classified as threatened/rare or uncommon ones. Their habitat area is widespread, although the area affected by the impoundment of the proposed Agos Reservoir is a fraction of the total area. The construction of dam project, however, entails a large spatial disturbance on the biological materials such as removal of trees and disturbance/dislocation of wildlife habitat. While these adverse impacts are irreversible, measures to mitigate these impacts are recommended.

To maintain the level of diversity, transplantation of threatened and rare plants species through collection of their germplasm prior to the inundation of the reservoir is proposed. A proposed measure would be to establish a nursery or genebanks for all the selected plants that require propagation. Areas with low tree density can be subject to enrichment planting or simply allowing assisted natural regeneration to operate. Vacant spaces can be planted with more than two species to promote and maintain species diversity in the area.

Access to the forested areas would be greatly improved using mechanized watercraft on the reservoir surface. However, if usage is left uncontrolled, the general populace would encroach, possibly exposing precious forest products to wild extraction and poaching. This could be mitigated by deputation of

Environment and Natural Resources Officers for Forest Protection (DENRO) or deputizing the local communities, e.g. Dumagats, to apprehend poachers. On the other hand, increased visibility of people/tourist in the area could also reduce or prevent poaching of forest products.

Microhabitat destruction will be a direct impact on threatened/rare wildlife species followed by disturbance caused by rising water level. Due to gradual inundation process, the survival of these species is not threatened as they can easily withdraw from the rising water level.

(2) Continuation of the Kaliwa Watershed Rehabilitation and Management (KWRM) Project

The on-going KWRM project, a component of the 'Forest Management Bureau Water Resources Development Project-Watershed Management Improvement Component', has drawn out a watershed development and management plan for the Kaliwa River Basin. One of its objectives is to formulate strategies to rehabilitate, manage and restore the productive and protective functions of the watershed. At present, the sustainability of the project is a problem. Funds are not sufficient to implement some of the programs/sub-projects such as structural soil conservation, bamboo/balete riverbank stabilization and greenbelt, reforestation/enrichment planting and agro-forestry.

The current KWRM project is scheduled to terminate in 2004. However, it is proposed that the similar activities would continue in the subsequent period until the watershed is restored to a fair environment. Collaboration with the KWRM project brings about a beneficial effect to the proposed project in terms of reducing the sediment yields and water turbidity.

(3) Measures for Mitigating Water Pollution

To mitigate water pollution in the Kaliwa River, changes in the existing land use in the watershed should be strictly regulated by land control development. Adequate wastewater treatment facilities must also be installed under a separate program especially for residential areas and agro-farms/industries located upstream of the proposed reservoir.

F5.1.3 Proposed Protection Measures

For the needs identified above, the following protection measures are proposed to be included as a part of the project components:

Proposed Environmental Protection Measures

	Proposed Work	Source of Budget	Entrusted to
1	Protection of Eco-System:		
	(a) Transplantation of threatened and rare plants including the establishment of a nursery or genebank	Project construction cost	LGU, DENR
	(b) Re-vegetation for the areas affected by construction works, such as spoil banks, temporary facilities area	Project construction cost	LGU, DENR
	(c) Forest protection by deputizing Environment and Natural Resources Officers (DENRO) and/or local communities	A fund system*	LGU, DENR
	(d) Periodical wildlife census survey	A fund system*	DENR
2	Collaboration with KWRM Project		
	(a) Provision of subsidy to cover a part of the KWRM project cost	A fund system*	DENR
3	Measures for Mitigating Water Pollution		
	(a) Land use management and wastewater control	Coordination with concerned agencies	DENR, DILG, DOH
	(b) Promoting the installation of community-based and/or household wastewater treatment units	A fund system*	LGU, DILG, DENR

Note: * A preliminary idea is to establish a special fund for these purposes, e.g., 'Agos River Environmental Development Fund', which will be managed by donation of a part of water revenue to be accrued from the government project (GOVw in Section F8.2 hereinafter). The mechanism on fund administration is subject to further study when the idea is accepted by major stakeholders.

F5.2 Resettlement Plan (Chapter V)

F5.2.1 Number of Project Affected Families (PAF)

An estimated 174 families will be directly affected by the dam/reservoir construction based on the census, inventory of losses and preliminary measurement survey results in EIA. Figure F5.1 shows the location of affected existing settlements along the Kaliwa River. Another 222 families will be affected by the construction of waterway facilities. Thus, the total number of PAFs is some 400 families.

F5.2.2 Public Perception on Relocation

The Study has attempted to draw out the reactions and perceptions of the project affected people (PAP) toward relocation through three steps of hearing survey.

(1) Focus Group Discussion (FGD) and Socio-economic Survey (SES)

As an initial activity, two methods were utilized to collect the general responses; focus group discussions (FGD, at 33 Sitios) and the socio-economic survey (SES, interview survey for 861 households). FGD was held with free participation of the people in the nearby area, including indigenous people. In both activities, the majority of the affected people responded that they were not willing to move to another place to give way for the project (82% for the FGD and 51% for the SES).

The difference on obtained figures between the two surveys is presumably due to the different way of collecting the responses; i.e. people's opinion at FGD was collected in the presence of many participants sitting together at a place, while SES was conducted in a one-on-one basis with each respondent. It seems that relatively high percentage of the PAP's disagreement, at this project beginning stage, is a natural response from the people since they have not fully been informed of the detail of the project as well as the resettlement plan.

Main reasons (apprehensions) cited by both FGD and SES respondents for 'not willing' to be relocated are:

i) Source of income/livelihood is in the area,

ii) Attachment to the place/community having been in the area for a long time,

iii) Ownership of the ancestral land/farmlands, and

iv) Lack of information about the resettlement site.

(2) Public Consultation

Public consultations were held at 3 places (General Nakar, Infanta and Daraitan) after the FGD and SES. People were invited to participate on free basis, where representatives from the LGUs were also present. In the public consultations, the issue on relocation of the PAP also drew varied reactions. While the general attitude of the participants was that of 'resigned acceptance', it was clear that the people would like to have "conditions" or "promised benefits" in place prior to the construction, a reflection of their attitude towards the government projects from their previous experiences.

(3) Workshop

Two workshops were held in the final stage of the Study (at Pililla in October 2002 and in Manila in February 2003), by inviting representatives of the LGUs and people's group. The participants expressed their general consent to the necessity of the proposed project, however, on a condition that the issues and concerns raised during the workshop and succeeding consultations should be given due considerations. Also asserted was a need that the people should be actively involved in the formulation of resettlement plans in the subsequent stages.

