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 II
## Master Plan Study
## Main Report

March 2003

Nippon Koei Co., Ltd.

NJS Consultants

## List of Volumes

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| **Volume I** | **:** | **Executive Summary** | |
| **Volume II** | **:** | **Phase 1:** | **Master Plan Study - Main Report** |
| **Volume III** | **:** | **Phase 1:** | **Master Plan Study - Supporting Report** |
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The cost estimate is based on the price level and exchange rate of June 2001.

The exchange rate is:

US$1.00 = PHP52.0 = ¥125.0

## 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

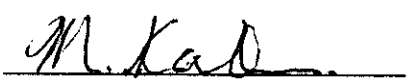
It is a great pleasure that we submit herewith the Final Report of the "Study on Water Resources Development for Metro Manila in the Republic of the Philippines".

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.

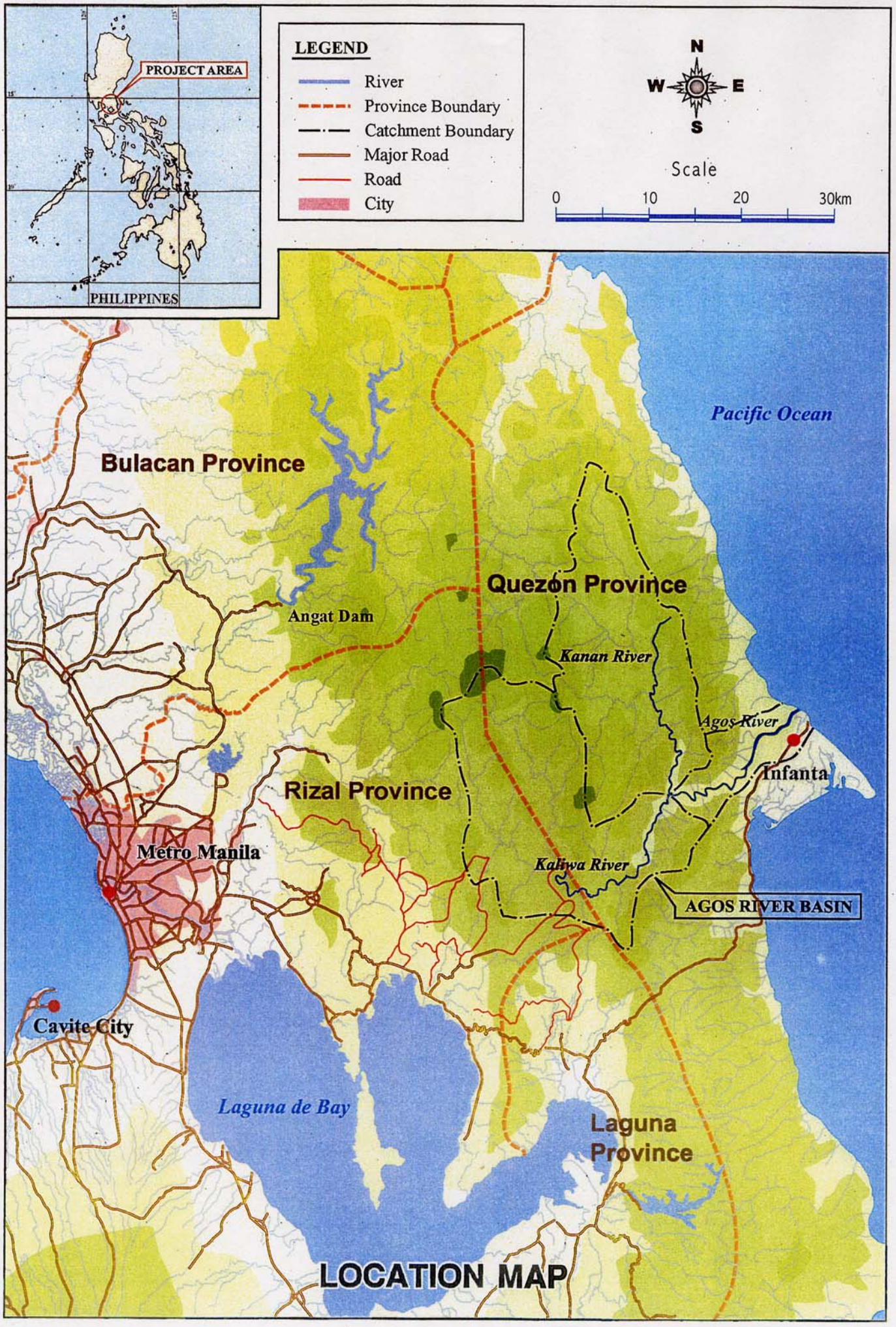
We wish to express our sincere gratitude to the personnel concerned of your Agency for the guidance and support given throughout the Study period. Our deep gratitude is also expressed to the National Water Resources Board and other concerned authorities of the Government of the Republic of the Philippines, 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
Infanta
Rizal Province
Metro Manila
Kaliwa River
AGOS RIVER BASIN
Cavite City
Laguna de Bay
Laguna Province
LOCATION MAP

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

VOLUME II MASTER PLAN STUDY- MAIN REPORT

# SUMMARY

## Study Activities in Master Plan Stage: (Chapter I)

1. As the first phase program of the Study, the JICA Study Team carried out field investigation works and home office studies during the period from March 2001 to November 2001. The main subject of the first phase study was the preparation of a master plan for the water resources development for Metro Manila towards the year 2025 by exploiting the water resources in the Agos River Basin. This Volume II summarizes the outcomes from the master plan study. The report was submitted to NWRB as an Interim Report for the Study and explained to the Philippine side in January 2002.

