**JAPAN INTERNATIONAL COOPERATION AGENCY**

**DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS**
**THE REPUBLIC OF THE PHILIPPINES**

# THE FEASIBILITY STUDY
# OF
# THE FLOOD CONTROL PROJECT
# FOR
# THE LOWER CAGAYAN RIVER
# IN
# THE REPUBLIC OF THE PHILIPPINES

# FINAL REPORT

## VOLUME I

## EXECUTIVE SUMMARY

**FEBRUARY 2002**

**NIPPON KOEI CO., LTD.**
**NIKKEN Consultants, Inc.**

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## List of Volumes

**Volume I : Executive Summary**

**Volume II : Main Report**

**Volume III-1 : Supporting Report**

- Annex I : Socio-economy
- Annex II : Topography
- Annex III : Geology
- Annex IV : Meteo-hydrology
- Annex V : Environment
- Annex VI : Flood Control

**Volume III-2 : Supporting Report**

- Annex VII : Watershed Management
- Annex VIII : Land Use
- Annex IX : Cost Estimate
- Annex X : Project Evaluation
- Annex XI : Institution
- Annex XII : Transfer of Technology

**Volume III-3 : Supporting Report**

Drawings

**Volume IV : Data Book**

The cost estimate is based on the price level and exchange rate of June 2001.

The exchange rate is:

US$1.00 = PHP50.0 = ¥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 Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Hideki SATO of NIPPON KOEI Co.,LTD. (consist of NIPPON KOEI Co.,LTD. and NIKKEN Consultants, Inc.) to the Philippines, six times between March 2000 and December 2001.

In addition, JICA set up an advisory committee headed by Mr. Hidetomi Oi, Senior Advisor of JICA between March 2000 and February 2002, which examined the study from technical points of view.

The team held discussions with the officials concerned of the Government 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 Philippines for their close cooperation extended to the Team.

February 2002

Takao Kawakami
President
Japan International Cooperation Agency

February 2002

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

Letter of Transmittal

It is with great pleasure that we submit to you the Final Report of the "Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines".

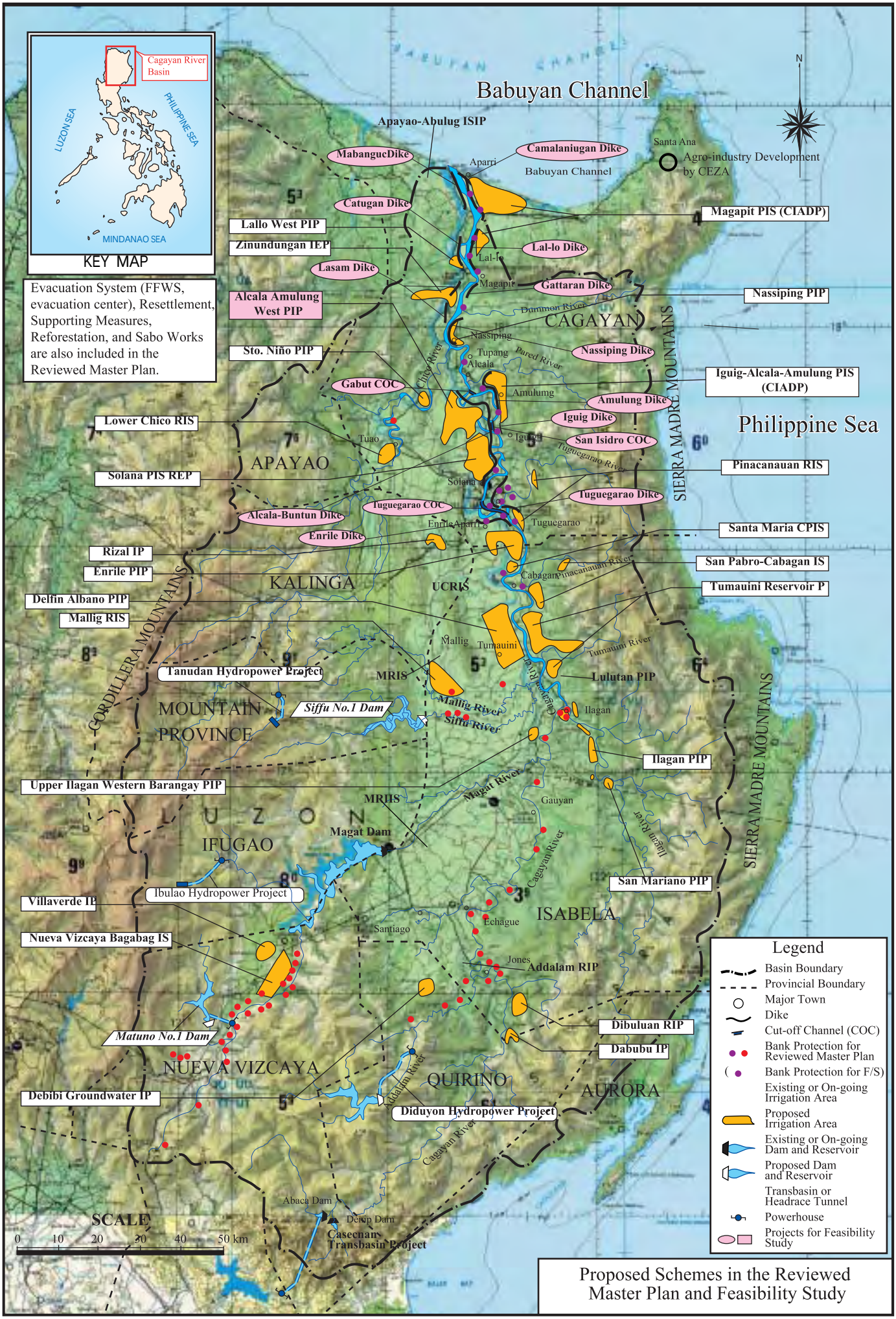
The Study has prepared the Reviewed Master Plan for the Cagayan River basin water resources development through examination and review of the Master Plan formulated in 1987, and conducted the Feasibility Study for the priority flood control projects and priority irrigation project in the Lower Cagayan River to protect life and properties from floods and to enhance efficient land use. The Report presents the said Reviewed Master Plan and feasibility study results.

We hope that this Report will be helpful for realization of the projects and programs proposed in this Study to mitigate the flood damage and enhance the land use in the Lower Cagayan River area, and will contribute to the socio-economic development of the Cagayan River basin.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, JICA Philippines Office, the Embassy of Japan in the Philippines, the Department of Public Works and Highways and the authorities concerned of the Government of the Republic of the Philippines for the courtesies and cooperation extended to us during our Study.

Very truly yours,

Hideki Sato
Team Leader
for the Feasibility Study
of the Flood Control Project
for the Lower Cagayan River
in the Republic of the Philippines


Babuyan Channel
Apayao-Abulug ISIP
MabangucDike
Camalaniugan Dike
Babuyan Channel
Aparri
Santa Ana
Agro-industry Development by CEZA
Catugan Dike
Magapit PIS (CIADP)
Lallo West PIP
Zinundungan IEP
Lal-lo Dike
Lal-lo
Lasam Dike
Magapit
Gattaran Dike
Alcala Amulung West PIP
Nassiping PIP
Dummon River
CAGAYAN
Nassiping
Sto. Niño PIP
Tupang
Alcala
Pared River
Nassiping Dike
Chico River
Gabut COC
Amulung
Iguig-Alcala-Amulung PIS (CIADP)
Amulung Dike
Lower Chico RIS
Iguig Dike
Philippine Sea
Tuao
Iguig
San Isidro COC
Tuguegarao River
APAYAO
Solana PIS REP
Solana
Pinacanauan RIS
Tuguegarao Dike
Tuguegarao COC
Alcala-Buntun Dike
Enrile
Aparri
Tuguegarao
Santa Maria CPIS
Enrile Dike
Rizal IP
Enrile PIP
Cabagan
Pinacanauan River
San Pabro-Cabagan IS
KALINGA
UCRIS
Tumauini Reservoir P
Delfin Albano PIP
Mallig RIS
Mallig
Tumauini
Tumauini River
Tanudan Hydropower Project
MRIS
Lulutan PIP
Siffu No.1 Dam
Mallig River
Siffu River
Ilagan
MOUNTAIN PROVINCE
Ilagan PIP
Upper Ilagan Western Barangay PIP
Magat River
MRIIS
Gauyan
Magat Dam
IFUGAO
Ilagan River
San Mariano PIP
Ibulao Hydropower Project
Villaverde IP
Cagayan River
ISABELA
Santiago
Echague
Nueva Vizcaya Bagabag IS
Jones
Addalam RIP
Dibuluan RIP
Matuno No.1 Dam
Dabubu IP
NUEVA VIZCAYA
QUIRINO
AURORA
Addalam River
Debibi Groundwater IP
Diduyon Hydropower Project
Cagayan River
Abaca Dam
Dekip Dam
Casecnan Transbasin Project
SCALE
0 10 20 30 40 50 km
SIERRA MADRE MOUNTAINS
CORDILLERA MOUNTAINS
N
KEY MAP
Cagayan River Basin
LUZON SEA
PHILIPPINE SEA
MINDANAO SEA
Evacuation System (FFWS, evacuation center), Resettlement, Supporting Measures, Reforestation, and Sabo Works are also included in the Reviewed Master Plan.
Legend
Basin Boundary
Provincial Boundary
Major Town
Dike
Cut-off Channel (COC)
Bank Protection for Reviewed Master Plan
Bank Protection for F/S)
Existing or On-going Irrigation Area
Proposed Irrigation Area
Existing or On-going Dam and Reservoir
Proposed Dam and Reservoir
Transbasin or Headrace Tunnel
Powerhouse
Projects for Feasibility Study
Proposed Schemes in the Reviewed Master Plan and Feasibility Study

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

# OUTLINE OF THE STUDY

## *1. River Basin Condition*

| | | | |
|---|---|---|---|
| **Cagayan River** | **Location:** | **Northeastern Luzon Island** | |
| | **Basin area:** | **27,281 km$^2$** | |
| | **River length:** | **520 km** | |
| | **River width:** | **300 - 2,000 m in the lower reach** | |
| | **River slope:** | **1/7,000 – 1/21,000** | |
| **Socio-economy** | **Population:** | **2.55 million in 1995 (3.3% of the National)** | |
| | | **Region-2 84%** | |
| | **GRDP in R-2:** | **54.5 billion Pesos (1998)** | |
| | **Per-capita GRDP:** | **20,200 Peso (500 US$ in 1998)** | |
| | **Poverty incidence:** | **About 40%** | |
| **Hydrology** | **Annual rainfall:** | **2,600 mm** | |
| | **Annual runoff:** | **1,372 m$^3$/s** | |
| **Flood damage** | **Inundation area:** | **1,860 km$^2$ in 1973 Typhoon Openg** | |
| | | **1,740 km$^2$ in 1980 Typhoon Aling** | |
| | **Annual flood damage:** | **3.55 billion Peso in the lower reach** | |
| | **River bank erosion:** | **6 m - 28 m / year** | |
| **Watershed** | **Land area by slope:** | **less than 8%** | **6,600 km$^2$ (24.2%)** |
| | | **8% - 18%** | **3,400 km$^2$ (12.4%)** |
| | | **Over 18%** | **17,300 km$^2$ (63.4%)** |
| | **Forest area:** | **41.7%** | |
| | **Heavy land erosion:** | **Deposit in Magat Reservoir** | |
| | | **Denudation of watershed** | |
| **Land use** | **Agricultural land:** | **25%** | |
| | | **Paddy:** | **472,500 ha** |
| | | **Corn:** | **137,300 ha** |
| | | **Other:** | **66,600 ha** |
| | **Grass land:** | **31%** | |
| | **Forest area:** | **42%** | |
| | **Others:** | **2%** | |
| **Production** | **Paddy:** | **13% of national total** | |
| | **Corn:** | **16% of national total** | |