F5.2.3 Proposed Resettlement Plan

The number of PAP as a result of the dam construction is considered significant, which requires a full resettlement plan (RP). The requirement of RP is to compensate those directly affected with replacement cost and institute a sustainable income restoration measure. The proposed RP contains project policy on entitlements of lands and other properties, resettlement and compensation methods, resettlement strategies, mitigation measures, grievance redressals, implementation arrangements and schedule, and cost estimates.

The cost relevant to the resettlement is estimated at PHP 1.3 billion (US$ 25 million equivalent). The estimated costs include the cost of losses/compensation

assistance (affected land, houses and structures, communal/public structures, disturbance compensation, financial assistance), cost of resettlement site development, and cost of strategic communications.

F5.2.4 Resettlement Sites

There are two resettlement sites identified: (See Figure F5.1)

(1) Resettlement Site No. 1 is situated in Barangay Magsaysay. The site is intended to house the PAPs from the same barangay. In this way, social displacement and institutional adjustments are kept to a minimum. Located on the right bank of the Kaliwa River, the proposed site is planned along the shoreline of the reservoir of Agos Dam. Total land area of Resettlement Site No. 1 is 32 ha with land elevation ranging from 160 m to 275 m.

(2) Resettlement Site No. 2 is situated in Sitio Kiragpan in Barangay Pagsangahan. Located on the left bank of the Kaliwa River, the proposed site is also planned along the shoreline of the reservoir of Agos Dam. The site has relatively rolling terrain with elevation ranging from 160 m to 200 m. The total land area is 40 ha.

F5.3 Impact to Coastlines of Infanta Peninsula (Chapter IV)

The Agos River Basin yields sediments of the order of 980,000 m^3 annually at present. The Agos Reservoir, after the completion, will trap almost 90 % of these sediment yields. The discharge of sediment loads is reduced to some 190,000 m^3 at the Agos River mouth (corresponding to about 10 % of the present yield), of which the bed load is roughly estimated as 30,000 m^3. The reduction of sediment yield is presumed to give influence to the sediment environments of coastlines in the Infanta Peninsula.

A possible consequence may be the erosion of coastlines in the worst case, particularly along the coast south from the river mouth. A preliminary analysis in this Study has revealed that about 14,000 m^3 of sand is being transported annually southward from the river mouth along the shallow water zone of the coast. The quantity is not considered excessive. Although the extent of coastal erosion is difficult to estimate at the present stage (no sufficient data for a detailed analysis), it is not thought significant in view of a moderate quantity of sand transport as estimated above. Nevertheless, the condition of coastlines should be monitored for a period of decades by means of cross section survey and bathymetric survey along the coast.

Possible countermeasures, should the erosion take place, would be the provision of training work at the river mouth and a series of jetties along the coastlines. The estimated cost of such works is included as a part of O&M cost to reflect in the evaluation of the project.

F6 Associated Works for Supporting Regional Socio-Economic Activities
(Chapter X of Volume IV)

F6.1 Objective of the Proposed Works (Chapter X)

The implementation of the proposed project, particularly the Agos Dam, will bring about various inconveniences to the people in the project area, such as the disturbance during the construction, changes in the river environments, disconnection of local communities due to reservoir impoundment, etc.

As compensation for these inconveniences, the implementation of several works aiming at improvement of people's livelihood and enhancement of regional economic activities has been considered. The following is an outline of the works proposed in this respect.

F6.2 Bank Erosion Protection and Flood Damage Mitigation Work in the Lower Agos Plain (Chapter X)

F6.2.1 Present Condition

The municipalities of Infanta and General Nakar of Quezon Province are the major municipalities within the Agos River Basin. The town proper areas of these municipalities are located in the flood plains of the lower reach of the Agos River Basin (the Lower Agos); Infanta on the right bank of the river and General Nakar on the other. To date, these areas have suffered from the loss of lands due to erosion of the riverbanks and also the damage due to floods. The flood inundation is caused by the combination of storm surge by typhoons, overbank flow of the Agos River, and insufficient capacity of drainage systems in the municipality areas.

The works proposed for mitigating the present difficulties are categorized in three components: (i) bank erosion protection works, (ii) flood protection works, and (iii) drainage improvement works. A preliminary plan of the proposed works is shown in Figure F6.1.

F6.2.2 River Bank Protection Works

The bank erosion at Barangay Ilog of Infanta and the town proper of General Nakar is a serious issue causing a heavy loss of valuable land resources. In particular, the bank protection for the town proper of General Nakar requires early implementation since the riverbank has already been incised close to the perimeter of town proper area.

The municipality of General Nakar has already begun the construction of retaining walls to protect from further erosion in some areas. In addition to the retaining wall, gabion spur dikes are recommended to reduce the bank erosion and stabilize the river stream course. The retaining wall at Barangay Ilog is also proposed to prevent further bank erosion. A preliminary plan is shown in Figure F6.1.

Proposed Bank Protection Works

Place	Proposed Work	Length
Town Proper of General Nakar	Boulder masonry revetment work with gabion spur dykes	900 m
Barangay Ilog, Infanta	Boulder masonry revetment work	900 m

Although this bank erosion issue is not directly related to the proposed Agos Dam project (no adverse effect by the dam), it is proposed that the project would provide the protection works as a program of collaboration to the project affected area. The cost thereof, estimated approximately at US$ 420,000 equivalent, is included in the project cost of Agos Dam.

F6.2.3 Flood Protection Works

A 10-year probable flood is adopted for the formulation of the flood damage mitigation plan in the Lower Agos. Figure F6.2 shows the flood vulnerable area preliminarily delineated on a 1:5,000 map. The map indicates that the municipality of General Nakar is likely to suffer from the floods of the Agos River. Conversely, the municipality of Infanta experiences floods only in limited areas since most of the area is protected by natural levee.

A flood protection dike is proposed on the General Nakar side of the Agos River. The proposed alignment of earth dike is shown in Figure F6.1. Based on the non-uniform flow analysis, the height of the earth dike is estimated to be approximately 2 meters. The new Barangay road is also proposed for the evacuation purpose during flood period.

Proposed Flood Damage Mitigation Work

Place	Proposed Work	Length
General Nakar	Flood Protection Dike New Barangay Road	1,300 m 400 m

Although this flood issue is also not directly related to the proposed Agos Dam project (no aggravation of flood condition by the dam), it is proposed to provide the above work under the project as a program of collaboration to the project affected area. The cost thereof, estimated approximately at US$ 330,000 equivalent, is included in the project cost of Agos Dam.