## Socio-Economic Framework: (Chapter II)

2. The future population in the Study area covering NCR, Rizal Province and a part of Cavite Province was projected for the period up to year 2025, the target year of the present Study. The projection aims at providing data for the estimate of future water demand in the Study area at city/municipality level.

**Population Projection up to 2025**

(Unit: 1,000)

| | Population 2000 (Census) | Projected Population | | | | | Annual Growth Rate | |
|---|---|---|---|---|---|---|---|---|
| | | 2005 | 2010 | 2015 | 2020 | 2025 | 2000-2010 | 2010-2025 |
| The Philippines | 76,499 | 84,241 | 91,868 | 99,016 | 105,507 | 113,661 | 1.8% | 1.4% |
| Region IV | 11,794 | 12,860 | 14,525 | 16,357 | 18,225 | 20,320 | 2.1% | 2.3% |
| NCR *1 | 9,933 | 10,680 | 11,291 | 12,434 | 12,854 | 13,241 | 1.3% | 1.0% |
| Cavite Province *2 | 2,063 | 2,357 | 2,411 | 2,715 | 2,987 | 3,250 | 1.6% | 2.1% |
| Rizal Province *3 | 1,707 | 2,152 | 2,681 | 3,409 | 4,222 | 5,139 | 4.6% | 4.4% |
| Study Area Total | 13,073 | 15,189 | 16,383 | 18,558 | 20,063 | 21,630 | 2.3% | 1.9% |

Note: *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 2.3% and 1.9% for the periods of 2000-2010 and 2010-2025, respectively.

3. Gross Regional Domestic Product (GRDP) in the Study area was projected for the three major sectors of agriculture, industry and service for the period up to the year 2025. The GRDP projection is also needed to provide basic data for the estimate of future municipal and industrial water demands in the Study area.

**GDP/GRDP Projections for 2000-2025**

(Unit: Billion Pesos)

| | 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 Sec. | 0 | 0 | 0 | 0 | 0 | 0 | 0% | 0% |
| - Industrial Sec. | 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 Sec. | 34 | 37 | 38 | 39 | 40 | 41 | 0.7% | 16.1% |
| - Industrial Sec. | 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, which is higher than the GDP growth of the whole country.

## Water Demand Projection: (Chapter II)

4. Water demand consists of billed water (domestic + commercial + industrial) and non-revenue water (NRW). 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 |
|---|---|---|---|---|---|---|
| Projected Water Demand: (MLD) | | | | | | |
| Day average demand | 3,663 | 3,783 | 4,250 | 5,033 | 5,866 | 6,980 |
| Day peak demand | (4,400) | 4,577 | 5,143 | 6,090 | 7,097 | 8,446 |
| Existing Supply Capacity (MLD) | 4,090 | | | | | |
| Per capita consumption (Lpcd) | 119 | 125 | 139 | 153 | 170 | 188 |
| Service coverage (%) | 69 | 71 | 75 | 81 | 88 | 97 |
| Served population (1000) | 8,120 | 9,703 | 11,286 | 13,785 | 16,147 | 19,109 |
| Billed water (%) | 39.1 | 46 | 52 | 58 | 64 | 70 |
| NRW ratio (%) | 60.9 | 54 | 48 | 42 | 36 | 30 |
| of which, - Physical loss (%) | 33.5 | 30 | 28 | 26 | 20 | 20 |
| - Commercial loss (%) | 27.4 | 24 | 20 | 16 | 10 | 10 |

Note: Day peak demand is assumed as 1.21 times the average demand. The figure of day peak demand for 2000 represents the potential day peak demand.

5. The water demand projection above falls in the middle range of various previous projections made in the Water Supply and Sewerage Master Plan Study (JICA, 1995), Water Resources Master Plan Study (JICA, 1998) and the latest MWSS projection (2001).

## Development Scale of New Water Resources: (Chapter IV)

6. 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 are contemplating the augmentation of supply capacity by implementing several projects. The schemes contemplated at the stage of M/P Study 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 herein called the "Interim Schemes".

7. After these Interim Schemes are added, the total supply capacity becomes 4,790 MLD. 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). The need for further development of water resources towards year 2025 is then estimated as 3,020 MLD in terms of daily average supply quantity (6,980 MLD-3,960 MLD).

   Note: In this Study, water resources development is planned for daily average supply requirement, while the proposed facilities are planned to have the capacity to meet the day peak demand.