## *2. 1987 Master Plan*

**Water Resources Development Master Plan by JICA in 1985 -1987**

| | |
|---|---|
| **Multi-purpose dams:** | **Existing Magat Dam (Irrigation, Flood Control, Hydropower)** |
| | **Siffu No.1 (-Do-)** |
| | **Mallig No.2 (Irrigation, Flood Control)** |
| | **Matuno No.1 (Irrigation, Hydropower)** |
| | **Alimit No.1 (-Do-)** |
| **Flood control projects:** | **Tuguegarao dike** |
| | **Widening of Magapit Narrow** |
| | **Cabagan dike** |
| | **River bank protection** |
| **Agricultural development:** | **14 irrigation projects** |
| | **Permanent crop development** |
| | **Pasture land development** |
| **Hydropower development:** | **Ibulao** |
| | **Tanudan** |
| | **Diduyon** |

## *3. Basic Concept of the Cagayan River Basin Development*

**(1) Study Period: March 2000-January 2002**

**(2) Scope of Work:**

1) **Review of Master Plan**
2) **Feasibility Study of The Lower Cagayan Flood Control Project**
3) **Transfer of Technology**

**(3) Basic Concept:**

1) **Present condition: Depressed area / Low economic development/Less income**
2) **Causes: Natural calamity / less investment / little understanding of development needs**
3) **Needs of socio-economic development : Food security / balanced development / upgrading living standard**
4) **Development potential: Land resources / Water resources / others**
5) **Basic development concept:**
   - **Target year 2020**
   - **Per-capita GRDP to reach National Average Level**
   - **Reduction of Poverty Incidence**

- **Additional Investment for water resources development: 30 billion Pesos up to 2020**

**6) Project formulation**

- **Flood control**
- **Irrigation**
- **Watershed management**
- **Water supply / power generation**
- **Water quality management**
- **River environment management**
- **Project cost**

| | | |
|---|---|---|
| **<u>New / Additional Investment</u>** | | |
| **Multipurpose dam project** | **3,172** | **million Pesos** |
| **Flood control project** | **19,239** | |
| **Irrigation project** | **9,070** | |
| **Sub-total** | **31,481** | |
| **<u>Investment by regular fund / private sector</u>** | | |
| **Irrigation projects** | **9,500** | |
| **Watershed management** | **10,472** | |
| **Hydropower projects** | **47,901** | |
| **Sub-total** | **67,873** | |
| **Total** | **99,354** | |

## *4. Priority Projects (Feasibility Projects)*

- **Lower Cagayan Flood Control Project(1st Phase)**

| | |
|---|---|
| **#Urgent bank protection** | **21 sites** |
| **#River bank tree zone** | **70 km** |
| **#Left dike system (Rivermouth - Magapit)** | **17.3 km** |
| **#Right dike system (Rivermouth - Magapit)** | **26.0 km** |
| **#Non-structural/supporting measures** | **LS** |
| **<u>Total Project Cost</u>** | **<u>2,786 million Pesos</u>** |

- **Alcala Amulung West Irrigation Project(1st Phase)**

| | |
|---|---|
| **#Irrigation system (1st Stage only)** | **4,090 ha** |
| **#Supporting measures** | **LS** |
| **<u>Total Project Cost</u>** | **<u>1,626 million Pesos</u>** |

- **<u>Project cost (G.Total)</u>** **<u>4,412 million Pesos</u>**

## *5. Project Implementation (1st Phase)*

**Leading agency: DPWH**

**Cooperation: Coordination Committee in the members of DA, NIA, PAGASA, LGUs, etc.**

**Construction period: 2002-2007**

**Funding source: GOP and Foreign assistance**

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME I

**EXECUTIVE SUMMARY**

Table of Contents

## List of Tables



## List of Figures

## List of Acronyms

| | |
|---|---|
| A&D | Alienable and Disposable Land |
| ADB | Asian Development Bank |
| AFMA | Agriculture and Fisheries Modernization Act |
| AFMP | Agriculture and Fisheries Modernization Plan |
| AFP | Armed Forces of the Philippines |
| Agromet | Agro-meteorological Station, PAGASA |
| AIT | Asian Institute of Technology |
| AO | Administrative Order |
| APDMC | Asia Pacific Disaster Management Centre |
| ARC(s) | Agrarian Reform Committee(s) |
| ASEAN | Association of Southeast Asian Nations |
| B/C | Benefit-Cost Ratio |
| BAS | Bureau of Agricultural Statistics |
| BDCC | Barangay Disaster Coordinating Council |
| BFP | Bureau of Fire Protection |
| BM | Bench Mark |
| BOC | Bureau of Construction (DPWH) |
| BOD | Bureau of Design (DPWH) |
| BOD | Biochemical Oxygen Demand |
| BOI | Board of Investment |
| BOT | Bureau of Telecommunication |
| BRS | Bureau of Research and Standard, DPWH |
| BSWM | Bureau of Soils and Water Management |
| CAR | Cordillera Administrative Region |
| CARP | Comprehensive Agrarian Reform Program |
| CBFM | Community Based Forest Management |
| CBIS | Community-Based Information System |
| CDA | Cooperative Development Authority |
| CDCC | City Disaster Coordinating Council |
| CENRO | Community Environment and Natural Resources Office |
| CEZA | Cagayan Economic Zone Authority |
| CIADP | Cagayan Integrated Agricultural Development Project |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington Treaty) |
| CLUP | Comprehensive Land Use Plan |
| CPDC | City Planning and Development Coordinator |
| CPDO | City Planning and Development Office |
| DA | Department of Agriculture |
| DA-BFAR | Department of Agriculture – Bureau of Fisheries and Aquatic Resources |
| DAR | Department of Agrarian Reform |
| DBM | Department of Budget and Management |

| | |
|---|---|
| DCC | Disaster Coordinating Council |
| DECS | Department of Education, Culture and Sports |
| DENR | Department of Environment and Natural Resources |
| DFA | Department of Foreign Affairs |
| DILG | Department of the Interior and Local Government |
| DO | Department Order |
| DO | Dissolved Oxygen |
| DOE | Department of Energy |
| DOH | Department of Health |
| DOLE | Department of Labor and Employment |
| DOST | Department of Science and Technology |
| DOT | Department of Tourism |
| DOTC | Department of Transportation and Communication |
| DPWH | Department of Public Works and Highways |
| DSWD | Department of Social Welfare and Development |
| DTI | Department of Trade and Industry |
| ECA | Environmental Critical Area |
| ECC | Environmental Compliance Certificate |
| EIA | Environmental Impact Assessment |
| EIAPO | Environmental Impact Assessment Project Office |
| EIS | Environmental Impact Statement |
| EIRR | Economic Internal Rate of Return |
| EMB | Environmental Management Bureau |
| ENRO | Environment and Natural Resources Office (Provincial Government) |
| EO | Executive Order |
| FIDA | Fiber Industry Development Authority, DA |
| FIRR | Financial Internal Rate of Return |
| GA | Government Agency |
| GDP | Gross Domestic Product |
| GIS | Geographical Information System |
| GOJ | Government of Japan |
| GOP | Government of the Philippines |
| GPS | Global Positioning System |
| GRDP | Gross Regional Domestic Product |
| GVA | Gross Value Added |
| HLURB | Housing and Land Use Regulatory Board |
| HUDCC | Housing and Urban Development Coordinating Council |
| IBRD | International Bank for Reconstruction and Development |
| IEE | Initial Environmental Examination |
| IRA | Internal Revenue Allotment |
| IUCN | International Union for the Conservation of the Nature and Natural Resources |
| JAFTA | Japan Forest Technical Association |

| | |
|---|---|
| JBIC | Japan Bank for International Cooperation (Ex-OECF & EXIM) |
| JICA | Japan International Cooperation Agency |
| LARC | Local Amateur Radio Club |
| LBP | Land Bank of the Philippines |
| LGU(s) | Local Government Unit(s) |
| LTO | Land Transportation Office |
| LWD | Local Water District |
| LWUA | Local Water Utility Agency |
| M/D | Minutes of Discussion |
| MDCC | Municipal Disaster Coordinating Council |
| MGB | Mines and Geo-science Bureau |
| MLUC | Municipal Land Use Committee |
| MM | Minutes of Meeting |
| MMSL | Meters above Mean Sea Level |
| MPDC | Municipal Planning and Development Coordinator |
| MPDO | Municipal Planning and Development Office |
| MTPDP | Medium Term Provincial Development Plan |
| NAAD | Network of Areas for Agricultural Development |
| NAMRIA | National Mapping and Resource Information Authority |
| NAPHIRE | National Post Harvest Institute for Research and Extension |
| NAPOCOR | National Power Corporation (or NPC) |
| NCDPP | National Calamities and Disaster Preparedness Plan |
| NCIP | National Commission on Indigenous Peoples |
| NCR | National Capital Region |
| NDCC | National Disaster Coordinating Council |
| NEDA | National Economic and Development Authority |
| NEPC | National Environmental Protection Council |
| NFA | National Food Authority |
| NGA(s) | National Government Agency (Agencies) |
| NGO(s) | Non-Government Organization(s) |
| NHA | National Housing Authority |
| NIA | National Irrigation Administration |
| NIPAS | National Integrated Protected Areas System |
| NPC | National Power Corporation□or NAPOCOR□ |
| NPAAAD | Network of Protected Areas for Agriculture and Agro-industrial Development |
| NPAAD | Network of Protected Areas for Agricultural Development |
| NPV | Net Present Value |
| NSCB | National Statistical Coordination Board |
| NSO | National Statistics Office |
| NTC | National Telecommunication Commission |
| NWRB | National Water Resources Board (Ex-NWRC) |
| O&M or O/M | Operation and Maintenance |

| | |
|---|---|
| OCD | Office of Civil Defense |
| PAGASA | Philippine Atmospheric, Geophysical and Astronomical Services Administration |
| PAMB | Protected Area Management Board |
| PAWB | Protected Area and Wildlife Bureau |
| PCA | Philippine Coconut Authority |
| PCM | Project Cycle Management |
| PCG | Philippine Coast Guard |
| PD | Presidential Decree |
| PDCC | Provincial Disaster Coordinating Council |
| PDMO | Provincial Disaster Management Office |
| PDZ | Permanent Danger Zone |
| PENRO | Provincial Environment and Natural Resources Office |
| PFDA | Philippine Fishery Development Authority |
| PHIVOLCS | Philippine Institute of Volcanology and Seismology |
| PHO | Provincial Health Office |
| PIA | Philippine Information Agency |
| PMO | Project Management Office (DPWH) |
| PMO-MFCDP | Project Management Office - Major Flood Control and Drainage Projects |
| PMS | Presidential Management Staff |
| PNP | Philippine National Police |
| PNR | Philippine National Railways |
| PNRC | Philippine National Red Cross |
| PPA | Philippine Port Authority |
| PPDC | Provincial Planning and Development Coordinator |
| PPDO | Provincial Planning and Development Office |
| PPFP | Provincial Physical Framework Plan |
| PRA | Participatory Rural Appraisal |
| PSWDO | Provincial Social Welfare and Development Office |
| PTA | Philippine Tourism Authority |
| RA | Republic Act |
| RDC | Regional Development Council |
| RDCC | Regional Disaster Coordinating Council |
| RPFP | Regional Physical Framework Plan |
| RRA | Rapid Rural Appraisal |
| RSRDAD | Remote Sensing and Resource Date Analysis Department |
| SAFDZ | Strategic Agricultural and Fisheries Development Plan |
| SRA | Social Reform Agenda |
| SS | Suspended Solid |
| SW | Scope of Works |
| TESDA | Technical Education and Skills Development Authority |
| TOR | Terms of Reference |

## Measurements

### Length

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

### Area

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

### Volume

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

### Derived Measures

| | | |
|---|---|---|
| m/s | = | meter per second |
| $m^3/s$ | = | cubic meter per second |
| kWh | = | kilowatt hour |
| MWh | = | megawatt hour |
| GWh | = | gigawatt hour |
| PPM | = | parts per million |
| kmph | = | kilometer per hour |

### Weight

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

### Currency

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

### Time

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

### Other Measure

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

### Energy

| | | |
|---|---|---|
| W | = | watt |
| kW | = | kilowatt |

### Fiscal Year

January 1 to December 31

# Part-I GENERAL

## I. INTRODUCTION

### Background and Authority of the Study

1.1 The Master Plan on the Cagayan River Basin Water Resources Development was firstly formulated in 1987 (1987 Master Plan) by Japan International Cooperation Agency (JICA) based on the mutual agreement between the Government of the Philippines (GOP) and the Government of Japan (GOJ). The GOP has endeavored to implement the projects proposed in the said Master Plan, however, no project has been realized for reasons beyond the government's control, such as political disturbance, insecure peace-and-order situation in the objective area, financial constraints, etc. This situation has improved remarkably in recent years. Accordingly, the GOP now wishes to implement the projects proposed in the 1987 Master Plan.