F6.2.4 Drainage Improvement Works in Infanta

The town proper area of Infanta experiences the inundation from time to time due to insufficient flow capacity of drainage systems in the town and also a main drainage canal to the sea (Bantilan River). The flow capacity of the Bantilan River under the present condition is computed as 10 to 45 m^3/sec varying by stretch, whereas the design flood is estimated to be 50 to 70 m^3/sec. Augmentation of flow capacity of the Bantilan River is required, together with improvement of a drain channel in the southern part so that runoff from the southern area does not flow into the Infanta town proper area.

Proposed Infanta Drainage Improvement Works

Place	Proposed Work	Quantity
Infanta	Improvement of the Bantilan River (Open Canal with wet masonry revetment, 15-30m x 1.5m)	2,500 m
	Improvement of Town Drainage Facilities (15 ha)	15 ha
	Improvement of a Southern Drainage Canal (Earth-excavated Channel, 3m x 1m)	1,000 m

This issue is also not directly related to the Agos Dam project. In view of relatively large cost requirement (US$ 2.4 million equivalent), the work will be undertaken under a separate project.

F6.3 Associated Works Proposed for Supporting Regional Socio-Economic Activities (Chapter X)

F6.3.1 Provision of River Water Use Facility

Water transfer to Metro Manila (34.7 m^3/sec at the ultimate stage) will result in a reduction of dry season flow in the downstream reach, although the daily average flow of 26.3 m^3/sec (equivalent roughly to the present 95 % discharge) would still be maintained by flow release from the Agos power plant. The reduced flow may lead to the lowering of river water levels. The release from the power plant varies from 15.7 m^3/sec to 55.4 m^3/sec depending on the operation mode of the power plant. This causes the daily fluctuation of river water levels, which is estimated to be around 1 m.

To reduce the people's inconvenience caused by such fluctuation of river water levels, it is proposed to provide a riverbank structure for facilitating the people's use of the river: such as navigation, bathing and washing, at the place where people use the river. The proposed structure is a stairway type of riverbank revetment work, which would be usable at any river water levels for boat landing, bathing and washing.

The facility will be provided at 21 places. Figure F6.3 shows the location of the proposed works with a typical section of the riverbank structure. Each structure is proposed to be about 10 m in length.

F6.3.2 Provision of Access Roads/Footpaths for the Communities

The proposed Agos Reservoir, once impounded, will interrupt the existing traffic paths (mostly footpaths) presently used by people in the area. To compensate this, the project will provide several facilities, which are shown in Figure F6.4 and described below.

(1) Access Road to Resettlement Sites

Resettlement scheme for the Agos Dam contemplates the relocation of affected settlements to the two new resettlement sites as shown in Figure F6.4. The project will provide access roads to the new resettlement sites. The total length is estimated as 14 km.

(2) Footpaths

In addition to access roads to the resettlement sites, a trunk footpath connecting Agos Dam and Barangay Daraitan will be built. A footpath will also be built along the Kanan River. These footpaths will facilitate the people's access to shops, schools, medical facilities and other public facilities located presently at Barangay Daraitan and Barangay Magsaysay. Total length of the footpaths is estimated as some 30 km.

(3) Reservoir Crossing Facility

At six locations where local people have to cross the reservoir, a boat landing facility will be provided, including one near the Agos Dam, to facilitate the people's traffic across the reservoir and also travel from and to the upstream area. The proposed locations are shown in Figure F6.4.

The boat landing facility is a sloped masonry concrete structure similar to the riverbank structure shown in Figure F6.3. It extends from the MOL up to the FSL in elevation, with a width of 2 m.

(4) Access to Barangay Daraitan

The upstream end of Agos Reservoir reaches close to the Barangay Daraitan village proper. When the reservoir water level is lower than the Full Supply Level (FSL, 159 m), the river flow condition is unchanged from the present. However, the reservoir raises the river water level by about 2 m when the reservoir is at its FSL. This will make access by vehicles difficult, where presently vehicles can cross the shallow part of the river in the dry season.

To provide a permanent access measure to the village, construction of an access road (1.5 km) with two bridges (70m+80m) is planned. The proposed alignment of access road and bridges is shown in Figure F6.4.

F6.3.3 Flood Protection Bund for Barangay Daraitan

It is foreseen that flood water levels at the Barangay Daraitan would become slightly higher than the present levels due to backwater effect when the reservoir water level is at FSL or higher. This suggests the provision of a flood protection bund along the perimeter of the village on the left bank. Drainage of the inner land will be by gravity through drainage sluices. Figure F6.4 shows a preliminary layout plan of the flood protection bund.

F6.3.4 Establishment of a Manpower Training Center

Some of the project-affected families (PAFs) will have to change their occupation due to resettlement outside the present livelihood area, though the relocation is within the same Barangay. As a program of supporting the sustainable livelihood of those affected people, a manpower training center will be established at a place to suit the people involved (e.g. Barangay Daraitan, Agos Damsite or a new resettlement site). The center will be operated by the project during the construction period and transferred to the municipality concerned after the construction works.

F6.3.5 Establishment of a Health Center

The hearing through FGD, SES and public consultation has revealed the people's strong desire to establish a health center in the vicinity. The proposed work is to build a new health center with the minimum required equipment, staffed by a physician, a nurse and a mid-wife. The new health center will be located either at Barangay Daraitan or the new resettlement site. The health center will be operated by the project during the construction period and later transferred to the municipality concerned.

F6.3.6 Cost Estimate

The cost required for the above-proposed works is estimated roughly to be US$ 5.0 million equivalent or Peso 260 million, which is included in the construction cost of the Agos Dam.