8. On one hand, the earliest commissioning of the Agos water supply scheme is foreseen to be around the year 2010 at the earliest on the basis of a rushed implementation program. This means that water demand growth up to 2010 should be met by additional inputs of the Interim Schemes (a total of 1,053 MLD in day peak supply capacity, 5,143 MLD-4,090 MLD). If all the demand up to 2010 is met by the additional Interim Schemes, the need for water resources development in the Agos River Basin is 2,730 MLD to meet the water demand growth between 2010 and 2025 (6,980 MLD-4,250 MLD) in daily average supply quantity.

9. Assessing the overall figures derived in Para.7 and 8 above, this Study assumes that the development requirement of water resources in the Agos River Basin is 3,000 MLD in daily average supply quantity. This corresponds to the figure assessed in Para.7 above and includes about 10 % allowance for the figure assessed in Para.8 above. The allowance for the latter is deemed to cover the uncertain factors involved in the actual achievement of implementation of the Interim Schemes and also in the assumptions set forth for water demand projection, particularly the projection of NRW reduction.

**Exploitable Water Resources: (Chapter III)**

10. Long-term runoff of the Kaliwa River was estimated using tank model analysis. The Agos River runoff was estimated from the runoff records at Banugao Station and the Kanan runoff by deducting the Kaliwa runoff from the Agos runoff. Low flow study and reservoir operation study revealed the exploitable water resources at selected water development sites to be as follows:

**Exploitable Water Resources at Water 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 Intake: | | | | | |
| 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, roughly corresponding to a 97-98 % dependability for the whole period
(2) Run-of-River Scheme: 90 % dependable discharge, after releasing river maintenance discharge, which is taken at 10 % of 80 % discharge
(3) Exploitable water at Agos Dam represents the total yield usable for water supply and hydropower
*1 MWSP III Study *2 EDCOP Study

## Geological Survey: (Chapter III)

11. Initial survey conducted during the M/P study identified the following geological issues to be taken into account in formulating the master plan:

(a) Seismicity due to proximity to the active Philippine Fault (Infanta Fault). This issue is common to all dam schemes

(b) The existence of many faults near the proposed damsites and along waterways, some of which are categorized by PHILVOLCS as assumed active fault. This issue is also common to all dam and waterway schemes, although the extent varies by scheme

(c) Concern for reservoir watertightness due to limestone masses occurring in the reservoir areas, for both the Laiban and Agos Dams

(d) Thick riverbed deposit at Agos Dam and potential landslide problems at both the Agos and Kanan No.2 Damsites

## Initial Environmental Examination: (Chapter IV)

12. Initial environmental examination (IEE) has identified varying degrees of socio-environmental impacts that may arise due to the proposed projects. The major issues are as follows:

(a) Impact on the riverine environment in the downstream reaches due to reduction of flow caused by water transfer to Metro Manila and reduction of sediment discharges caused by construction of dams.

(b) Change of flow regime will force local people to change the way of river use. Of a more serious concern is the possible 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 being constructed.

(c) Need for watershed management, especially for the Kaliwa River basin

(d) Need for protection of ecosystems already being affected by illegal logging and human encroachment. This issue is particularly important in the Kanan-Agos watersheds.

(e) Need for preparation of a feasible Resettlement Action Plan (RAP) for relocating 300 to 3,000 households. 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)

**Formulation of Water Resources Development Plans: (Chapter V & VI)**

13. In order to find the least costly development plan, eight (8) alternative development scenarios were formulated for comparison. The development scenarios were formulated as the combination of three (3) dam/reservoir schemes and three (3) run-of-river schemes for water source development and three (3) waterway schemes for water conveyance to Metro Manila area. The formulated scenarios are shown in the table below:

**Alternative Development Scenarios**

| Develop. Scenario | Ultimate Supply Capacity (MLD) | First Stage Development | Second Stage Development | | Water way |
|---|---|---|---|---|---|
| | | | 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 | *2 |
| F | 3,330 | Laiban Dam + 1st Waterway | Agos Dam + 2nd Waterway | | *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 Capacity: Day average supply quantity
2. Waterway Scheme: *1 Laiban~Pantay~Taytay *2 Kaliwa~Abuyod~Angono
*3 Laiban~Karan Batu~Angono
3. Layout Plan: See Figure 5.4 of Main Text

**Comparison of Alternative Development Scenarios: (Chapter VII)**

14. The relative attractiveness of the eight (8) alternative development scenarios presented above was evaluated through comparison of "unit water cost" per $m^3$ of water supply. The project cost estimated in this Study included the costs of water

source exploitation (dam/reservoir), a water treatment plant and water conveyance facilities up to a main service reservoir planned at Taytay (Scenarios A and F) or Angono (Scenarios B to H). Hence, the water cost evaluated herein represents the cost at the main service reservoir, which is regarded as the off-take point for distribution to the supply network.