1.2 Frequent flood inundation has been a main constraint in the promotion of sustainable socio-economic development and improvement of the living condition of the people in the Cagayan River basin. In view of this and realizing the priority of the flood control project proposed in the 1987 Master Plan, GOP made a request to GOJ in May 1999 for technical assistance to conduct the feasibility study of the flood control project for the Lower Cagayan River. In response to the request, the GOJ decided to conduct the feasibility study (the Study). The Implementing Arrangement on the technical cooperation for the Study was agreed upon between the Department of Public Works and Highways (DPWH) and JICA on December 17, 1999. The Study was performed in conformity with the Implementing Arrangement.

1.3 JICA organized the Study Team with the selected consultants in order to carry out the Study. The Team conducted the Study in close cooperation with the GOP through the Counterpart Officials. JICA also established an Advisory Committee formed by staff of the Ministry of Land, Infrastructure and Transport, Ministry of Foreign Affairs and Japan Bank for International Cooperation (JBIC) in order to guide the Study Team and review the findings thereby. The GOP established a Steering Committee chaired by the Undersecretary of the DPWH with members from various related agencies and established the Technical Working Groups, one each by DPWH and National Irrigation Administration (NIA) to support the Study Team. Furthermore, the GOP provided counterpart personnel to support the Study Team working together.

## Objectives of the Study

2. The objectives of the Study are:

1) to carry out the feasibility study for the flood control project including land use planning in the Lower Cagayan River, and
2) to conduct technology transfer to the Philippine counterpart personnel in the course of the Study.

The Study also covers a review of the 1987 Master Plan focusing on flood control, watershed management and land use within the objective areas aiming at enhancing socio-economic development in the basin..

## Study Area

3. The area for the feasibility study is the Lower Cagayan River area. The area for the review of the 1987 Master Plan is the whole Cagayan River basin.

## Study Schedule and Activities

4.1 The Study commenced in March 2000 and completed in January 2002. Through six (6) field and five (5) home works including data collection and analyses and field investigations covering topographic survey, geological and soil investigation, hydrological survey and analysis, environmental investigations, etc., the 1987 Master Plan was reviewed and the feasibility study for the priority projects was conducted. The Reviewed Master Plan has been formulated on the basis of the reviewed long-term plans on flood control, watershed management and land use. The feasibility study covers flood control projects in the Lower Cagayan River and a selected priority irrigation project.

4.2 Transfer of technology was made through on-the-job training in the course of the day-to-day Study works, eight (8) joint meetings with the counterparts, four (4) workshops and two (2) technology transfer seminars. Two (2) public consultation meetings were also held with the Local Government Units (LGUs) for exchanging opinions on the LGUs' participation in the project implementation.

## Final Report

5.1 This Final Report contains all the findings of the field investigations and the results of the Study including the Reviewed Master Plan and the Feasibility Study. This Final Report was prepared incorporating the conclusions of the last Steering Committee Meeting held on 13 December 2001 and all the comments of the respective Philippine Government agencies on the Draft Final Report which the Study Team submitted on 4 December 2001.

5.2 This Final Report consists of six (6) Volumes; Volume I Executive Summary,

Volume II Main Report, Volume III Supporting Report which consists of three (3) separate volumes, Volumes III-1, III-2 and III-3, and Volume IV Data Book.

## II. CAGAYAN RIVER BASIN

### Geographical Location

6. The Cagayan River basin, the largest river in the Philippines having a catchment area of 27,281 $km^2$ and river length of 520 km, is located in the northeastern part of Luzon Island. It is bounded by mountain ranges, the Sierra Madre in the east, Cordillera Central in the west and Caraballo-Maparang in the south. And it faces to the Babuyan Channel in the north (Refer to the Location Map for the Project).

### Socio-economy

7.1 The Cagayan River basin extends over Region 2, Cordillera Administrative Region (CAR) and some part of Region 4, administratively. The basin consists of 110 cities/municipalities in nine (9) provinces, including two (2) cities of Tuguegarao and Santiago. The former is located in Cagayan Province and is the central city in the Region 2, and the latter is located in Isabela Province.

7.2 The Cagayan River basin population was 2.55 million in 1995 corresponding to 3.3% of the national population of the Philippines. The average growth rate in the 1980's was 2.25% per annum, however it decreased to 1.73% in the 1990's. Eighty-four percent (84%) of the basin population (2.14 million) belongs to Region 2, 16% (410 thousand) to CAR and just under 0.5% (9 thousand) to Region 4. Thus, it may be said that the socio-economy of Region 2 represents that of the Cagayan River basin.

7.3 Gross Regional Domestic Product (GRDP) of Region 2 was 54.5 billion Pesos (about 1.35 billion US$ equivalent) in 1998, which ranked as fourteenth ($14^{th}$) among all 15 regions in the Philippines (excluding Region 13 having no data in 1998). Per capita GRDP of Region 2 was 20,200 Pesos (about 500US$ equivalent) in the same year, which ranked as twelfth ($12^{th}$) among the 15 regions, corresponding to about 55% of the national average. Thus, the Cagayan River basin is recognized to be economically underdeveloped area in the Philippines. The poverty incidence of Region 2 is currently about 40%, which is lower than the national average. However, it is still high in absolute term.

### Topography and Geology

8.1 The Cagayan River basin has much sloped area, with 6,600 $km^2$ having slope less than 8%, 3,400 $km^2$ between 8% to 18%, and 17,300 $km^2$ over 18%. Major tributaries of the Cagayan River are the Magat, Ilagan, Siffu-Mallig, Tuguegarao, and Chico Rivers. These tributaries flow down the eastern, western and southern slopes of the Cagayan River basin and join the main course of the Cagayan River.

The main Cagayan River runs from the south to the north in the flat alluvial plain and finally empties into the Babuyan Channel.

8.2 Rocks of the Cagayan River basin consist of the metamorphic and plutonic rocks of pre-Tertiary age, which have been uplifted by igneous intrusions during the Late Tertiary and Quaternary. The Oligocene section consists of basic lava flows, metamorphosed conglomerate, tuff breccia, and tuffaceous sandstone and siltstone. There occurred many earthquakes to the west in northern Luzon, but relatively few in the Cagayan River basin located in the east of northern Luzon. The Baguio earthquake occurred in July 1990 was of the biggest among those recorded in the past and the magnitude was 7.8 on the Richter scale. The earthquake caused the collapse of slopes in the southwestern area of the Cagayan River basin leading to large increases in sediment yield/load in the Magat River basin.

## Meteorology and Hydrology

9. The Cagayan River basin has ample water resources having a mean annual rainfall of 2,600 mm and mean annual runoff of 1,372 $m^3/s$ at the river mouth of the Cagayan River. There is no distinct separation of the dry and the rainy seasons climatically in the basin but the former is roughly from December to April and the latter from May to November. There is a rather wide range in the annual rainfall, from more than 4,000 mm in the mountainous area to less than 2,000 mm on the plain in the north. The 100-year probable flood is estimated at 21,400 $m^3/s$ at the river mouth of the Cagayan River, which is equivalent to 0.784 $m^3/s/km^2$ of specific flood runoff.

## Present River Condition

10.1 In the downstream of the Cagayan River from Tuguegarao to Alcala, the discharge capacity of the river is about 2,000 $m^3/s$, which is less than two (2)-year probable flood. The longitudinal riverbed slope varies from 1/7,000 to 1/21,000 and the river width from 300 m to 2,000 m. There is a narrow stretch, so called the Magapit Narrows with the river width of about 300m in a reach between 30 km and 70 km upstream from the river mouth.

10.2 The Lower Cagayan has a narrow river width section from 30 km to 70 km from the river mouth so called Magapit Narrows. Since the upstream reach of the Magapit Narrows has a gentle water surface slope due to a backwater by the Narrows, river meandering is significant causing the movement of the river course, such that the river course near Iguig has moved about 5 km for the past 50 years. On the other hand, it may be said that the riverbed elevation is rather stable without much change in the Lower Cagayan River, although slight rising of

riverbed has been observed in the reach between the Magapit Bridge and the confluence of the Tuguegarao River with the Cagayan River.

## Flood Damages and Flood Control Projects

11.1 Since the discharge capacity of the Cagayan River is very small, floodings have occurred frequently and the basin people residing along the river have suffered from flood damage. In particular, the major flood disasters occurred in 1973, 1980 and 1998 (refer to Figure 1). Typhoons Openg, Aling and Iliang brought these flood disasters, with the flooded areas covering about 1,860 $km^2$, 1,740 $km^2$ and 620 $km^2$, respectively. The 1973 flood, the recorded biggest flood, is estimated to be equivalent to about 25-year probable flood. The average annual flood damages in the area between Tuguegarao and the river mouth of the Cagayan River is estimated at about 3.6 billion Pesos, which is equivalent to about 6.6% of GRDP of Region 2.

11.2 Bank erosion is observed at various places in all reaches of the Cagayan River. In particular, heavy erosion and large damages have occurred in 73 places where the average annual bank erosion rates have reached 6 m to 28 m.

11.3 The flood control structural measures which have been implemented so far by the DPWH and the LGUs are limited to small-scale bank protection works and small-scale spur dike works because of the limited budget. There are flood forecasting and warning systems in the basin as one of the non-structural measures for flood control. However, it may be pointed out that parts of the forecasting system have not been properly operational because of faulty equipment and insufficient management. Hence, flood forecasting has not been performed properly. Furthermore, the existing shelter facilities for emergency use are not sufficiently provided.

## Present Watershed Condition

12.1 The forest area in the Cagayan River basin is 41.7% of the whole basin area, which has been slightly decreased from 42.3% reported in the 1987 Master Plan Study, hence the conservation of the forest area is required. Slope collapses have occurred since the earthquake in 1990 in the upstream area of the Magat River and sediment yields have greatly increased. Sediment deposition in the Magat Dam reservoir was increased abruptly since the 1990 earthquake. Its accumulated deposition reached about 188 million $m^3$ in 1999 for 17 years since the dam completion in 1982, which corresponds to 62.7% of the designed dead storage capacity (268 million $m^3$) for life time of 100 years. Furthermore, about 30 million $m^3$, which have been retained in the upstream river course of the reservoir,

would be a potential sediment deposition in the Magat Dam reservoir. In order to extend the lifetime of the existing Magat Dam reservoir, countermeasures against sedimentation flowing into the reservoir are urgently required.

12.2 The Department of Environment and Natural Resources (DENR) and other government offices have implemented watershed conservation measures such as reforestation, check dam constructions and so on under the technical and financial assistance of the foreign governments, non-government organizations and so on. However, owing to lack of fund and incompleteness of overall watershed conservation plan, these initiatives are insufficient to stabilize the watershed and reduce sediment yields.

**Present Land Use**

13.1 Of the Cagayan River basin, about half of the area is higher than 400 m in elevation and more than 60% of the area is steeper than 18% in slope. Agricultural land occupies 25%, grassland 31% and forests 42% and other land uses 2%. The agricultural land consists of paddy field (472,500 ha), cornfield (137,300 ha) and other diversified crop fields (66,600 ha). The existing irrigation area is 218,000 ha corresponding to 46% of the potential irrigable area.

13.2 The Cagayan River basin is an isolated area surrounded by steep mountain ranges on three sides and the sea on the other. The Dalton Pass route, being the trunk route to and from Metro Manila, has been closed sometimes by land collapse making it an insufficient transportation system, which is one of the most critical problems in the basin. Other problems in the basin are heavy land erosion, large-scale land possession in the hilly area and low agricultural productivity in the plains. The heavy land erosion is due to past tree felling, and causes heavy sedimentation in the downstream. The large-scale land possession in the hilly area impedes its active land use, although the area has high potential of livestock development. Low agricultural productivity in the plains is due to flood and drought.

13.3 The Cagayan River basin is a granary in the Philippines, and production of paddy and corn during 1995 to 1999 in Region 2 shared 13% and 16% of the total production of the Philippines, respectively. Problems in agricultural farming are frequent flood and drought, high rate of post-harvest loss, insufficient processing, marketing and credit systems, and so on. They are some of the key reasons why poverty and regional inequity have not been improved in the basin.