F7 Project Implementation Cost (Chapter IX)

The project will be implemented in three stages. The estimated cost is summarized below:

Estimated Project Cost

(Unit: Million US$ equivalent)

Stage	Package	Main Works	F.C. Portion	L.C. Portion	Total
1	GOVw	Kaliwa Low Dam and 1st Waterway	166.1	86.0	252.1
	BOTw	WTP #1 Unit and 1st Waterway from WTP to S/R	177.8	80.5	258.3
		Sub-total	343.9	166.5	510.4
2-1	GOVw	Agos Dam	292.6	210.6	503.2
	BOTw	WTP #2 Unit	59.0	32.3	91.3
	BOTa	Agos Power Station	67.3	13.5	80.8
		Sub-total	418.9	256.4	675.3
2-2	GOVw	Kaliwa-Lagundi 2nd Waterway	125.8	50.5	176.3
	BOTw	WTP #3 and #4 Units	245.2	123.3	368.5
		Sub-total	371.0	173.8	544.8
	Project Cost at 2002 Price (*)		1,133.8	596.7	1,730.5
	Price Contingency		351.8	287.9	639.7
	Taxes		113.4	59.7	173.1
	Total Project Cost (Fund requirement excluding IDC)		1,599.0	944.3	2,543.3

Note: (*) Base construction cost at 2002 price + Engineering Services + Administration Cost + Physical Contingency

Abbreviation

GOVw: Government project for water supply development (See Section F8.2 below)
BOTw: BOT project for water supply development (Ditto)
BOTa: BOT project for Agos Hydropower Development (Ditto)
LDC: Interest during Construction

F8 Implementation Program (Chapter XI of Volume IV)

F8.1 Implementation Schedule (Chapter XI)

In the M/P, the completion schedule of the Kaliwa-Agos project was assumed to be 2010 for comparison of alternative development scenarios. This was modified in

this F/S to be 2013 in consideration of the following factors revealed during the F/S:

(1) EIA survey has identified that the majority of local residents showed 'no' or 'not willing' attitudes to the relocation. This infers that the formation of public acceptance would take a relatively longer time period than the assumed before.

(2) In the earlier study, the financing from MWSS own budget source was assumed for the detailed design aiming at the earliest proceeding of the implementation. In this Study, the financing for the detailed design is assumed to be from ODA fund sources, which will require an extra lead-time.

Thus, the earliest attainable completion schedule of the Stage-1 project is deemed to be Year 2013. Figure F8.1 shows the proposed implementation schedule of overall project covering Stages 1 to 2-2.

Figure F8.2 shows the balance of water demand and supply capacity in the case of commissioning of the proposed project in Year 2013. The demand-supply scenario shown in Figure F8.2 was worked out with the following consideration:

(1) The proposed Kaliwa-Agos project will meet the day peak demand of 3,640 MLD, out of the total demand growth of 4,360 MLD arising between the present (4,090 MLD) and Year 2025 (8,450 MLD).

(2) MWSS proposes to implement two interim schemes: a 50 MLD Project at Wawa river and a 300 MLD Project on a performance-based target scheme (one of the candidate water sources is the Laguna Lake). This Study further proposes that, to fill the demand-supply gap remaining till the Kaliwa-Agos project is on stream in Year 2013, an additional interim scheme of at least 350-400 MLD should be commissioned in the earliest attainable year. The water demand after Year 2014 can be met by the supply from the Kaliwa-Agos project, except for the gap still remaining during 2014-2016.

(3) The proposed schedule assumes that 4 units of water treatment plant (WTP #1 - #4) will be commissioned at 3-year interval. This schedule is almost similar to that contemplated in the M/P.

F8.2 Procurement of the Project (Chapter XI)

F8.2.1 Implementation Packages

Taking into consideration the recent government's policy to promote private sector participation in public works, the project is designed on a build, operate and transfer (BOT) basis except for the construction of Dams and Tunnel No.1 for which the government is assumed to take initiatives. The whole project is planned to comprise the following three (3) schemes:

1) A government scheme for dam and tunnel construction (hereinafter referred to as GOVw),
2) BOT scheme for the construction of water treatment plant and conveyance facilities (BOTw), and
3) Another BOT scheme for hydropower development at Agos Dam (BOTa)

The reasons for proposing the GOVw as a government project are twofold:

(a) Construction of Agos Dam (165 m high) and Tunnel No.1 (27.5 km long) involves varieties of technical risks and requires a large investment cost, both of which would be large burdens to BOT proponents.

(b) The high importance of a supply of cheap water to the consumers. The least costly approach is to utilize the ODA soft loans of low interest rate and longer repayment period, which could minimize the annual repayment amount and accordingly contribute to minimizing the water cost.

It is assumed in this Study that the water produced by the GOVw scheme will be handed over at the entrance of the water treatment plant to the joint venture company of BOTw with full-cost-recovery basis without any return to the government.

The water will then be treated by the BOTw joint venture company and transferred to the existing Concessionaires at the exit of the service reservoir to be built by the project. The BOTw is implemented with full-cost-recovery basis plus the return that can be considered reasonable by the responsible government agency (MWSS) and is high enough to attract BOT proponents as well.

F8.2.2 Financial Procurement for the Implementation

(1) GOVw Scheme

For the GOVw scheme, the ODA loan of foreign government's assistance is assumed taking the advantages of long-term repayment period and the concessional interest rate, as stated above. Its repayment period is usually around 20-30 years including a grace period of 5-10 years. The domestic currency portion is also desirably to be financed as far as possible through ODA financial facilities as well.

The DFI (development financing institutes) loan with concessional terms and conditions is also assumed to supplement the ODA fund.

The remaining requirement for local funding is to be raised by the government with such fund for which the project will not be responsible in terms of either principal repayment or interest payment. When the significant importance of the project as water supply to Metro Manila is recognized, it is not deemed hard for the government to obtain inter-agency consensus for appropriating the project.

(2) BOT Schemes (BOTw and BOTa)

Joint venture companies (JVC) will be established under BOT bases. The core of the JVC may be a local water company for BOTw scheme and a local power company (IPP) for BOTa scheme. Members other than the core company will

include construction companies, manufacturers, trading companies and financial institutions from both local and foreign sources.

Member companies of JVC are required to contribute the share of the equity capital of the JVC. The total equity capital is assumed in this Study at 35% of the total fund requirement of each BOT scheme. The remaining 65% will be financed by either concessional loans of DFI or commercial loans of city banks.

The concession period is assumed to be 25 years for BOTw and BOTa schemes starting from the operation of Projects to the transfer of project facilities. The JVC is expected to repay all the debt and secure an appropriate return to its investment before the end of the concession period.

F8.3 **Implementation Framework** (Chapter XI)

F8.3.1 Executing Agency

The Steering Committee meeting held on August 21, 2001 agreed that "MWSS will handle the implementation of the water resources development of the Agos River Basin until such time the 'River Basin Authority' (See Section 8.4.2) is created. Following this conclusion, the MWSS will take the role of Executing Agency.

F8.3.2 Inter-Agency Coordination Committee

In order to assist and coordinate the roles and duties of the MWSS, an "Inter-Agency Coordinating Committee" will be organized. The composition and functions of the Committee are proposed to be as follows: (See Figure F8.3).