15. Since the proposed development scenarios are formulated to differ in their development scales, 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 total incurred costs and expected revenues by discounting to 2001 prices at a discount rate of 12 % per annum. It is assumed that a part of the invested cost is recovered by electricity energy revenue and the remainder should be recovered 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 portion to be recovered by water revenue (the portion remaining after deducting the portion to be recovered by energy revenue) and the present worth of water revenue.

16. The evaluation horizon is set at 40 years after the first stage scheme is commissioned. Although the earliest attainable completion year of the first stage scheme varies by scenario from 2010 to 2013, the Study assumed that the first stage project of all the Scenarios would be completed in year 2010 to enable a comparison of the Scenarios within the same time frame. Therefore, the evaluation horizon assumed is from 2011 to 2050 in this comparative study.

17. 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 | 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 water sale amount, discounted at 12% per annum. The water sale price is escalated at 3% per annum.

18. As indicated in the table above, the unit water cost index is evaluated to be the least for Scenario B, followed by Scenarios C, D, F and H being at an almost equal level. The favorable index of Scenario B can be explained by the larger quantity of water exploitable by the Agos reservoir, which is usable either for water supply and hydropower, as indicated in the table shown in Para.10 above.

19. On one hand, the unit water cost index of the Laiban Dam project showed an index value almost comparable to that of Scenario B. Hence, this Study proposes that both the Scenario B (evaluated as least costly on scenario basis) and Laiban Dam (evaluated as attractive on an individual project basis) would be worthy of further consideration in formulation of the master development plan of the Agos River Basin.

**Proposed Master Plan: (Chapter VIII)**

20. A master plan was formulated basically in line with the plans proposed in Development Scenario B. The configuration of the proposed master plan is shown in Figure 8.1 of the main text.

Water Supply Development Plan:

21. Scenario B envisages the development of Kaliwa Low Dam initially and Agos Dam ultimately 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**

| Proposed Facilities | 1st Stage Develop | 2nd Stage Development | |
|---|---|---|---|
| | | Stage 2-1 | Stage 2-2 |
| Water Supply Q'ty | 550 MLD initially | Additional 950 MLD | Additional 1,500 MLD |
| Kaliwa Low Dam | Supply of 550 MLD initially | (Supply substituted by Agos Dam) | - |
| Agos Dam | - | Supply of 1,500 MLD, including 550 MLD earlier supplied by Kaliwa Low Dam | Supply of additional 1,500 MLD |
| Waterways | 1st Waterway for 1,500 MLD | - | 2nd Waterway for additional 1,500 MLD |
| Water Treatment Plant (WTP) | WTP #1 – 750 MLD | WTP #2 - 750 MLD | WTP #3 & #4, each 750 MLD |
| Main Service Reservoir (SR) | SR #1 for 750 MLD | SR #2 for 750 MLD | SR #3&4 for additional 1,500 MLD |

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.

22. As stated above, the Laiban Dam project was retained for consideration in the master plan. The project is already committed by the Memorandum Order No.10 of August 5, 1998, which mandated the MWSS to resume the implementation of the project.

23. There are two hurdles for the implementation of Laiban Dam. One is the resettlement of about 3,000 households or 15,000 people, which constitutes a large social problem. The other is the concern for possible delay in completion due to the

time requirement for solving the resettlement issue before construction and also potential problems that may arise during the construction. The implementation of Laiban Dam depends on MWSS's confidence in how quickly the resettlement issue could be solved and how fast the project could be commissioned.

Hydropower Development:

24. Three (3) potential hydropower development schemes are proposed in the master plan: (i) Abuyod power station at the downstream end of the water conveyance tunnel, (ii) Agos power station at the toe of Agos Dam, and (iii) Kanan No.2 power station at the toe of Kanan No.2 Dam. The proposed hydropower development is summarized in table below:

**Summary of Hydropower Development Plan**

| Scheme | Power Output (MW) | | 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 | 85.6 | 71.3 | 178.0 | 240.9 | 418.9 |
| Kanan No.2 P/S *2 | 209.5 | 135.3 | 406.4 | 97.2 | 503.6 |

Notes: *1 Installed after the completion of Agos Dam and 2nd Waterway
*2 Can be implemented independently from the water supply schemes

Measures for Mitigation of Socio-Environmental Issues:

25. The socio-environmental study (Chapter IV) has identified several potential issues to arise due to the proposed projects. These issues should be taken into account in the subsequent feasibility study.

(1) Impact to River Mouth Alluvial Plain due to Reduced Sediment Yield

A major impact of serious concern is, as stated in Para.12 above, the possible change morphology of river mouth and coastlines.

(2) Resettlement Scheme

The proposed water resources development and conveyance projects will require a varying degree of relocation of households. This issue is an important sociological parameter determining the viability of the proposed projects and hence is taken up as a planning element of the master plan.

(3) Watershed Management in the Kaliwa River Basin

The Kaliwa River Basin is yielding a large quantity of sediments due mainly to deforestation over a long period and active development of land for cultivation. Also, the destruction of forest cover results in wildlife habitat loss, and consequently diminishing biodiversity and wildlife.