**Existing Flood Control Facilities and Related River Structures**

14. The existing major flood control structures are a jetty and concrete parapet walls

near the estuary of the Cagayan River, cut-off channel and revetment works on the banks in the lower reach in the Tuguegarao River, and bank protection works with groins in various places. Further, in the Cagayan River basin, there are the Magat Dam, the flood forecasting and warning systems, and designated shelters for emergency evacuation from flood. The other related structures are the MARIS intake weir, Baligatan intake weir, Chico intake weir, Casecnan dam, Magapit pump station, Amulung pump station, Iguig pump station, Solana pump station, some bridges and so on.

**Present Water Uses**

15. Annual diversion water for irrigation from the Cagayan River is estimated at 3.44 billion $m^3$ in the year 2000. The municipal water requirement in the year 2000 is estimated at 282,000 $m^3$/day (103 million $m^3$/year). Water resources of the Cagayan River basin are ample (annual average runoff of 1,372 $m^3$/s or 43.3 billion $m^3$/year). Therefore, there is no serious problem regarding the balance between the water resources potential and the water demand, although the water deficit due to the seasonal variation of available water are observed.

**Environment**

16.1 There are 298 species of terrestrial flora and 182 species of terrestrial fauna recorded in the whole Cagayan River basin. These include species registered in the red list of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES so-called as the Washington Treaty) or the International Union for the Conservation of the Nature and Natural Resources (IUCN). Also, there are a few-known extinct or rare species. Further, around forty (40) nekton species are found out in the Cagayan River system, and of these, the most remarkable species is Ludong. However, the number of Ludong has been decreased because of recent excessive fishing and decrease of habitat area due to the Magat Dam construction. There are 18 protected areas, such as National Parks, the protection area of fauna and flora, and forest protection areas in the Cagayan River basin. Most of them are located far from the main river course of the Cagayan River.

16.2 The water quality of the Cagayan River is generally good with low concentration of BOD at less than 2 ppm and high DO at more than 7 ppm. However, there are some areas where the river water is contaminated by biological bacteria such as colon bacillus. The water quality of wells is also generally good in the same manner as the Cagayan River, but contamination by colon bacillus has been confirmed in some wells. Regarding the ambient air and noise, there are no

serious issues as they satisfy the corresponding terms in the environmental guidelines.

16.3 The Cagayan River provides good fishing areas to the local people. Most people are mainly engaged in the agricultural production activities and full-time fishermen are few. There are 18 ferryboat navigation routes in the lower reach of the Cagayan River. Most of them are small passenger ferries, but there are also some small car ferries. There are many items of historical and cultural heritage in the Cagayan River basin, most of which are churches constructed during the Spanish colonial era. Further, there are rice terraces distributed in Ifugao Province registered in the World Heritage Treaty.

16.4 Recently, public sanitation has been improved greatly, however there is still a necessity for improvement because of the access rate to safe water is only about 73% and the diffusion rate of the sanitary toilet is about 80%. Regarding education, both the school attendance and graduation rates have been improved greatly, and in particular, the elementary school attendance rate is more than 95% at present. The present problem on education is the lack of educational equipment and materials, and furthermore other problem is that the school cannot be opened at the emergency of flood occurrence because they are used as the evacuation centers (shelters).

16.5 Lots of minority tribes or indigenous people have existed in the Cagayan River basin. However, most of them have been assimilated into the majority culture and their life style and culture are not distinguished currently.

**Institutional Study**

17.1 Water management, including water resources development, water use, etc. has been undertaken by more than 20 government agencies in the Philippines. There is no unified authority to implement and control overall river management and water resources development. The National Water Resources Board (NWRB) is a regulatory board for water resources management, however it may be insufficient in its capacity and capability. The Philippine Government is now examining several conceivable measures such as strengthening of NWRB, establishment of a Department of Water Resources, establishment of a River Bureau in DPWH, etc. An overall management system for water and rivers is required. Figure 2 shows the current institutions of water-related agencies in view of those functions and organizations.

17.2 The Water Code is the basic law on water and rivers. It contains the provisions on water allocation, water use, river maintenance and management, designation of

river areas and flood control areas, etc. One of the basic law on land use is NIPAS Act. The Philippine Government prohibits the diversification of land use from agricultural land to others, since the Philippines is not self-sufficient in rice and corn production and needs to sustain and increase agricultural production.

17.3 The Philippine Government is gearing towards decentralization from a position of centralized administrative power. For realization of this strategy, the Local Government Code has been enforced. However, local governments are obliged to rely on the support of the national government since they have insufficient financial and engineering capacity/capability.

17.4 Although the law and regulations have been well provided, the review and strengthening of implementing rules and regulations are essential, since there are many cases of the laws not being adequately enforced.

## Part-II REVIEW OF 1987 MASTER PLAN

### III. 1987 MASTER PLAN

#### Outline of 1987 Master Plan

18.1 The 1987 Master Plan Study for the Cagayan River basin was conducted by JICA from 1985 to 1987. The objective of the Study was to formulate a Master Plan for water resources development in the entire Cagayan River basin covering an area of 27,281 $km^2$. The target of regional economic development was set to raise the per capita GRDP of Region 2 by the year 2005 up to that of the national average excluding the highly industrialized National Capital Region (NCR) and Region 4.

18.2 Framework Plans and Long-term Plans were formulated for each sector of the water resources development as presented below. The Framework Plan was defined as a potential development plan prospecting indefinitely future ideal development. The Long-term Plan was defined as a plan being more economically effective within the target period.

1) Flood Control Plan:

Framework Plan:

a) The framework plan of the flood control contemplated alleviating flooding along the Cagayan River for the design flood of 100-year probable flood.
b) Flood control dams were planned in the upstream reaches to reduce flood magnitude.
c) The Magapit Narrow improvement (widening) in the Lower Cagayan River was contemplated increasing discharge capacity thereat.
d) The areas along the middle and lower reaches were planned with dike systems to prevent flooding in the low-lying areas.
e) Tributary area was planned to retain natural flood retarding effect as much as possible.

Long-term Plan:

a) The long-term plan was formulated on the basis of the framework plan by reducing the design discharge to a 25-year probable flood as a more economically effective scale.
b) The long-term plan consisted of ;
   i) dike embankment including revetment and sluice along the main Cagayan River and major tributaries (the Siffu, Ilagan and Magat),
   ii) narrow excavation at Nassiping (a portion of the Magapit Narrows),

iii) cut-off channel works (Gabut and San Isidro),
iv) bank protection,
v) flood control dams (Cagayan No.1 and Ilagan No.1),
vi) Flood control function in the multipurpose dam projects (Siffu No.1, Mallig No.2, and Magat) in addition to the above.

2) Agricultural Development Plan: The agricultural development plan presented was based on the following concept:

Framework Plan:

a) Full development of agricultural land of 1,080,000 ha, consisting of low land 476,000 ha (of this, the existing irrigation area is 224,000 ha) and upland 604,000 ha,
b) Full development of low land area 476,000 ha, dividing into 306,000 ha for paddy with full irrigation system and remaining 170,000 ha for diversified crop,
c) Full development of upland area 604,000 ha dividing into 200,000 ha for permanent crop, 300,000 ha for pasture land for cattle grazing and 104,000 ha for grass land, and,
d) Fresh-water aquaculture development for the main source of fishery products.

Long-term Plan:

The long-term plan consisted of the following:

a) Nine (9) new irrigation and extension schemes for 65,330 ha (including command area belonging to the multipurpose dam schemes of Chico, Mallig and Matuno),
b) Five (5) irrigation rehabilitation and improvement schemes for 12,212 ha,
c) Full development of diversified crop for 170,000 ha,
d) Full development of permanent crop land for 200,000 ha,
e) Full development of pasture land for 300,000 ha, and,
f) Fresh water aquaculture development for the main source of fishery products.

3) Hydropower Schemes:

Framework Plan: Hydropower development potential of the Cagayan River was estimated at about 4 million KW. About 50% of this potential could be developed economically. The Framework Plan contemplated full development of this potential.

Long-term Plan: Proposed hydropower schemes envisaged within the Cagayan River basin were as follows:

a) Single purpose projects consisting of Ibulao (17 MW: Run-of-river type), Tanudan (25 MW: Run-of-river type) and Diduyon (352 MW: Dam scheme),
b) Multipurpose dam schemes consisted of Siffu No.1 (5.4 MW), Matuno No.1 (180 MW), Alimit No.1 (12.2 MW) and Magat Dams (360 MW),
c) Besides the above, the Casecnan multipurpose dam project including hydropower development (268 MW), which was recognized as an on-going project at the 1987 Master Plan stage.

4) Municipal Water Supply: Total source requirement of municipal water in 2005 was estimated to reach 860,000 $m^3$/day. Most of municipal water has been taken from ground water and / or springs. Regarding municipal water, water demand and source requirement only was estimated in the 1987 Master Plan without physical planning for water supply.

5) Multipurpose Dams Schemes: Proposed multipurpose dam schemes were as follows:
a) Siffu No.1 Dam (Flood control, irrigation and hydropower)
b) Mallig No.2 Dam (Flood control and irrigation)
c) Matuno No.1 Dam (Irrigation and hydropower)
d) Alimit No.1 Dam (Irrigation and hydropower)
e) Magat Dam (Existing dam for flood control, irrigation, hydropower)

Of these dams, the Magat Dam is the existing one and others were the proposed. The 1987 Master Plan revealed that the Magat Dam Reservoir capacity was insufficient to supply irrigation water to its command area and also was to be allocated more to flood control function since it is located at a strategic location for the purpose. Combined operation of the Alimit No.1 Dam, Siffu No.1 Dam, Matuno No.1 Dam and Magat Dam was proposed as the optimum scheme to meet the deficit of the Magat project (94 MCM) for irrigation water supply and to allocate a part of the Magat reservoir space to flood control (139 MCM).

18.3 The following projects and schemes were selected for inclusion in the proposed Master Plan (Refer to Figure 3):

1) Multipurpose Projects: Siffu No.1 Dam Project, Mallig No.2 Dam Project, Matuno No.1 Dam Project, Alimit No.1 Dam Project and Magat Dam (allocation of flood control space),
2) Flood Control Schemes: Tuguegarao Dike, Cabagan Dike, Narrows Improvement (Nassiping Lower-Left Bank, NLL), Narrows Improvement (Nassiping Lower-Right Bank, NLR), Bank Protection Works,

3) Agricultural Development Schemes: 14 Irrigation Development/ Rehabilitation Schemes, Diversified Crops Development, Permanent Crops Development, and Pasture Land Development,
4) Hydropower Development Schemes: Ibulao, Tanudan, and Diduyon Hydropower Development Schemes.

Total cost for the proposed Master Plan was estimated to be Pesos 33.0 billion (US$ 1,736 million equivalent) at 1987 price level.

18.4 The 1987 Master Plan also proposed a Short-term Plan to be implemented within 10 years. Schemes proposed for the Short-term Plan were selected among the projects in the Master Plan as follows:

1) Multipurpose Dam Projects: Siffu No.1 Dam, Mallig No.2 Dam, and Matuno No.1 Dam projects,
2) Flood Control Schemes: Tuguegarao dike, Narrows improvement (Nassiping Lower-Left bank, NLL), bank protection works and modification of the Magat Dam operation including flood control,
3) Agricultural Development Schemes: Pinacanauan irrigation scheme, Dabubu irrigation scheme, and model developments in the uplands.

**Change in the Cagayan River Basin after 1987 Master Plan**

19.1 A population in the Cagayan River basin was 1.88 million in 1980 and increased to 2.55 million in 1995 according to the national census. Its annual growth rate was 2.07% on average. GRDP of Region 2 was 15.3 billion Pesos in 1985 as presented in the 1987 Master Plan and was 17.5 billion Pesos in 1999 at 1985 constant prices. The 1985 GRDP value had increased by 2.2 billion Pesos or 14% over 13 years. Hence, the regional growth rate was calculated at 1.0% on average, which was considerably lower than the national average growth rate of 3.4%. The agriculture and services sectors increased 1.3 billion Pesos and 1.1 billion Pesos over 13 years, respectively. The industry sector, however, decreased 0.3 billion Pesos over 13 years. Per capita GRDP was 7,225 Pesos in 1985 and 6,441 Pesos in 1998 at 1985 constant prices. It decreased 784 Pesos for 13 years at 1985 constant prices. Its annual growth rate was negative 0.88% on average. This implies that the imbalance in economic development among the regions in the country has been magnified. On the other hand, socio-economic and political disturbances that were observed in the 1987 Master Plan stage seemed to have ceased. Under these circumstances it is appropriate for suits for the implementation of the development projects to proceed.