1) Name of the committee:	Inter-agency Coordination Committee on Agos River Basin Project (ICCARBP)
2) Composition:	Chairman (1): MWSS Members (9): NEDA, DPWH, DENR, DILG, DOE/NPC, NWRB, NIA, Provinces of Quezon and Rizal
3) Functions of the Committee:	Coordination activities among agencies concerned with such matters that require consensus, cooperation and/or adjustment including land acquisition, water appropriation, environmental conservation and others.
4) Termination:	The ICCARBP is to be terminated upon the completion of construction works of the Project and its powers and functions are to be inherited by the Agos River Basin Committee (ARBC, see below) after necessary modification.

A "Project Management Office" (PMO) will be built in the MWSS headquarter. The PMO is composed of seconded staff of each member agency who will be dispatched for the limited time of the project construction. Thus, all the wide-ranging expertise that is required for implementing the project will reside in the

PMO. It is expected that the PMO will administer the project at the level of daily operation covering both the government scheme and BOT schemes.

F8.4 Organization Structures after the Completion of the Project (Chapter XI)

F8.4.1 Agos River Basin Committee (ARBC)

After the completion of construction works, the ICCARBP will be reorganized into the Agos River Basin Committee (ARBC). The ARBC will be composed of the same water-related agencies as those of the ICCARBP except that the chair agency will be changed from MWSS to NWRB. The NWRB as the chair agency of the ARBC will be responsible for all the areas of development and management activities of the Agos River Basin through the power/function delegation mechanism as shown in Figure F8.4.

Although NWRB is responsible for all the areas of development and management activities of the Agos River Basin, daily routine operational works in every area of development/management works are to be within the responsibility of each executing agency. In other words, all the sector-specified operations in this proposed organizational framework are delegated from NWRB as the chair agency of ARBC to each responsible agency.

The river basin development and management organization comprises the water resources conservation sector, (which together with water quality management is to be the responsibility of DENR), and the flood control sector (which together with river environment sector) DPWH is to be responsible. The sector of water quantity management and water resources development is to be covered by the collaboration of all the member agencies including DENR, NEDA, MWSS, NIA, DOE/NPC, DPWH, DILG and LGUs of the Provinces of Quezon and Rizal.

F8.4.2 River Basin Authority (RBA)

The ARBC proposed above is an organization that is to be upgraded to the River Basin Authority (RBA) when the idea currently contemplated by NEDA and relevant agencies is realized. Finally, the RBA is expected to become an organ under the umbrella of Water Resources Authority of the Philippines (WRAP) when the WRAP is established.

F8.4.3 O&M Works of BOT Projects

The operation and management of the BOT schemes including BOTw and BOTa schemes will be the responsibility of each JVC by the end of the concession period under the supervision of ARBC. Member agencies of ARBC in respective areas are to be responsible for the supervision; for example, MWSS be responsible for supervising the water schemes including GOVw and BOTw schemes and DOE/NPC (TRANSCO as the agency) for BOTa scheme.

F8.5 Reformation of NWRB (Chapter XI)

The Executive Order (EO) 123, series of 2002 titled “Reconstituting the National Water Resources Board (NWRB)”, was approved by the President and publicized

on September 14th 2002, thence NWRB was transferred to the Office of the President (OP). With the approval by the President of the revised organization and manpower structure of the NWRB Secretariat, NWRB will be transferred to DENR as one of its bureaus. The first step of reforming the NWRB has at long last commenced.

Meanwhile, in August 2002, another "WRAP" bill with a House Bill No. 1109 titled "An Act providing for a comprehensive water resources management to address the national water crisis" was submitted again to the Congress. In Chapter 1, it declares that "the Water Resources Authority of the Philippines (WRAP)" shall be hereby created. The Authority will be an attached agency of the Office of the President (OP). The Authority will exercise the powers and functions of the NWRB. The Director General of the Authority will be an ex officio member of the Board of NEDA. The budgetary preparation will be made by the creation of "Water Resources Conservation and Development Fund" from the raw water fees, administrative fees, and other revenue of the Authority. Unlike EO123, however, it will take a long time for the bill to pass the Congress.

F9 Evaluation of the Proposed Project (Chapter XII of Volume IV)

F9.1 Framework of Economic and Financial Evaluation (Chapter XII)

The project is evaluated from the two different aspects, namely economic and financial aspects. Major differences are compared in the table below:

Framework of Project Evaluation

Method	Point of view	Benefit and cost	Indicator	Criteria (target)
Economic evaluation	National economy	Cost: Economic cost Benefit: WtP, Cost of alternative thermal	EIRR	More than 12% (Opportunity cost of capital) More than 15% (NEDA criteria)
Financial analysis	Project company	Cost: Market price + Tax + inflation Benefit: Sales revenue of water and power	FIRR ROE WACC DSCR	Evaluation of financial indicators

Note: 1) WtP: Willingness to pay; 2) WACC: Weighted average cost of capital
3) DSCR: Debt service coverage ratio

Economic evaluation is undertaken to ascertain the economic viability of the project from the point of view of the socio-economy as a whole. Financial analysis looks at the point of view of project companies, namely the joint venture companies of two BOT schemes in this Study.

In principle, evaluation is carried out for each individual scheme of GOVw, BOTw and BOTa. However, the economic evaluation is rendered for the integrated scheme of GOVw and BOTw as these two schemes are components of one identical water supply project supplying water to Metro Manila and they can function only when they are operated in combination.

F9.2 **Economic Evaluation** (Chapter XII)

F9.2.1 Economic Cost and Benefit

Base costs estimated in preceding Chapter F7 are utilized for the project evaluation. The shadow pricing is applied for foreign exchange (by applying a standard conversion factor) and unskilled labor wage. The evaluation period is set at 50 years considering economic life of facilities and the replacement cost considered for metal and electrical works every 20 years.

Economic benefit of water supply is measured by willingness to pay (WtP) of consumers for water. The WtP is estimated at Pesos 38.9 per m^3 for billed water after taking into account the bottled water prevailing at markets. In addition, an external social benefit is estimated and incorporated by valuing the time of housewives freed up from caring water.

The economic benefit of hydropower project is estimated based on the cost of alternative thermal power plant assuming that the said cost can be avoided in case hydropower plant is built by the project. This is one of the conventional ways of evaluating the economic benefit of a hydropower project.

F9.2.2 Assessment of EIRR

(1) Integrated Water Supply Scheme (GOVw and BOTw)

In order to relate to the benefits stated above, the cost should cover all the costs incurred to the project from the dam through household faucets. It includes not only the project cost for the construction of dam and water conveyance facilities, but also costs of operation and maintenance (O&M) costs of the water treatment plant, transmission mains and distribution networks including primary distribution mains. Costs such as those related to coastal monitoring and landslide prevention in the Agos Reservoir area are also included as a part of O&M costs.