The DENR-Forest Management Bureau (FMB) is currently implementing a Watershed Rehabilitation and Management Improvement Project for the Kaliwa catchment. Since the recovery of a fair watershed environment takes a relatively long period, the activities of Kaliwa Watershed Management Project should be further strengthened and continued henceforward.

(4) Conservation of Eco-Systems in Kanan-Agos Watershed

The Kanan and Agos River Basins are covered by thick vegetation. This vegetation cover is home to some migratory and permanent endangered fauna, such as the Philippine deer, wild pig, monitor lizard and kalaw. These species are important components in the stability and productivity of the ecosystem.

Extensive logging especially in the Kanan River watershed is already posing a serious threat to the primary forest in the upper catchment. Furthermore, the impoundment of the Agos reservoir and the construction of Kanan No.2 Dam (including the reservoir, access road and transmission line) will have significant impacts on the forest environment and ecological system in the basin.

Projects for Enhancement of Regional Development:

26. The implementation of water resources development will cause various types of 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 project will have to provide necessary measures to improve people's livelihood and enhance regional economic activities. The following describe the outline of the projects proposed in this respect:

(1) Bank Erosion Protection Work in the Infanta-General Nakar Alluvial Plain

In the Infanta-General Nakar alluvial plain, severe bank erosion is taking place along the both banks of the Agos River. The erosion at the heaviest portion was as large as 300-400 m during 1952 and 1995. The bank has already been incised very close to the main part of the General Nakar town. According to people in the area and the Municipality Office, the most urgent project needed in this area is the protection of the banks from further erosion. The proposed work consists of revetment work coupled with the installation of groins in selected portions of the river course.

(2) Provision of Riverbank Structure for Facilitating the People's River Use

The riverine environment downstream of the Agos Dam will change significantly, e.g. degradation of riverbed level, decrease of dry season flow, etc. This will cause the people in the area to change the ways of water use or river. The proposed project is to provide riverbank structures for facilitating the people's use of the river at places where people use the river. The proposed structures are for boat landing and bathing/washing that will be usable at any river water level.

(3) Provision of Access Roads/Footpaths for the Communities

The resettlement scheme for the Agos Dam contemplates relocation of the existing settlements to lands at higher elevations in the vicinity of the original locations. The project being proposed herein is to provide access to those new resettlement areas by extending a road from the access roads built for the construction works. If the resettlement site is less populated or in a relatively remote location, access will be by footpath. In addition, a trunk footpath connecting Agos Dam, Kaliwa Low Dam

and Barangay Daraitan will be built. This footpath will facilitate the people's access to shops, schools, medical facilities and other public facilities located in the vicinity. Also, for improving access to Barangay Daraitan during flood season, a footpath suspension bridge will be built just upstream of the existing ferry site.

(4) Establishment of a Manpower Training Center

Some of the PAFs (project affected families) will have to change their occupation due mainly to resettlement outside the present livelihood area. To support sustainable livelihood of the PAFs, a manpower training center will be established at Barangay Daraitan or new resettlement site.

(5) Establishment of a Health Center at Barangay Daraitan

In Barangay Daraitan, there are at present two health centers staffed by a nurse and a midwife, the latter visiting once a week, which is a lower level of service than is required for a medical facility in an area with a population in the order of 4,000. The proposed project is to build a health center equipped with the minimum equipment required and being staffed by a physician and a nurse.

(6) Power Supply to Infanta-General Nakar Area

The proposed master plan contemplates to supply the power generated at Agos Power Station to the Infanta-General Nakar area by a 69 kV transmission line. The stable supply of power will contribute to further development of economic activities in the area through stimulating industrial development.

**Economic Evaluation of Proposed Schemes: (Chapter VIII)**

27. Economic evaluation was made for two major schemes proposed in the master plan: one is the scheme comprised of Kaliwa Low Dam, Agos Dam and Kaliwa-Angono Waterway for multi-purpose development of water supply and hydropower. The other is Kanan No.2 Dam scheme for hydropower 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.

28. Analysis of the cost and benefit streams revealed that the economic internal rate of return (EIRR) is 13.5 % for the former multi-purpose scheme and 5.4 % for the Kanan No.2 hydropower scheme. The EIRR evaluated for the Kanan No. 2 scheme is relatively low. The Kanan No.2 scheme will require a further elaboration of the plans for justifying the viability.

**Proposed Implementation Organizations: (Chapters VIII & X)**

29. The Steering Committee meeting for this Study, 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 that a River Basin Authority is created". The Study assumes that MWSS would act as the Executing Agency for the proposed project.

30. In order to assist and coordinate the roles and duties of the MWSS, an "Inter-Agency Coordinating Committee" will be organized. The Committee will be composed of representatives from NEDA, DPWH, DENR, DILG, DOE/NPC, NWRB, NIA, MWSS, and Quezon and Rizal Province. MWSS will chair the Committee. Chapter X of the main text describes the detail of the roles and functions of the Committee and also the proposed organizational structure in the operation and maintenance stage.