19.2 There is no remarkable changes or improvement in the river conditions in the recent 10 years. Riverbank erosion due to heavy meandering has been serious problems for the people as before. Serious riverbank erosion sites were identified at 75 sites in the 1987 Master Plan and even now, 73 such sites still exist. Low-lying areas along the Cagayan River have suffered from frequent inundation as serious as ever, especially in the upstream reaches of Alcala. The JICA study in 1987 recommended the implementation of the urgent flood control works as priority projects selected from the said Master Plan to mitigate flood damage in the basin. However, probably owing to budget limitations, less understanding on the real problematic situation and / or less understanding on the necessity of the development, they have not yet been realized.

19.3 In the 1987 Master Plan stage, the forest cover of the Cagayan River basin was 11,528 $km^2$ equivalent to 42.3% of the basin area. The present forest cover is 11,384 $km^2$ equivalent to 41.7% of the basin area. This change in the forest cover implies that the forest area in the basin has gradually decreased. The land collapses as well as severe land erosion caused by the 1990 earthquake resulting in increase of sediment runoff have affected the reservoir capacity of the existing Magat Dam. The accumulated sediment deposition in the reservoir was 188 MCM in 1999, which was substantially more than expected in the design.

19.4 In the Cagayan River basin, paddy and corn productions have increased in comparison with averages in 1982-1984 and in 1998-1999. Recent share to national production is 13.8% for paddy and 14.0% for corn. After completion of several National Irrigation Projects (NIPs) which were under implementation at the time of 1987 Master Plan, any NIP was not completed until now although there are two on-going NIPs. The irrigation area increased slightly from about 210,000 ha in 1987 to about 218,000 ha at present.

**Need of Review of 1987 Master Plan**

20. Around 14 years have passed since the 1987 Master Plan was formulated for the Cagayan River basin. Differences between the projected socio-economic bases of the 1987 Master Plan such as population, GVAs or GRDP and current values have developed during these 14 years. No major flood control projects proposed in the 1987 Master Plan have been implemented. Only 8,000 ha of irrigation area have expanded since the year 1987 in the national irrigation system and communal irrigation system in the basin. Watershed conservation has been recognized as one of the important sectors in the basin development plan. The above mentioned facts meant there was a necessity to review the 1987 Master Plan.

## IV. SOCIO-ECONOMIC FRAMEWORK PLAN

### Projection of Population

21. The future basin populations projected in the years 2000, 2010 and 2020 are 2.84 million, 3.38 million, and 3.79 million, respectively. The respective annual growth rates are 2.22%, 1.75% and 1.13% on average.

### Economic Growth Target and Investment

22. The goal of the Reviewed Master Plan was set as that GRDP per capita in Region 2 attains to the national average, excluding National Capital Region (NCR), by the target year 2020. The economic growth scenario was drawn up on condition that the following economic events are implemented during the planning period. The total investment in the region during the planning period is summarized in the table below.

(Unit: Billion Pesos)

| Item | Investment | | Accumulated Investment | | |
|---|---|---|---|---|---|
| | 2010 | 2020 | 2000-'10 | 2011-'20 | Total |
| 1. Current Projects | 15.2 | 32.4 | 258.8 | 250.1 | 508.9 |
| 2. Special Projects | 20.0 | 33.3 | 141.7 | 267.6 | 409.3 |
| • AFMA | 0.7 | 1.2 | 6.4 | 9.9 | 16.3 |
| • CEZA | 1.6 | 2.7 | 13.3 | 21.9 | 35.2 |
| • Water Resources | 1.6 | 2.7 | 8.6 | 21.7 | 30.3 |
| • Other Capital Formation | 16.0 | 26.6 | 113.4 | 214.1 | 327.4 |
| 3. Total | 35.2 | 65.7 | 400.6 | 517.7 | 918.2 |

Thus, the government should invest approximately 30 billion pesos for water resources development including flood control projects by the target year 2020, in order for the economic level to reach the target per capita GRDP in 2020. Refer to Chapter 4 of the Main Report for details. Notes on the above table are given below.

The Current Projects mean that current investment in the various fields of the public investment is to be continued in the same level as ever. In addition to the current projects, the investment to the special projects such as AFMA, CEZA and water resources development to be proposed in the Reviewed Master Plan should be considered. Other Capital Formation means the private sector investment and other sources which may be expected to be induced following the public investment including those for Special Projects. According to the recent information given by CEZA, the investment thereto might be slowed down to only 50% of the above although it will make possible effort to attain the original scheme. The above required investment amount by category is to be applied flexibly such that if one decreases and the another should be increased.

## V. METEOROLOGY AND HYDROLOGY

### Flood

23. The available rainfall data recorded since the 1987 Master Plan study is very limited, so that it cannot be judged whether the probable flood peak discharges obtained in this Study with the limited additional rainfall data have a higher accuracy than those obtained in the 1987 Master Plan study. Therefore, no change was made to the probable flood runoff obtained in the 1987 Master Plan and all the calculated floods in the 1987 Master Plan are adopted in this JICA Study as well.

The 100-year probable flood peak discharges for a number of base points are as given below.

| Base Point | | 100-year Probable Flood Peak ($m^3/s$) |
|---|---|---|
| BP-1 | River Mouth of Cagayan Main Stream | 21,400 |
| BP-2 | Confluence of Cagayan and Chico (Nassiping) | 21,000 |
| BP-3 | Confluence of Cagayan and Siffu | 25,300 |
| BP-4 | Confluence of Cagayan and Ilagan | 23,500 |
| BP-5 | Confluence of Cagayan and Magat | 14,700 |
| BP-6 | Chico River Mouth | 8,700 |
| BP-7 | Siffu River Mouth | 3,300 |
| BP-8 | Ilagan River Mouth | 9,400 |
| BP-9 | Magat River Mouth | 10,600 |

### Stream Flow

24. Applying the sub-basin divisions as well as the tank model constructed for the 1987 Master Plan, the additional long term naturalized 10-day mean runoff was generated for the period from 1985 to 1998. The generated runoff is combined with the runoff from 1963 to 1984 estimated in the 1987 Master Plan. The following summarizes the annual average runoff for each basin of the major tributaries for 36 years from 1963 to 1998:

| Tributary | Catchment Area ($km^2$) | Annual Average Runoff ($m^3/s$) |
|---|---|---|
| Upper Cagayan River | 6,633 | 289.3 |
| Magat River | 5,113 | 269.8 |
| Ilagan River | 3,132 | 147.1 |
| Siffu Mallig River | 2,015 | 88.2 |
| Chico River | 4,551 | 256.1 |
| Whole Basin | 27,281 | 1,371.6 |

## Water Balance

25.1 The water balance analysis was conducted with the representative runoff of 5-year probable drought and future water demand. Conditions of the analysis adopted are that 1) river maintenance flow is 0.0046 $m^3/s/km^2$, and 2) percentages of return flow are 30% for irrigation water supply, 100% for hydropower, and 40% for municipal water supply.

The total municipal water source requirement for the year 2020 was projected at 979,000 $m^3$/day (11.3 $m^3/s$) for the study area based on the projected population up to the year 2020. The irrigation water requirement for the year 2020 was estimated to be in a range from 65 $m^3/s$ to 377 $m^3/s$.

25.2 The water deficit estimated was the balance of the representative runoff of 5-year probable drought and future water demand, which was computed as the sum of the irrigation water requirement, municipal water requirement and the river maintenance flow. In order to make up the deficit for irrigation water, small-scale dams are required.

## Sediment

26. The sediment runoff equivalent to soil erosion of 1.5 mm/year was estimated for the whole Cagayan River basin in the 1987 Master Plan. This was retained for the current Study, since no significant difference in the annual sediment runoff is observed between 1987 Master Plan and this Study except the Magat River basin which is discussed in the Watershed Management.

## Riverbed Fluctuation

27. Simulation analysis of the riverbed fluctuation shows that widening of the Magapit Narrows will not cause any drastic riverbed change in the upstream and downstream of the Narrows.

## Saline Water Intrusion

28. Hydraulic analysis for saline water intrusion indicates that the tip of salt water wedge for 5-year probable drought runoff cannot reach the Magapit Bridge because of the topographical barrier existing about 22 km upstream from the river mouth. As long as the deepest riverbed elevation is not altered, salinity intrusion length will not be elongated, even if the Magapit Narrows are widened.

## Flood Inundation

29. A flood inundation analysis was conducted along the Lower Cagayan River from the river mouth to Cabagan. The inundation area was divided into meshes of 1 km

× 1 km grid cells. The maximum inundation area, inundation depth and duration were calculated for each cell for different probable floods. The following shows the maximum inundation area in the reach between the river mouth and Cabagan for each probable flood:

| Probable Flood | 2-Year Flood | 5-Year Flood | 10-Year Flood | 25-Year Flood | 50-Year Flood | 100-Year Flood |
|---|---|---|---|---|---|---|
| Inundation Area ($km^2$) | 350 | 650 | 740 | 810 | 840 | 870 |

## VI. MULTIPURPOSE DAM PROJECTS

### Review of Multipurpose Dam Projects Proposed in 1987 Master Plan

30. All five (5) multipurpose dams proposed in the 1987 Master Plan were formulated to utilize the maximum potential at the respective dam sites. Hence, the physical project features for all dams were retained unchanged from the 1987 Master Plan.

### Reviewed Multipurpose Dam Projects

31. The following is an outline of the five (5) multipurpose dams:

| | Multipurpose Dam | | Features |
|---|---|---|---|
| 1) | Magat Dam | - | Rockfill type, |
| | | - | 114 m high, 18 million $m^3$ in embankment volume, 4,160 m in crest length, |
| | | - | 795 million $m^3$ in effective storage volume, 164 million $m^3$ in flood control space, |
| | | - | proposed additional flood control space of 139 million $m^3$, |
| | | - | installed capacity of 360 MW, irrigation area of 95,000 ha, |
| 2) | Siffu No.1 Dam | - | Earthfill type, |
| | | - | 58 m high, 1.7 million $m^3$ in embankment volume, 240 m in crest length, |
| | | - | 93 million $m^3$ in effective storage volume including 41 million $m^3$ for supplemental irrigation water supply to Magat Irrigation project, 115 million $m^3$ in flood control space, |
| | | - | installed capacity of 5.4 MW, |
| 3) | Mallig No.2 Dam | - | Rockfill type, |
| | | - | 84 m high, 2.4 million $m^3$ in embankment volume, 300 m in crest length, |
| | | - | 545 million $m^3$ in effective storage volume, 112 million $m^3$ in flood control space, |
| | | - | irrigation area of 31,200 ha, |
| 4) | Matuno No.1 Dam | - | Rockfill type, |
| | | - | 147 m high, 10 million $m^3$ in embankment volume, 580 m in crest length, |
| | | - | 97 million $m^3$ in effective storage volume, |
| | | - | installed capacity of 180 MW, irrigation area of 12,860 ha, |
| 5) | Alimit No.1 Dam | - | Concrete dam, |
| | | - | 89 m high, 0.65 million $m^3$ in concrete volume, 430 m in crest length, |
| | | - | 156 million $m^3$ in effective storage volume, |
| | | - | installed capacity of 12.2 MW, |

# VII. FLOOD CONTROL

## Basic Concept of Flood Control

32. Flood damage mitigation measures consist of structural measures, non-structural measures and supporting measures. Stage-wise development of the flood control projects is contemplated from technical and financial viewpoints aiming at the target year of 2020.

## Framework Plan

33. The framework plan of flood control proposed in the 1987 Master Plan was also applied for the Reviewed Master Plan without modification, because the fundamental relevant characteristics of the Cagayan River and its basin have not changed since the 1987 Master Plan was formulated.