As the result of computation, an EIRR of 16.7% is derived for the integrated water supply project combining GOVw and BOTw schemes. The EIRR exceeds both opportunity cost of capital assumed at 12% in this Study and the EIRR criteria of 15% set by ICC of NEDA. Therefore, the project is economically justified.

(2) Hydropower Scheme (BOTa)

The EIRR of BOTa scheme is computed in a same manner as the above and a value of 14.4% is derived. This assessed EIRR is slightly less than the criteria of ICC NEDA (15%), but is sufficiently larger than the opportunity cost of capital (12%). The scheme is regarded economically justifiable taking also into account other intangible social benefits to be accrued from the project (See Chapter XII of Volume IV for detail of intangible benefits).

F9.2.3 Sensitivity Test

The sensitivity of the EIRR is examined by increasing and decreasing the values of costs and benefits by 10% respectively. The result shows that, in the case of the worst conditions of cost increase by 10% with benefit decrease by 10%, the EIRR

of the integrated water scheme goes down to 14.0% and the EIRR of BOTa to 9.4%.

F9.3 **Financial Analysis** (Chapter XII)

F9.3.1 General

The purpose of financial analysis differs by each scheme.

(i) GOVw scheme:

The purpose of financial analysis of GOVw is to verify if the full-cost-recovery can be realized in implementing the GOVw scheme. It will be proved when no deficit is observed in the cash surplus stream of projected cashflow statement.

(ii) BOTw scheme:

The function of BOTw is to treat the raw water purchased from GOVw scheme and to sell the treated water to the Concessionaires at the exit of service reservoirs. The buying price of raw water of GOVw at the entrance of WTP will be determined by the equalizing water rate (EWR) that makes the total cost stream of GOVw equal to its total revenue stream by discounting at the rate of 12%. The selling price of treated water at the exit of service reservoirs should be high enough for the BOT company to gain appropriate profit. Finally, the selling price is required to meet the affordability-to-pay of consumers at the household level.

(iii) BOTa scheme:

The financial viability of BOTa hydropower scheme relies on the assumed selling price of electricity.

F 9.3.2 Conditions and Assumptions

The following conditions and assumptions are adopted for the financial analysis.

(1) The following are major terms and conditions assumed for possible fund sources for the project:

Terms and Conditions Assumed for Possible Fund Sources

Capital requirement	Interest Rate (% p.a.)	Repayment Period (years)	Front-end Fee (% p.a.)	Commitment Fee (% p.a.)
GOVw Scheme				
75%: ODA loan	2.0	20	-	-
15%: DFI loan	4.5	15	1.0	0.75
10%: GOP contribution	-	-	-	-
BOT scheme				
35%: DFI loan	4.5	15	1.0	0.75
30%: Commercial loan	10.0	10	1.0	0.75
35%: Equity capital	-	-	-	-

As shown above, the GOVw scheme is assumed to be financed by ODA loan, DFI (Development Financing Institution) loan and GOP capital contribution. The BOT schemes are assumed to get project funding from DFI loan, commercial bank loan and the company's own equity capital.

(2) Concession period

The concession period for BOT schemes is assumed to be 25 years following the usual practice of BOT schemes in the Philippines. When the concession period is terminated, all the properties of the project will be transferred to the government.

(3) Package loan by stage-wise

It is assumed that loan agreements will be concluded at each stage of construction. Therefore, interest payment and principal repayment are computed stage-wise for each scheme. The interest during the construction is consequently calculated for each scheme stage-wise as well.

F 9.3.3 Capital Expenditures of each Scheme

The capital expenditures of each scheme are estimated based on the base cost at 2002 market prices. They are summarized as shown below:

Capital Expenditures of Each Scheme

(Unit: US$ million)

Scheme	First Stage Dev. Stage 1	Second Stage Development		Total
		Stage 2-1	Stage 2-2	
GOVw Scheme	338.8	737.9	270.5	1,347.2
BOTw Scheme	335.8	137.8	600.3	1,073.9
BOTa Scheme	-	122.0	-	122.0

Note: The above capital expenditures including price escalation and tax.

F 9.3.4 Equalizing Water Rate

The equalizing water rate is defined as the water rate that makes the scheme's total cost equal to the scheme's total revenue by discounting at 12%. In other words, when the raw water is sold at the EWR, then the cost of GOVw scheme can be fully recovered. The EWR was computed stage-wise for GOVw and BOTw schemes respectively. The result of the EWR computation is shown below:

Equalizing Water Rates

(Unit: Peso/m^3)

Scheme	First Stage Dev. Stage 1	Second Stage Development	
		Stage 2-1	Stage 2-2
GOVw scheme	7.3	18.7	7.3
BOTw scheme	14.2	22.8	12.0

The EWR of BOTw scheme means that, if the treated water is sold at this EWR, then the cost of BOTw scheme can be fully recovered.

F 9.3.5 GOVw Scheme

Since it is assumed that no return is to be expected for GOVw scheme, the financial analysis of GOVw aims at ascertaining the possibility of loan repayment. According to the financial analysis, the projected cashflow statement proves that loan repayment is possible and also verifies that some cash surplus is generated from the initial stage of operation after rendering interest payment and principal repayment of loans.

F 9.3.6 BOTw Scheme

The financial analysis of BOTw was made firstly based on the EWR at Stage 2-2 (12.0 Peso/m^3). The derived financial indices showed that the scheme cannot be feasible with this water rate on a BOT basis: cash surplus being negative for 3 initial years, FIRR at 11.3%, ROE at 7.5% and WACC at 6.4%. It is inevitable because the EWR of 12.0 Peso/m^3 does not include any profit to BOTw scheme but covers only full cost of GOVw and BOTw schemes.

Regarding the selling price of treated water, it should be such value that covers not only full cost but also an appropriate profit to run the project company. The "appropriate" level of the profit, however, is obscure and arbitrary. The price of water will actually be determined in the agreement to be concluded between the Project Company and the distribution Concessionaires. In this Study, however, the ROE of 15% is proposed taking into consideration long-term interest rates and yields of national bonds. Actually, the criteria that ROE should be greater than 15% was adopted in the Laiban Dam study that is similar in nature to the present project.

The financial analysis of BOTw scheme was conducted by applying the water rate of 15.9 Peso/m^3 that corresponds to the ROE of 15%. The FIRR was derived at 17.6% and WACC (weighted average cost of capital) at 9.0%. The minimum DSCR (debt service coverage ratio) in the projected cashflow statement was 1.4 at the first year with gradual yearly improvement. Meanwhile, the necessary condition for a BOT project to be implementable is for the FIRR to be greater than WACC. This condition is satisfied as well. These financial indicators show the scheme's financial viability under the BOT basis assuming a ROE of 15%.