**Proposed Financial Arrangement: (Chapter VIII)**

31. This Study proposes the following procurement approaches to be most advantageous to the project:

(1) Project under BOT (Build-Operate-and-Transfer) Scheme:

In line with the policy of the Government as well as that of the MWSS, a basic principle would be to procure the work through the maximum use of private financing resources (e.g. BOT). This procurement will be applied to the following work components:

- Water treatment plant and conveyance facilities (from water treatment plant up to service reservoirs)
- Distribution mains (preferably to be implemented by the present water distribution concessionaires)
- Hydropower plants at Abuyod and Agos Dam

(2) Projects under Government Project

On the other hand, construction of the water resources facilities (dam and tunnel) involves greater technical risks and requires a large investment cost, which would be a large burden to most BOT Proponents. The least costly approach is to build the water resources facilities as a government project by utilizing the ODA soft loans of a low interest rate longer repayment period, which affords minimizing the annual costs and accordingly minimizing the water cost. The work components proposed for the implementation as a government project include:

- Water source development, i.e. Kaliwa Low Dam and Agos dam
- Water conveyance tunnel up to Abuyod hydropower plant
- Projects proposed for regional development (See Para.27 above)

The fund for repayment of loans can be generated from the sale of raw water to the BOT concessionaires for water supply and electricity supply.

**Selection of Project for Subsequent Feasibility Study: (Chapter IX)**

32. Among the projects included in the proposed master plan (Para.20 to 27 above), the most urgent project is water supply development for attaining the earliest supply of water to Metro Manila. Hence, the subsequent feasibility study will take up the 1st stage development of the water supply schemes proposed in Development Scenario B, which is outlined in the table shown in Para.21 above.

33. The 1st stage project consists of the Kaliwa Low Dam with the 1st waterway. A matter to be noted is that the viability of the 1st stage project relies largely on the feasibility of the Agos Dam. Therefore, the feasibility study should also include the investigation and studies of the Agos Dam as well.

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

**FINAL REPORT**

**VOLUME II**
**PHASE 1: MASTER PLAN STUDY**
**MAIN REPORT**

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## ABBREVIATION

| | | |
|---|---|---|
| ACP | : | Asbestos Cement Pipe |
| ADB | : | Asian Development Bank |
| AMSL | : | Above Mean Sea Level |
| ANR | : | Assisted Natural Regeneration |
| ASEAN | : | Association of Southeast Asian Nations |
| AWLR | : | Automatic Water Level Recorder |
| AWSOP | : | Angat Water Supply Optimization Project |
| AWWA | : | American Waterworks Association |
| BIR | : | Bureau of Internal Revenue |
| BOD | : | Biochemical Oxygen Demand |
| BOO | : | Build Operate Own |
| BOT | : | Build-Operate-and-Transfer |
| BP | : | Bank Policy |
| BRS | : | Bureau of Research and Standards |
| BSWM | : | Bureau of Soils and Water Management |
| CA | : | Concession Agreement |
| CALABARZON | : | "Cavite, Laguna, Batangas, Rizal and Quezon Provinces" |
| CAPEX | : | Capital Expenditure |
| CARP | : | Comprehensive Agrarian Reform Program |
| CBFM | : | Community-Based Forestry Management |
| CD | : | Community Development |
| CDO | : | Cease and Desist Order |
| CENRO | : | Community Environment and Natural Resources Office |
| CERA | : | Currency Exchange Rate Adjustment |
| CFRD | : | Concrete Face Rockfill Dam |
| CO | : | Community Organization |
| COA | : | Commission On Audit |
| CPC | : | Certificate for Public Convenience |
| CPCN | : | Certificate for Public Conveniences and Necessity |
| CPI | : | Consumer's Price Index |
| DA | : | Department of Agriculture |
| DAO | : | DENR Administrative Order |
| DAR | : | Department of Agrarian Reform |
| DBCC | : | Development Budget Coordination Committee of NEDA |
| DECS | : | Department of Education, Culture and Sports |
| DENR | : | Department of Environment and Natural Resources |
| DFI | : | Development Financing Institutes |
| DILG | : | Department of Interior and Local Government |
| DMA | : | District Metering Area |
| DMS | : | Detailed Measurement Survey |
| DMZ | : | District Monitoring Zone |
| DO | : | Dissolved Oxygen |
| DOE | : | Department Energy |
| DOF | : | Department Of Finance |
| DOH | : | Department of Health |
| DPWH | : | Department of Public Works and Highways |
| DSCR | : | Debt Service Coverage Ratio |
| DSWD | : | Department of Social Welfare and Development |