## Reviewed Long-Term Plan

34.1 To cope with flood control problems involved in the basin, the long-term flood control plan proposed in the 1987 Master Plan was reviewed through a comparative study. The target area was the whole Cagayan River basin and its major tributaries. The review was made for a 25-year probable flood as a more economically effective scale for development.

34.2 The identified structural measures in the reviewed plan are shown in Figure 4 and summarized below.

1) Dike embankment
   - In the main Cagayan River
   - In the major tributaries, the Siffu, Ilagan, and Magat Rivers
2) Cut-off channel works
   - In the main Cagayan River at Gabut, San Isidro and Tuguegarao
   - In the Magat, Siffu and Mallig Rivers
3) Bank protection at 73 sites
4) Flood control dams
   - Cagayan No.1 dam
   - Ilagan No.1 dam

The major modification of the long-term plan between the 1987 Master Plan and this Study are as enumerated below.

1) Magapit Narrow Improvement Scheme which had been proposed in the 1987 Master Plan was reviewed in detail by using river cross sections and topographic maps surveyed in this Study. It was concluded that this scheme

showed lower economic efficiency, hence was discarded in the reviewed long-term plan.

2) The Gabut Cut-off Channel and San Isidro Cut-off Channel had been included in the 1987 Master Plan. The Tuguegarao Cut-off Channel was newly proposed in the reviewed long-term plan.
3) Bank protection works were counted for 75 sites in the 1987 Master Plan. In this Study, 73 sites needing bank protection works were identified and included in the long-term plan.

34.3 The non-structural measures to be incorporated in the long-term plan are as follows:

1) Evacuation system including flood forecasting and warning system and evacuation centers, and
2) Resettlement including resettlement area development.

A hazard map was also prepared in terms of flood inundation, riverbank erosion and soil surface erosion for the whole Cagayan River basin.

34.4 The supporting measures to be incorporated in the long-term plan are as follows:

1) Strengthening of funding for flood control works,
2) Strengthening of river administration including organizational improvement and capacity building, and
3) Peoples awareness building.

All these supporting measures are essential for the implementation of flood control projects. However, these supporting measures should be contemplated as a nationwide program separately from this Study since those are related to the nationwide institutional aspects.

## VIII. WATERSHED MANAGEMENT

### Basic Concept of Watershed Conservation Plan

35. The existing problems are decrease of forest area and increase of sediment yield in the upper Magat River basin. The main objectives of the long-term watershed conservation plan are to mitigate flood magnitude and to reduce the sediment yield of the Cagayan River basin, thus to function as a measure of the flood control of the Cagayan River. Components to be incorporated in the plan are reforestation and sabo works, which are common and effective measures for the watershed conservation.

### Long-Term Plan

36.1 The area of required reforestation in the Cagayan River basin was estimated on the assumption that all land over 18% slope, except for present agricultural land, should be covered by forest. The area of the required reforestation for the entire Cagayan River basin was estimated to be 3,188 $km^2$ as illustrated in Figure 5 and summarized below.

| Sub-basins | Land Area over 18% Slope excluding Agricultural Land ($km^2$) | Present Forest Area in Land over 18% Slope ($km^2$) | Proposed Reforestation Area ($km^2$) |
|---|---|---|---|
| Upper Cagayan River basin | 3,657 | 3,266 | 391 |
| Magat River basin | 3,670 | 2,443 | 1,227 |
| Ilagan River basin | 2,389 | 2,371 | 18 |
| Siffu-Mallig River basin | 1,032 | 694 | 338 |
| Chico River basin | 3,832 | 3,249 | 583 |
| Lower Cagayan River basin | 2,380 | 1,749 | 631 |
| Whole Cagayan River basin | 16,960 | 13,772 | 3,188 |

Agro-forestry and rehabilitation of infrastructure are included to ensure peoples' livelihood and attain sustainable reforestation activities. Participation of volunteers is expected in the plantation establishment, maintenance and protection. The reforestation is to be implemented through Community Based Forest Management (CBFM) strategy established by the GOP. The estimated cost for reforestation is Pesos 5 billion.

36.2 The existing Magat Dam faces reservoir sedimentation problem, which has been accelerated by land collapses in the Magat River basin that were caused by the earthquake occurred in July 1990. Urgent sabo works are required in the upstream of the Magat reservoir to extend the lifetime of the Magat Dam reservoir. Sabo dams are considered efficient and the total number of required sabo dams is estimated to be 26. The estimated construction cost is Pesos 5.47 billion.

36.3 Illegal tree cutting and slash-and-burn activities are major problems in terms of forest conservation. An intensive survey on these activities and study of efficient countermeasures should be conducted in order to preserve the existing and future watershed in due consideration of residents' livelihood.

# IX. LAND USE

## Reviewed Land Use Plan

37. Since the 1987 Master Plan was formulated, there have been some changes in such land use as increased agricultural land and decreased grassland. These changes quite conformed to the basic strategy of the GOP that the country has still needs to increase agricultural production by means of retaining or increasing the agricultural areas. Basic concepts for the reviewed land use plan are as follows:

1) Present total agricultural area is to be maintained, though paddy field area is to be increased and cornfield area is to be decreased.
2) Crop production is to be increased through increase of cropping intensity and unit yields.
3) Pastureland is to be increased, while grassland and brushes are to be decreased.
4) Agro-forestry, forest, and built-up areas and others are to be increased.

The reviewed land use plan is shown in Figure 6. In the land use plan, the most important sector for development of the Cagayan River basin is irrigation. The Study, therefore, focused on the irrigation development plan.

## Irrigation Framework Plan

38. Irrigation Framework Plan for the Cagayan River basin is composed of the following.

1) The irrigable area of 475,000 ha is to be fully irrigated, out of which currently non-irrigated area of 257,000 ha is to be newly irrigated.
2) The existing irrigation system is to be rehabilitated and maintained for 100 % or full operation.

## Reviewed Irrigation Long-Term Plan

39.1 There are 38 irrigation projects selected for the irrigation long-term plan with consideration of economic viability of each project as listed below. The proposed irrigation projects are categorized into two groups; one is a group of projects needing flood control project to be implemented simultaneously and another group of projects not needing flood control measures. The locations of the schemes are shown in Figure 7.

| | | |
|---|---|---|
| Irrigation Project affected by Flood | Alcala Amulung West PIP | Pinacanauan RIS |
| | Solana PIS-REP | San Pablo-Cabagan IS |
| | Mamil PIP | Santa Maria PIS |
| | Santa Isabel PIP | Delfin Albano PIP |
| | Damao PIP | Tumauini Reservoir P |
| | Lapogan PIP | Upper Chico RIS |
| | Lulutan PIP | Mallig RIS |
| | Gamu PIP | Nueva Vizcaya Bagabag IS |
| | Enrile PIP | Ilagan PIP |
| | Zinundungan IEP | Napaccu PIP |
| | Lallo West PIP | Tagaran PIP |
| | Nassiping PIP | Reina Mercedes PIP |
| | Magapit PIS (CIADP) | Santo Nino PIP |
| | Iguig-Alcala-Amulung PIS (CIADP) | |
| Irrigation Project not affected by Flood | Upper Ilagan Western Barangay PIP | Bantug PIS |
| | San Agustin PIP | San Mariano PIP |
| | Dibuluan RIP | East Tabacal PIP |
| | Dabubu IP | Debibi Groundwater IP |
| | Rizal IP | Villaverde IP |
| | Lower Chico RIS | |

39.2 Supporting measures recommended for irrigation development are as follows:

1) Continuation and enhancement of on-going agriculture support services including promotion of agrarian reform through CARP by DAR, financial support by Land Bank, promotion of farmers' organization by DA, improvement of infrastructure by DPWH and DA, etc.,
2) Strengthening of supporting system for irrigation system, including strengthening of post-harvest facilities such as drying facilities, farm to market road, rice mill, etc., improvement of micro credit system, enhancement of Irrigator's Association, and so on, mainly by DA, NIA and LGU. As one of the measures for the above, establishment of rural development center is considered as a core of the supporting system, and
3) Enhancement of marketing and transportation system between the National Capital Region (NCR) and the Cagayan River basin. This includes conceivable improvement of the Dalton Pass route by a tunnel and sea route via the Irene Port. The Irene Port is to be developed with the northern coastal area development by CEZA together with DPWH, LGU, DA, and NIA.

## X. REVIEWED MASTER PLAN

### Basic Concept of Cagayan River Basin Development

40.1 Present Socio-economic Situation: Per Capita GRDP in Region 2 was Pesos 20,200 which was equivalent to 55.3% of the National Average of Pesos 36,500 and was in 12th position or 4th lowest among the 15 Regions. This implies that Region 2 is an under-developed or depressed region in the Country. The regional annual average family income in Region 2 was Pesos 86,822 in 1997, which was far less than the national average of Pesos 123,168. When the Water Resources Development Master Plan was formulated in 1987, there were some political disturbances in the Region. Therefore, few of the development projects proposed in the 1987 Master Plan were implemented. At present, there is no political disturbance in the objective area and the mutual agreement on the project implementation has been confirmed through consultation meetings among the National Government and LGUs concerned. This implies that it is now good timing to implement the Master Plan Projects.

40.2 Background/Causes of Under-development: Frequent flooding has occurred in the Cagayan River basin, especially in the lower Cagayan. The recorded maximum flood in the Cagayan basin occurred in 1973, and had an inundation area of 1,860 $km^2$, equivalent to 39.2% of the total irrigable area in the basin. Flood inundation is one of the major causes of the low regional economic development. Other natural calamities, which have affected the area, are earthquake, deforestation, erosion and sedimentation especially in the upstream area. The Workshops conducted identified that the most serious problem encountered in the regional development is low investment and financial constraints. The conclusion of the Workshops was "Insufficient fund $\Rightarrow$ No comprehensive development Master Plan $\Rightarrow$ No chance to look for the finance $\Rightarrow$ No Feasibility Study $\Rightarrow$ No Project Implementation". The Workshops also pointed out that the both National Governments and LGUs did not understand and/or ignored the needs of the Development in the Cagayan Valley.

40.3 Need to Socio-economic Development (National Level): The Philippines is not self-sufficient in rice production at present. The DA has forecast for the rice production shortage even in 2010 by 5% of the total demand. More intensive irrigation for rice production is needed to reach self-sufficiency in the country. The Government has a basic policy to realize balanced/equitable development in the country in order to abolish a disparity in economic development among the regions. The under-developed areas, like Region 2, should be given higher priority

for development with necessary investment. The Medium-Term Development Program (MTDP) of the Cagayan Province stated that the target of development for the Cagayan Province is to realize international competitiveness for the agricultural-industry sector.

40.4 Development Potentials: The Cagayan River is the largest river in the Philippines having a land area of 27,281km$^2$. The irrigable area in Region 2 covers 475,000 ha, which contains 218,000 ha of the existing irrigation system (about 45.9% of the total). Remaining areas for irrigation development in Region 2 are 257,000 ha, which is the largest in the country with remaining potential for further development. Those areas are fertile and good for agricultural cultivation. The Cagayan River has plenty of surface water resources. Average runoff at the river mouth is 1,372 m$^3$/s or 43.2 billion m$^3$/year. Water resources developments implemented so far are limited to the Magat Dam and Irrigation Project, Casecnan Diversion Project and other minor small-scale projects. There is still a room to develop the area with such untapped development potential.

40.5 Basic Development Concept: The target year for Master Plan was set at the year 2020. The target Per Capita GRDP in Region 2 in the year 2020 was set to reach the national average excluding National Capital Region with the mutual consent of the Steering Committee for this Study. The poverty incidence should be reduced to 20% at least in the target year 2020. In order to realize this target of Per Capita GRDP, the required investment up to the year 2020 is estimated as shown below (Refer to Item 22, Chapter IV).

| | |
|---|---|
| Current Projects | 508.9 billion Pesos |
| Special Projects | |
| AFMA | 16.3 |
| CEZA | 35.2 |
| Water Resources Projects | 30.3 |
| Other Capital Formation | 327.4 |
| Total | 918.2 |

The Study assumed that allocation of the water resources development fund of Pesos 30.3 billion would be about Pesos 20 billion for flood control, and about Pesos 10 billion for irrigation. Hydropower, watershed management and others are expected to be funded from other sources for current projects, private sector investment, etc. Of the above investment, about 30-40% will be in foreign currency and 60-70% in local currency.