The above selling price of water of 15.9 Peso/m^3 at service reservoirs was examined for consumers' affordability-to-pay for water. In this examination, it was assumed that Angat water will be blended, monthly water consumption is 30 cubic meters per family, NRW will be improved up to 30% in and after 2025, and inflation rate will be 3% per annum in average. On the basis of these assumptions, it was verified that the household expenditure for water would occupy 0.8% of total family income in 2025. Judging from the statistics that the share of total expenditures for electricity, fuel and water in 1997 was 5.5% of monthly family income, the water rate of 15.9 Peso/m^3 is deemed to be within a range of affordability-to-pay of consumers.

F 9.3.7 BOTa Scheme

The financial analysis of BOTa scheme was made under the assumption of a power-selling price of 3.5 Peso/kWh (at 2002 prices). The resulted cashflow statement shows no deficit of cash surplus with minimum DSCR of 2.5 at the first year. The FIRR is derived at 25.6%, real ROE at 38.4% and WACC at 17.9%. These financial indices show the scheme's financial viability under BOT basis. The selling price of power would affect financial achievements in the case of BOTa scheme. The change of financial indices is shown below:

Sensitivity for Power-Selling Rates

Power Selling Rate (Peso/kWh)	FIRR (%)	ROE (%)	WACC (%)	Deficit of Cash Surplus	Minimum DSCR (Times)
2.5	19.1	26.8	13.7	None	1.7
3.0	22.5	33.0	15.9	None	2.1
3.5	**25.6**	**38.4**	**17.9**	**None**	**2.5**
4.0	28.5	43.3	19.6	None	2.9
4.5	31.3	47.6	21.1	None	3.3

F9.3.8 Summary of Project Evaluation Results

Analytical indices of economic evaluation and financial analysis of each scheme are summarized in the table below:

Summary of Economic Evaluation and Financial Analysis

Scheme	EIRR (%)	FIRR (%)	ROE (%)	WACC (%)	Min. DSCR (Times)
GOVw	16.7	-	-	-	-
BOTw		17.6	15.0	9.0	1.2
BOTa	14.4	25.6	38.4	17.9	2.5

F9.4 Evaluation of Water Scheme (GOVw + BOTw) Stage 1 (Chapter XII)

Taking into consideration the large amount of capital investment required for the whole project, the feasibility of Stage 1 of the integrated water project that is composed of GOVw and BOTw schemes was examined independently. This examination assumes such case where the project was planned as a whole with three stages at the initial phase but, by some reasons, the construction was brought to a halt when the Stage 1 construction was completed. Therefore, the utilization of a part of the capital investment rendered in Stage 1 like waterways and treatment plant is forced to be postponed until later stages, which means "a prior investment." This may inevitably affect the feasibility of the Stage 1 construction.

F 9.4.1 Computation of Economic Internal Rate of Return (EIRR)

The cost required for construction of Stage 1 facilities covering both GOVw and BOTw schemes was compared with the benefit to be accrued at the Stage 1. The benefit was computed based on the water supply volume scheduled for Stage 1 with a maximum throughput of 750 MLD.

As the result of computation, EIRR of 15.0% was derived for Stage 1 of the integrated water project. Although it is worse than the EIRR for the whole stage (16.7%), the derived EIRR for Stage 1 exceeds the opportunity cost of capital of 12% and indicates that the integrated water project can be economically justified even when it is implemented independently from the whole project.

The sensitivity test was carried out with varying costs and benefits by 10% respectively. The EIRR under the worst case, cost increase by 10% with benefit decrease by 10%, was derived at 12.2% which was still higher than the opportunity cost of capital of 12%.

F 9.4.2 Financial Analysis of Stage 1 of the Integrated Project of GOVw and BOTw

In preparing the cashflow statement, the water rate of 17.7 P/m^3 (2002 price level) was assumed based on the predetermined ROE of 15%. For the cost side, the raw water purchase from GOVw scheme was considered to cover all the costs incurred from raw water production of GOVw. Therefore, the cost to be analyzed in computing financial indicators thereafter is limited to the costs proper to BOTw scheme. As the result, no deficit in the item of "cash surplus" was observed and the minimum DSCR was 1.7 in the first year.

The FIRR of 16.6% was derived after incorporating the raw water purchasing cost from GOVw and deducting income tax to be paid by BOTw. The WACC of 9.1% was obtained with the real cost of borrowing of 6.1% and the ROE of 15%.

The necessary condition for a BOT scheme requiring the FIRR to be greater than the WACC is satisfied. Therefore, the water project contracted to sole Stage 1 can be said financially viable. It is to be noted, however, that this financial analysis becomes meaningful on the assumption that the ROE of 15% brought about by the water rate of 17.7 P/m^3 can be realized by BOTw scheme.

The consumers' affordability-to-pay for water was tested and the share of payment for water in monthly family income was computed at 0.9% in 2025, which is deemed to be within the range of affordability-to-pay of consumers.

The result of project evaluation of Stage 1 for the integrated water project of GOVw and BOTw schemes is summarized hereunder:

Summary of Evaluation Result of GOVw + BOTw Schemes (Stage 1 Project)

Scheme	EIRR (%)	FIRR (%)	ROE (%)	WACC (%)	DSCR (times)
GOVw	15.0	-	-	-	-
BOTw		16.6	15.0	9.1	1.7

F9.5 Evaluation from Technical Aspects (Chapter XII)

F9.5.1 Technical Difficulties Involved in the Project

The proposed project involves several technical difficulties peculiar to the site conditions, which should be tackled by proper planning and design. They are:

(a) Risk to earthquakes due to proximity to the Philippine Fault (Infanta Fault) known as a major active fault.

(b) Need for elaboration on the design of the Agos Dam foundation work in consideration of thick riverbed deposit (40m) and five low velocity zones

(c) Need for detailed investigation for an assumed active fault on the Tunnel No.1 route

(d) Need for further investigation with regard to the stability of coastlines of Infanta-General Nakar Plain

However, these difficulties are of a nature that they can be solved by proper planning of preventive measures and/or proper design of the structures.