| | | |
|---|---|---|
| DTI | : | Department of Trade and Industry |
| EA | : | Executing Agency |
| ECAs | : | Environmentally Critical Areas |
| ECC | : | Environmental Compliance Certificate |
| ECPs | : | Environmental Critical Projects |
| ECRD | : | Earth Core Rockfill Dam |
| EDCOP | : | Engineering and Development Corporations Of the Philippines |
| EIA | : | Environmental Impact Assessment |
| EIARC | : | EIA Review Committee |
| EIRR | : | Economic Internal Rate of Return |
| EIS | : | Environmental Impact Statement |
| ELC | : | ELC Electroconsult |
| EMB | : | Environmental Management Bureau |
| EMMP | : | Environmental Management and Monitoring Plan |
| EMP | : | Environmental Management Plan |
| EMS | : | Environmental Management System |
| EO | : | Executive Order |
| EPA | : | Extraordinary Price Adjustment |
| ERB | : | Energy Regulatory Board (of DOE) |
| EVAT | : | Expanded Value Added Tax |
| FC | : | Foreign Currency |
| FGD | : | Focus Group Discussion |
| FIRR | : | Financial Internal Rate of Return |
| FMB | : | Forest Management Bureau |
| F/S | : | Feasibility Study |
| FSL | : | Full Supply Level |
| G.S. | : | Gauging Station |
| GDP | : | Gross Domestic Products |
| GHD | : | Gutteridge Haskins and Davey Pty Ltd. |
| GI | : | Galvanized Iron |
| GNP | : | Gross National Products |
| GOCC | : | Government Owned and Controlled Corporations |
| GOJ | : | Government of Japan |
| GOP | : | Government of the Philippines |
| GRDP | : | Gross Regional Domestic Products |
| HP | : | Hydropower |
| HUDCC | : | Housing and Urban Development Coordinating Council |
| HWL | : | High Water Level |
| IAs | : | Implementing Agencies |
| IBRD | : | International Bank for Reconstruction and Development or the World Bank |
| ICC | : | Investment Coordination Committee of NEDA |
| ICCs | : | Indigenous Cultural Communities |
| IEC | : | Information-Education and Communications |
| IEE | : | Initial Environmental Examination |
| IICDA | : | Infanta Integrated Community Development Assistance |
| IOL | : | Inventory of Losses |
| IPs | : | Indigenous Peoples |
| IPRA | : | Indigenous People's Right Act |
| IRR | : | Implementing Rules and Regulations |

| | | |
|---|---|---|
| IU | : | International Union for the Conservation of Nature and Natural Resources |
| JBIC | : | The Japan Bank for International Cooperation |
| JICA | : | Japan International Cooperation Agency |
| JVC | : | Joint Venture Company |
| JWWA | : | Japan Waterworks Association |
| LC | : | Local Currency |
| LCB | : | Local Competitive Bidding |
| LFPR | : | Labor Force Participation Rate |
| LGU | : | Local Government Unit |
| LLDA | : | Laguna Lake Development Authority |
| Lpcd | : | Liter per capita per day |
| LPG | : | Liquefied Petroleum Gas |
| LTPDP | : | Long-term Philippines Development Plan |
| LWL | : | Low Water Level |
| LWUA | : | Local Water Utilities Administration |
| M/P | : | Master Plan Study |
| MARILAQUE | : | Manila-Rizal-Laguna-Quezon |
| MEMSI | : | "MADECOR Environmental Management Systems, Inc." |
| MENT | : | Multi-Partite Environment Monitoring Team |
| MERALCO | : | Manila Electric Company |
| MGB | : | Mines and Geosciences Bureau |
| MLD | : | Million Liter per Day |
| MMDA | : | Metro Manila Development Authority |
| MMT | : | Multi-partite Monitoring Team |
| MMUTIS | : | Metropolitan Manila Urban Transportation Information System |
| MOA | : | Memorandum of Agreement |
| MOL | : | Minimum Operation Level |
| MTPDP | : | Medium-Term Philippines Development Plan |
| MWCI | : | Manila Water Company Inc. |
| MWSI | : | Maynilad Water Services Inc. |
| MWSP | : | Manila Water Supply Project |
| MWSRP | : | Manila Water Supply Rehabilitation Project |
| MWSS | : | Metropolitan Waterworks and Sewerage System |
| NAMRIA | : | National Mapping and Resource Information Authority |
| NATM | : | New Austrian Tunneling Method |
| NCIP | : | National Commission on Indigenous Peoples |
| NCR | : | National Capital Region |
| NEDA | : | National Economic and Development Authority |
| NEPC | : | National Environmental Protection Council |
| NGO | : | Non-Government Organization |
| NGOs | : | Non-Government Organizations |
| NIA | : | National Irrigation Administration |
| NP Junction | : | Novaliches Portal Junction |
| NPC | : | National Power Corporation |
| NPCC | : | National Pollurion Control Commission |
| NRW | : | Non-Revenue Water |
| NSCB | : | National Statistical Coordination Board |
| NSDW | : | National Standard for Drinking Water |
| NSO | : | National Statistical Office |
| NTFW | : | Non-timber Forest Product |