## Review of 1987 Master Plan

41.1 In the review of the 1987 Master Plan, the sectors of flood control, irrigation, watershed management, water supply and power generation, water quality

management and river environment management were contemplated.

41.2 In order to select the projects for the Reviewed Master Plan among the candidate projects of the flood control plan and land use plan, seven (7) project packages were constructed combining a multipurpose dam with flood control and irrigation projects relating to the multipurpose dam. The packages were then compared with respect to economy, urgency, equitable development and environment to select the most suitable package.

41.3 Among the five dams proposed in the 1987 Master Plan (Siffu No.1, Mallig No.2, Alimit No.1 combined with Magat Dam and Matuno No.1 Dams), the Siffu No.1 Dam and Alimit No.1 Dam/Magat Dam were selected for packaging because of their high economic viability of 28.3% and 20.7%, respectively. The Matuno No.1 Dam has the highest EIRR of 36.8% among five dams owing to high hydropower generation benefit. However, the Matuno No.1 Dam was not selected for the packaging considering that the country's privatization policy for the power generation sector does not permit the implementation of power-oriented project by public investment. In addition, the present installed capacity in the whole country meets the demand and does not present an urgent need for implementation of the project. The Mallig No.2 Dam was discarded because of its low EIRR of 16.6%.

41.4 The seven packages consist of the Siffu No.1 Dam or Alimit No.1 Dam with flood control and irrigation projects located downstream of the dam. The projects of flood control and irrigation are those identified in the reviewed long-term plan.

41.5 Among the seven packages, the package consisting of the Siffu No.1 Dam and related flood control and irrigation projects has the highest EIRR of 19.7%. The Siffu No.1 Multipurpose Dam is expected to supply water to the part of the irrigation command area of the existing Magat Dam, that presently cannot be supplied because of insufficient supply capacity. The supply of irrigation water from the Siffu No.1 Dam will lead to an increase in agricultural production to the level of the Magat command area. There are no serious environmental issues among seven packages.

41.6 From the result of the study on project packages above and some adjustment of the project to meet the target budget being more or less 30 billion Pesos, the reviewed Master Plan was formulated consisting of the following projects:

1) Multipurpose dam project: Siffu No.1 Dam,
2) Flood control schemes
    a) Dike embankment including revetment, sluice and riverbank tree zone
        - in the main Cagayan river from river mouth to Tuguegarao

b) Cut-off channel works
   - Gabut, San Isidro and Tuguegarao
c) Bank protection works
   - 21 sites from river mouth to Cabagan in the main Cagayan
   - 52 sites upstream from Tumauini in the main Cagayan, Siffu, Mallig, Ilagan, and Magat Rivers
d) Evacuation system including FFWS and evacuation center
e) Resettlement
f) Strengthening of institution and organization

3) Watershed management schemes
   a) Reforestation plan (Reforestation area 3,188 $km^2$)
   b) Sabo works plan (26 Sabo dams)
4) Agricultural development schemes

   Structural measures:
   a) New irrigation / extension schemes (17 schemes with total 54,985 ha)
   b) Irrigation rehabilitation / improvement schemes (7 schemes with total 22,506 ha)
   c) Diversified crops development (148,400 ha)
   d) Permanent crops development (105,100 ha)
   e) Pasture land development (152,700 ha)
   f) Magat O&M improvement

   Supporting measures:
   a) Continuation and enhancement of on-going agricultural support services
   b) Strengthening of support system for irrigation system
   c) Enhancement of marketing and transportation system
   d) Establishment of upland development experimental center
5) Hydropower development schemes
   a) Ibulao scheme (run-of-river type)
   b) Tanudan scheme (run-of-river type)
   c) Diduyon scheme with Diduyon dam
   d) Matuno No.1 Dam

Total project cost is estimated to be Pesos 31.5 billion for the projects of above item 1), 2) and part of 4). Location of the selected projects in the Reviewed Master Plan is shown in Figure 8.

41.7 Outside the investment amount of Pesos 31.5 billion, it is recommended to implement the following projects:

1) Irrigation projects proposed in the long-term plan other than those included in the Reviewed Master Plan, which are to be implemented by the NIA regular funds,
2) The watershed management projects are to be implemented by the DENR with its regular fund and / or private sector investment,
3) The Alimit No.1 dam and the modification of the Magat Dam operation are to be implemented in order to provide additional flood control space to the Magat dam,
4) Hydropower projects of Ibulao, Tanudan and Diduyon schemes are to be implemented by looking for private sector investment, and
5) The Matuno multipurpose dam project, which is the most prospective dam scheme in terms of EIRR, is to be implemented by private investment.

**Evaluation of Reviewed Master Plan**

42.1 Natural and Physical Environmental Impact Evaluation: In the 1987 Master Plan, environmental evaluation was conducted on 1) Dam Projects, 2) Flood Control Projects and 3) Agricultural Development Projects. In this Study, the watershed management and resettlement area development schemes were added. The environmental evaluation was conducted on those additional schemes as well as the three projects above mentioned.

Dam construction will cause the area of the reservoir to be submerged resulting in the loss of all vegetation and disturbance on migration of some aquatic organisms owing to the disconnection of the special connectivity of the river system. The proposed dam schemes encompass some protection areas. Hence, an EIA study is necessary for dam projects at the feasibility study (FS) stage thereof.

Flood control and agricultural development projects may not bring about source of environmental pollution in principle, however may cause turbid water flow, air pollution and noise in and around the construction sites and transportation routes. These effects, however, will not last but will be confined within the construction phase.

42.2 Social Environmental Impact Evaluation: The flood control projects are planned to contribute or improve social environment such as flood damage mitigation, protection of life and property as a project nature. Therefore, no social environmental adverse impact may be considered in principle. However, there are some issues to be considered. The navigation existing in the lower Cagayan River is so important for the people that river planning should be done in order to prevent or minimize the lowering of the water level of the river to secure existing navigation system. Regarding the existing items of cultural and historical

heritage, there will be no impacts on them because of adequate distance between them and the planned projects. There would be no significant impacts on minority tribes along the Cagayan River because they have already been assimilated with the majority people in the Region. However, at the F/S stage of dam construction, a study on minority tribes should be done for social considerations. Dam construction will create a water body, which might act as a source of water-related diseases such as malaria and dengue fever. Thorough vector control and education on environmental health to local people, therefore, should be carried out.

42.3 Economic Evaluation: The projects were evaluated under present socio-economic conditions in general. However, socio-economic conditions will be enhanced in accordance with the economic development scenario by the various target years. In this Study, the projects are evaluated under the enhanced socio-economic conditions, referred to as "under future conditions". The project features of the Reviewed Master Plan and its economic effect in terms of EIRR are summarized below.

| Project | Major work component | Project cost $10^6$ Pesos | EIRR (%) |
|---|---|---|---|
| **A. Multipurpose Dam** | | | |
| 1) Siffu No.1 Dam Project | Purpose: Flood control, irrigation & hydropower<br>Earthfill dam: H=58m, Em.V=1.7 million $m^3$<br>Storage capacity: 93 million $m^3$ irrigation<br>115 million $m^3$ flood control<br>Power: 5.4 MW / 41.1 GWH | 3,172 | 28.3% |
| **B. Flood Control** | | | |
| ***Structural Measures*** | | | |
| 1) Dike embankment | Embankment including revetment, sluice and riverbank tree zone in the Main Cagayan from river mouth to Tuguegarao | | |
| - River mouth ~ Nassiping | L=82.7 km, Em.V=9.3 million $m^3$ | 2,844 | 28.1 |
| - Alcala ~ Tuguegarao | L=57.5 km, Em.V=8.5 million $m^3$ | 2,891 | 27.0 |
| 2) Cut-off channel | | | |
| - Gabut COC | L=0.9km, Ex.V=4.0 million $m^3$ | 1,008 | 16.6 |
| - San Isidro COC | L=2.1 km, Ex.V=7.4 million $m^3$ | 1,722 | 18.8 |
| - Tuguegarao COC | L=6.7 km, Ex.V=17.5 million $m^3$ | 4,662 | 15.0 |
| 3) Bank protection | 73 sites in total | 4,383 | 15.1 |
| - River mouth ~ Cabagan | 21 sites, L=18.8 km, A=514,900 $m^2$ | 726 | 19.2 |
| - Main Cagayan: upstream of Tumauini, Tributaries: Siffu, Mallig, Ilagan, Magat | 52 sites, L=51.9 km, A=931,000 $m^2$ | 3,657 | |
| ***Non-structural Measures*** | | | |
| 1) Evacuation system | | | |
| - FFWS | Improvement of facilities<br>Strengthening of Tuguegarao Sub-center | 242 | 18.0 |
| - Evacuation center | Strengthening evacuation center & DCC | 152 | |
| | | | |

| | | | |
|---|---|---|---|
| 2) Resettlement | Number of households 2,776, land acquisition 7,468 ha | 1,185 | - |
| ***Supporting Measures*** | | | |
| 1) Strengthening institution & organization | | 150 | - |
| **C. Watershed Management** | | | |
| 1) Reforestation | Reforestation area 3,188 $km^2$ | 5,000 | 16.3 |
| 2) Sabo works | 26 Sabo dams in Magat River basin | 5,472 | 16.8 |
| **D. Agricultural Development** | | | |
| ***Structural Measures*** | | | |
| 1) New irrigation/extension | 17 schemes for 54,985 ha | | |
| - By new fund 10 schemes / 35,085 ha | Alcala Amulung west PIP | 1,527 | 22.8 |
| | Other 9 schemes | 6,327 | 17.6~ 25.0 |
| - By NIA regular fund | 7 schemes/19,900 ha | 4,214 | 16.1~ 18.4 |
| 2) Irrigation rehabilitation & improvement | | | |
| - By new fund | 5 schemes/19,960 ha | 866 | 27.0~ 37.1 |
| - By NIA regular fund | 2 schemes/2,546 ha | 192 | 27.3~ 29.0 |
| 3) Diversified crop | 148,400 ha for increase of unit yield | - | - |
| 4) Permanent crop | 105,100 ha for enhancing fruits cultivation | - | - |
| 5) Pasture land | 152,700 ha for cattle grazing | - | - |
| 6) Magat O&M impr't | Improvement of irrigation efficiency | - | - |
| ***Supporting Measures*** | | 1,310 | - |
| **E. Hydropower Development** | | | |
| 1) Ibulao scheme | Run-of-river type, 17 MW, 85 GWH | 1,653 | 26.6 |
| 2) Tanudan scheme | Run-of-river type, 25 MW, 130 GWH | 1,938 | 31.5 |
| 3) Diduyon scheme | Diduyon concrete gravity dam H=111m 352 MW, 957 GWH | 26,745 | 26.5 |
| 4) Matuno No.1 Dam project | Rockfill dam, H=147m 180 MW, 528 GWH, Irrigation area 12,860 ha | 17,565 | 36.8 |

## Implementation Schedule and Implementing Structure

### 43.1 Implementation Schedule

The implementation schedule of the Reviewed Master Plan was prepared as presented in Figure 9. The assumed cost disbursement for the Reviewed Master Plan is shown in Table 1.

### 43.2 Implementing Structure

1) Nature of the Projects

The recommended projects herein are the basin-wide water resources development and management including watershed management, water utilization, flood control, water quality management and river environment conservation. These works extend over many agencies under current administrative arrangements.

2) Implementing Structure of Multi-purpose Projects in the Philippines

There is no unified agency to handle overall water resources development and management in the Philippines. In the case of implementing multi-purpose projects, the following three forms/systems have been adopted to meet to the requirement of the projects.

a) Coordination Committee System

This system may be applied to such projects that may have a comparatively high level of independence among the individual components and extending over 2-3 agencies only. The Coordination Committee may be formed with mutual agreement among the agencies concerned.

b) Commission System

This system may be applied to such projects that would be rather hard to coordinate among the agencies concerned in the case that the projects are related to many agencies. The Commission under this system has its own staff and budget for project implementation, and may be established with a Presidential Order.

c) Authority System

This system may be applied to such projects that may encompass many factors/purposes with many agencies to be involved, including in the operation and maintenance of the project after its completion. This may be established by an act passed the congress.