F9.5.2 Tolerability for Extraordinary Droughts

The Agos Reservoir, having an effective capacity of 409 million m^3, is capable of yielding 61 m^3/sec (5,270 MLD) of water at the maximum (total of 34.7 m^3/sec for water supply and 26.3 m^3/sec for hydropower). With this gross yield capacity, the reservoir can supply the designated water of 3,000 MLD without a major deficiency even in the drought year of 30-year recurrence probability, on a basis that water use for power is reduced accordingly in the case of such extraordinary conditions. In this regard, the Agos Reservoir has a sufficient tolerance for extraordinary droughts.

F9.5.3 Development Program Consistent with the Growth of Water Demand

The proposed project envisages a staged development meeting closely the growth of water demand. Water source facilities (Kaliwa Low Dam and Agos Dam) are commissioned in 2 stages when the demand requires such water sources. Waterways will also be implemented in 2 stages and water plants (water treatment plant, pump station and service reservoir) in 3 to 4 stages. This stage-wise development can minimize the cost burden in terms of the present worth of investment costs.

F9.5.4 Adoption of Appropriate Construction Method

Planning and design of the proposed facilities took into account the adoption of construction methods most appropriate to the respective site conditions. Some of the methods specifically proposed are described in Section 12.4 of Volume IV.

Most of the proposed works are of conventional type of construction, except for the tunneling by TBM planned for Tunnel No.1. This will afford the maximum participation of local construction industries.

F9.5.5 Operation and Maintenance Aspects

The proposed project does not include any specific O&M skills requiring very high technologies. Most of O&M duties are attainable by proper training of personnel by means of lectures and on-site practices. The training program will include the assignment of O&M guidance experts in respective fields for a year period at the beginning period of the O&M operations.

F9.5.6 Procurement of Works through LCBs

In the present Study, details of construction packages are not provided. However, the project, at least in the Government initiated portion (GOVw project), envisages to have local competitive bidding (LCB) contracts as many as appropriate. The works will include access roads, government quarters, reservoir clearing, and bank erosion and flood protection works. BOT projects will also adopt many LCB contracts.

F9.6 Evaluation from Social and Environmental Aspects (Chapter XII)

F9.6.1 Intangible Benefits Accrued from Water Supply

The intangible benefits attributable to the Project are identified and enumerated as much as possible in the F/S Main Report (Volume IV). One of the most significant intangible benefits will be the health improvement effect.

According to the statistics of DOH, the number of patients suffered from diarrhea amounted to 866,400 in the Philippines in 2000. The diarrhea was the top cause of morbidity followed by bronchitis, pneumonia, influenza and hypertension. The distribution by age group shows that, out of the total casualties of diarrhea, the largest share of 62% were the infants of less than four (4) years old. The statistics also indicate the reducing trend of diarrhea morbidity rate per 100 thousand populations from the highest ceiling of 2000 in 1994 to nearly 1000 in 2000.

During the period, the service coverage of household connection in Metro Manila is estimated to have increased from less than 60% to nearly 70%. This noticeable inverse correlation is deemed to indicate the effect of water supply for reducing water-borne diseases.

F9.6.2 Social Impacts Arising from Relocation of People

The proposed Agos reservoir will inundate 21 Sitios (hamlets) situated along the Kaliwa and Kanan Rivers, which will necessitate the relocation of 174 families. This relocation quantity is deemed to be of a manageable extent for solving successfully if a proper resettlement plan is deployed.

The construction of waterways also requires the relocation of 222 families. According to EIA survey, the affected people in the area do not express strong opposition to the relocation.

F9.6.3 Impacts on Natural Environments

The Study has attempted to formulate the proposed project to be "an environmentally friendly project" as much as possible. Nevertheless, in view of huge development scale and varieties of construction works, the project would bring about relatively wide range of impacts on the natural environments. Among others, the following four (4) major impacts are noteworthy:

(1) Loss of forest-agriculture-dwelling lands of 20 km^2 due to inundation by the Agos reservoir

(2) Production foregone in the areas procured for construction of water conveyance facilities: 100 ha for water treatment plant, 20 ha for Taytay Service Reservoir, 7 ha for Antipolo Service Reservoir and 9 ha for Antipolo Pump Station

(3) Reduction of the dry-season river flow from the present 30 m^3/sec (present 90 % discharge) to 26.3 m^3/sec

(4) Reduction of sediment yields in the Agos downstream reach from 980,000 m^3/year to 190,000 m^3/year, which may give consequences of lowering of

the riverbed levels and also the possible change of sediment environments of coastlines in the Infanta-General Nakar alluvial plain.

These four impacts are regarded as the change of natural conditions that are unavoidable consequences arising from the construction of the project. No substituting measure could be taken for (1) and (2) above. These must be accepted as substitutes of other beneficial effects brought about by the project. For the issues of (3) and (4), provision of technical countermeasures as discussed in the preceding sections could mitigate the extent of impacts.

F10 Recommendation of Further Actions (Chapter XIII of Volume IV)

F10.1 Early Decision of the Implementation (Chapter XIII)

As stated in the earlier Sections, the proposed Kaliwa-Agos project would need the earliest commissioning since the demand-supply gap is projected to worsen year by year as its commissioning is delayed. This requires a quick mobilization of the project for moving to the implementation stage. For this purpose, it is strongly recommended for MWSS to decide the implementation of the proposed project at the earliest possible time.

There is another implementation option; e.g., Laiban Dam is to be initiated. However, overall comparison has indicated that the proposed Kaliwa-Agos project should be given priority. The detailed description in this regard is given in Section 11.6 of Volume IV.

F10.2 Actions towards the Implementation (Chapter XIII)

Once the decision of the implementation is made, it is strongly recommended fir MWSS to immediately commence the activities for mobilizing the project, initiated by dialogue with the project-affected people for solving the relocation issue. The other activities needing the immediate commencement are described in Section 11.7 of Volume IV.

F10.3 Technical Aspects to be Further Examined (Chapter XIII)

There are some technical aspects that could not be fully detailed in this Feasibility Study stage, owing mainly to the limited quantities of field investigation works and the lack of existing data made available at the present stage. These items should be refined during the detailed design stage. All of those items are of technically solvable nature. The major items needing the further investigations and studies are listed in a table contained in Chapter XIII of Volume IV.

F10.4 Decision on Issues raised at Public Consultations/Workshops (Chapter XIII)

Various opinions were expressed from the people and LGUs in the project affected area, at the places of three public consultations held as a part of EIA survey and the two workshops held at the end phase of the Study. This Study examined the

proposed responses to the public opinions raised at the workshops as are presented in a table contained in Chapter XIII of Volume IV.

It is strongly recommended that MWSS will review the concepts suggested in the table and decide how to respond to the PAPs and LGUs in these regards. The decision should be reached before the commencement of dialogue with them.