| | | |
|---|---|---|
| NTU | : | Nephelometric Turbidity Unit |
| NWDCC | : | National Water Data Coordinating Center (to be created) |
| NWRB | : | National Water Resources Board |
| NWRMP | : | National Water Resources Master Plan |
| O&M | : | Operation and Maintenance |
| ODA | : | Official Development Assistance |
| OP | : | Office of the President |
| PAC | : | Poly Aluminum Chloride |
| PAFs | : | Project Affected Families |
| PAGASA | : | Philippine Atmospheric, Geophysical and Astronomical Services Administration |
| PAMB | : | Protected Area Management Board |
| PAPs | : | Project Affected Persons |
| PD | : | Presidential Decree |
| PENRO | : | Provincial Environment and Natural Resources Officer |
| PFDA | : | Philipine Fisheries Development Authority |
| PHILVOLCS | : | Philippine Institute of Volcanology and Seismology |
| PHP | : | Philippine Peso |
| PMF | : | Probable Maximum Flood |
| PMP | : | Probable Maximum Precipitation |
| PNSDW | : | Philippine National Standards for Drinking Water |
| PO | : | People's Organization |
| PR | : | Public Relations |
| PROC | : | Proclamation |
| P/S | : | Power Station |
| PSY 2000 | : | Philippine Statistical Yearbook 2000 |
| PTFWRDM | : | Presidential Task Force on Water Resources Development and Management |
| PVC | : | Poly Vinyl Chloride |
| QUEZELCO | : | Quezon Electric Company |
| RA | : | Republic Act |
| RAP | : | Resetlement Action Plan |
| RBW | : | Receiving Body of Water |
| RBWA | : | River Basin and Watershed Authorities |
| RCCD | : | Roller Compacted Concrete Dam |
| REECS | : | "Resources, Environment and Economics Center for Studies" |
| RIZWADA | : | Rizal Water Districts Association |
| ROE | : | Return on Equity |
| ROW | : | Right Of Way |
| RPV | : | Pressure Reducing Valve |
| SAMAKA | : | Samahang Mahalin ang Kalikasan |
| SAMAKABAY | : | Samahang Magsasaka ng Bantay Bayan |
| SCP | : | Strategic Communications Plan |
| SEC | : | Securities and Exchange Commission |
| SES | : | Socio-Economic Survey |
| S.G.S. | : | Streamflow Gauging Station |
| SMBDSM | : | Samahan ng Magsasaka sa Bundok na Dahilig ng Sierra Madre, Inc. |
| SO2 | : | Sulfur Oxides |
| STP | : | Sewerage Treatment Plant |
| SR | : | Service Reservoir |
| SRD | : | Social Resettlement Division |

| | | |
|---|---|---|
| TBM | : | Tunnel Boring Machine |
| TCD | : | Tribal Community Development |
| TCU | : | True Color Unit |
| TDS | : | Total Dissolved Solids |
| TOR | : | Terms Of Referece |
| TRANSCO | : | National Transmission Company |
| TSS | : | Total Suspended Solids |
| UATP | : | Umiray-Angat Transbasin Project |
| UP | : | Univerdity of the Philippines |
| UPSARDFI | : | "UP Social Action and Research for Development Foundation, Inc." |
| WACC | : | Weighted Average Cost of Capital |
| WB | : | World Bank |
| WCS | : | Water Conveyance Schemes |
| WCT | : | Water Conveyance Tunnel |
| WD | : | Water District |
| WRAP | : | Water Resources Authority of the Philippines |
| WRDP | : | Water Resources Development Project |
| WTP | : | Water Treatment Plant |
| WtP | : | Willingness to Pay |

## Measurements

Length

| | | |
|---|---|---|
| mm | = | millimeter |
| cm | = | centimeter |
| m | = | meter |
| km | = | kilometer |

Volume

| | | |
|---|---|---|
| $cm^3$ | = | cubic centimeter |
| l | = | liter |
| kl | = | kiloliter |
| $m^3$ | = | cubic meter |

Weight

| | | |
|---|---|---|
| g | = | gram |
| kg | = | kilogram |
| ton | = | metric ton |

Time

| | | |
|---|---|---|
| sec | = | second |
| min | = | minute |
| hr | = | hour |
| d | = | day |
| y | = | year |

Energy

| | | |
|---|---|---|
| W | = | watt |
| kW | = | kilowatt |
| MW | = | Megawatt |

Area

| | | |
|---|---|---|
| $m^2$ | = | square meter |
| ha | = | hectare |
| $km^2$ | = | square kilometer |
| cu m | = | cubic meter |

Derived Measures

| | | |
|---|---|---|
| m/sec | = | meter per second |
| $m^3$/sec | = | cubic meter per second |
| kWh | = | kilowatt hour |
| MWh | = | megawatt hour |
| GWh | = | gigawatt hour |
| PPM | = | parts per million |
| kmph | = | kilometer per hour |
| MLD | = | million liter per day |
| mg/l | = | milligram per liter |

Currency

| | | |
|---|---|---|
| PHP | = | Philippine Peso |
| ¥ | = | Japanese Yen |
| US$ | = | US Dollar |

Other Measure

| | | |
|---|---|---|
| % | = | percent |
| $^o$ | = | degree |
| $^oC$ | = | degree(s) Celsius |
| $10^3$ | = | thousand |
| $10^6$ | = | million |
| $10^9$ | = | billion |