3) Implementing Structure of the Reviewed Master Plan Projects

The implementation of the Master Plan is scheduled to start with flood control projects and irrigation projects. At this stage, it is assumed that a Coordination Committee System will be sufficient for implementation. This may be transformed to a Commission System in such time that the projects will be expanded to full-scale development with the other components such as watershed management, water quality management, and river environment management. Furthermore, the implementing system may be reformed to an Authority when the basin-wide economic development will be geared to full-scale economic development, including CEZA and AFMA, which will bring the entire implementation together. This strategy of step-wise transformation of implementing structures was agreed on by the Steering Committee of this JICA Study. Figure 10 shows the proposed organization of the final features of the implementing structure to be established in future.

# Part-III FEASIBILITY STUDY OF PRIORITY PROJECTS

## XI. PRIORITY PROJECTS FOR FEASIBILITY STUDY

### Basic Approach of Feasibility Study

44. The Reviewed Master Plan has proposed the projects in the sectors of a) Flood control, b) Irrigation, c) Watershed management, d) Water supply and power generation, e) Water quality management and f) River environment management. Among the proposed sector projects, flood control and irrigation projects have been given priority for implementation in view of the development policy of the Government, regional economic target and results of the workshops conducted during the Study period.

The Reviewed Master Plan reveals that the flood control projects are prerequisites for the development of the Cagayan River basin, and that the flood control projects of the Lower Cagayan River should be implemented first from the viewpoints of engineering and economical effectiveness.

The Reviewed Master Plan also states that irrigation projects should be given the priority for development of the basin following the flood control projects. Agricultural development is the key industry in the Cagayan River basin as the DA has identified the Cagayan basin as a part of the granary of the country, specifically for rice and corn production. Hence, agricultural development has a very high priority. The Alcala Amulung West Pump Irrigation Project is one of the most promising projects in view of the NIA's development strategy and for effective use of land resources after implementation of the flood control projects.

### Projects for Feasibility Study

45.1 The feasibility study was conducted for the following flood control projects in the Lower Cagayan River. Figure 11 shows the general locations of each flood control project including urgent bank protection works in the Lower Cagayan.

1) Left dike systems in the reach from the river mouth to Nassiping (Mabanguc dike, Catugan dike, Lasam dike)
2) Right dike systems in the reach from the river mouth to Nassiping (Camalaniugan dike, Lal-lo dike, Gattaran dike, Nassiping dike)
3) Left dike systems in the reach from Alcala to Tuguegarao (Alcala-Buntun dike, Enrile dike)
4) Right dike systems in the reach from Alcala to Tuguegarao (Tuguegarao dike, Amulung dike, Iguig dike along national highway)

5) Cut-off channels (COCs) in the reach from Alcala to Tuguegarao (Gabut COC, San Isidro COC, and Tuguegarao COC)
6) Urgent bank protection works at 21 sites in the Lower Cagayan

45.2 The non-structural measures subjected to the feasibility study consist of (1) an evacuation system including the flood forecasting and warning system and evacuation center, and (2) resettlement area development.

45.3 The Alcala Amulung West Pump Irrigation Project (AAWPIP) is the most prospective irrigation development scheme. This project is selected for the pre-feasibility study, as referred to in Figure 11. The pre-feasibility study was conducted based on the topographic map of scale 1/10,000, which was prepared in this Study. This is herein referred to as a pre-feasibility since detailed investigations were not conducted for topographic survey, geological and soil investigations, etc. However, NIA conducted already a feasibility study of a part of this proposed project, which revealed an economic viability of this project supported by detailed investigations even a part of the project area. Hence, it is recommended that this project be implemented as early as possible recognizing that this pre-feasibility study is in a level of a feasibility study.

# XII. PRELIMINARY DESIGN

## Flood Control Projects

46.1 The feasibility study is conducted for all the flood control projects in the Lower Cagayan River identified in the Reviewed Master Plan. The 25-year probable flood is applied for the design of facilities. The location of the 16 proposed river improvement works is shown in Figure 11.

46.2 The design river width is set to be 1.5 to 2.0 km for the design flood of 100-year probable flood in order to avoid difficulty in widening in future.

46.3 The respective components are outlined below.

Left dike systems in the reach from the river mouth to Nassiping

1) Mabanguc dike (10.9 km in long)
2) Catugan dike (7.4 km)
3) Lasam dike (7.0 km)

Right dike systems in the reach from the river mouth to Nassiping

4) Camalaniugan dike (13.1 km)
5) Lal-lo dike (12.9 km)
6) Gattaran dike (6.1 km)
7) Nassiping dike (9.7 km)

Left dike systems in the reach from Alcala to Tuguegarao

8) Alcala-Buntun dike (33.5 km)
9) Enrile dike (12.2 km)

Right dike systems in the reach from Alcala to Tuguegarao

10) Tuguegarao dike (21.3 km)
11) Amulung dike (12.6 km)
12) Iguig dike along national highway (3.2 km)

Cut-off channels in the reach from Alcala to Tuguegarao

13) Gabut COC (0.7 km)
14) San Isidro COC (1.6 km)
15) Tuguegarao COC (5.8 km)

Urgent bank protection works in the Lower Cagayan

16) Urgent bank protection works in the Lower Cagayan (21 sites)

The cut-off channel and the low water channel, from Alcala to Buntun Bridge, are aligned on the right bank side where sound geology exists. The alignment is designed in conformity with the river morphology in the Cagayan Valley.

Major work quantities are estimated as follows:

1) Total excavation volume: 33.3 million $m^3$ of the three cut-off channels
2) Total embankment volume: 18.2 million $m^3$ of the dike
3) Total bank protection area: 306,000 $m^2$
4) Total tree zone area: 1.8 million $m^2$

46.4 The following non-structural measures are studied:

1) Improvement of existing flood forecasting and warning system facilities, Tuguegarao sub-center and disaster management capacity in Tuguegarao in association with Consultancy and Engineering Services. Total cost of 242 million Pesos is estimated.
2) Improvement of evacuation center, strengthening of Disaster Coordinating Councils (DCCs) and people's awareness/capability building. Total cost of 152 million Pesos is estimated.
3) Resettlement area development at 6 sites with the area of 58.7 ha in total.

**Irrigation Project**

47.1 A study of Alcala Amulung West Pump Irrigation Project is conducted at pre-feasibility study level. Total net irrigation area is 7,060 ha consisting of Stage I area of 4,090 ha and Stage II area of 2,970 ha. The NIA performed a feasibility study of 2,120 ha within the Stage I area in 1997. The Stage I area is covered with rain-fed paddy field at present. This area is located rather far from the Cagayan River and has relatively high elevation, hence this area has not suffered from flood damage by a flood with magnitude of 5-year probable flood or so. Stage II area is mainly covered by cornfield at present. This area is located near the Cagayan River and has relatively low elevation, hence this area has suffered from flood damages by a flood with a magnitude of 5-year probable flood. Implementation of Stage II area is to be carried out in concurrence with that of related flood control measures.

47.2 Major facilities of the project include intake and booster pump stations, irrigation and drainage systems, roads, siphons, a tributary cut-off channel and flood dike, and so on.

## XIII. CONSTRUCTION PLAN AND COST ESTIMATE

### Construction Plan and Schedule

48.1 Major construction works required for the Lower Cagayan River Flood Control Project are 1) bank protection works, 2) dikes construction including maintenance roads and tree zones, 3) construction of cut-off channels and 4) related river structures such as culverts and sluices.

Urgent implementation is required for the urgent bank protection works at 21 sites. Planting the riverbank tree zones of 70 km is to be started at an early stage of implementation by LGUs.

48.2 Flood control structural measures are planned to be implemented in 4 phases aiming at the target year of 2020 commencing in the year 2002 in order from river mouth toward upstream, as presented in the table below.

| Phase | Year | Projects |
|---|---|---|
| 1st | 2002-2007 | Urgent bank protection works, Lower Cagayan |
| | | River bank tree zones, Lower Cagayan |
| | | Left and right dike systems, river mouth to Magapit |
| 2nd | 2004-2011 | Left and right dike systems, Magapit to Nassiping |
| | | Amulung dike system |
| | | Gabut cut-off channel |
| 3rd | 2007-2015 | Alcala-Buntun and Iguig dike systems |
| | | San Isidro cut-off channel |
| 4th | 2011-2020 | Tuguegarao and Enrile dike systems |
| | | Tuguegarao cut-off channel |

48.3 The improvement of the evacuation system including flood forecasting and warning system is planned to implement in the 1st Phase. The resettlement area development is planned to implement well in advance in concurrence with the implementation of related structural measures.

48.4 To ensure the construction time schedule and the quality of structures, mechanized construction system should be applied for the construction of the huge amounts of dike embankment of 18.2 million $m^3$ and excavation of 33.3 million $m^3$ for cut-off channels at 3 sites in Gabut, San Isidro and Tuguegarao. The excavated soils in the construction operation are to be used effectively for dike embankments and improvement of low-lying land in the basin.

48.5 The Alcala - Amulung West Pump Irrigation Project is implemented in two (2) stages. Construction of Stage 1 (4,090 ha) is to be executed during the 1st phase, while Stage 2 (2,970 ha) is to be implemented in the 3rd phase. The implementation schedule and annual disbursement of the 1st phase are shown in Figure 12 and Table 2.

## Mode of Construction Execution

49. 1st phase projects include 1) urgent bank protection works, 2) construction of left and right dike systems from the river mouth to Magapit including river bank tree zones, and 3) development of the Alcala-Amulung West Pump Irrigation Project, stage 1. Contractors selected internationally will conduct the construction works in the 1st phase excluding tree zones dividing the works into three (3) contract packages for four (4) years construction period to be started in the year 2004. The LGUs concerned will execute tree zone construction. Financial support by foreign aid would be needed.

## Cost Estimate

50. The project cost in the 1st phase of the Lower Cagayan River Flood Control Project and the irrigation project AAWPIP was estimated as presented in the table below including the structural measures, non-structural measures, and supporting measures:

Flood Control

Unit: million Pesos

| Phase | Construction period | Total | FC | LC |
|---|---|---|---|---|
| 1 | 2003-2007 | 2,786 | 1,448 | 1,339 |
| 2 | 2008-2011 | 2,828 | 1,445 | 1.,383 |
| 3 | 2011-2015 | 4,420 | 2,337 | 2,083 |
| 4 | 2015-2020 | 5,347 | 3,156 | 2,190 |
| Total | | 15,381 | 8,385 | 6,996 |
| US$ equivalent | | 308 | 168 | 140 |

FC: Foreign Currency portion, LC: Local Currency portion

Irrigation

Unit: million Pesos

| Phase | Construction period | Total | FC | LC |
|---|---|---|---|---|
| 1 | 2004-2007 <1 | 1,626 | 763 | 863 |
| 3 | 2011-2015 <1 | 982 | 479 | 503 |
| Total | | 2,608 | 1,242 | 1,366 |
| US$ equivalent | | 52 | 25 | 27 |

Note <1: including rice mill plant and drying yard as supporting measures

## Operation and Maintenance Costs

51. Annual Operation and Maintenance Costs (O&M Costs) for the 1st phase flood control project were estimated at Pesos 7.93 million or US$ 158,600 equivalent covering the structural and non-structural measures. Annual O&M Costs for the irrigation project of stage 1 of the AAWPIP were estimated at Pesos 30.0 million or US$ 600,000 equivalent covering the intake and booster pump stations, irrigation and drainage facilities, and rice mills.

# XIV. IMPLEMENTATION PLAN

## Implementing Organization

52.1 It is planned that the projects are to be implemented by a Coordination Committee System with member agencies of DPWH, PAGASA, OCD, DA, NIA and the respective Local Governments. The DPWH is assumed the superintendent for the overall projects. The proposed organization chart is presented in Figure 13.

52.2 It is assumed that DPWH is the responsible agency for flood control project covering all the project components including the irrigation project. Under this, PMOs will be formed for each of the flood control and irrigation components.

Under the PMO for flood control project, 4 sub-PMOs (Sub-PMO for Lower Cagayan Flood Control, Sub-PMO for FFWS, Sub-PMO for Evacuation System, and Sub-PMO for Resettlement & Livelihood Program) will be formed.

The DPWH will directly manage the structural measures of the river improvement works. The PAGASA will be a leading agency for Sub-PMO for FFWS. The respective LGUs will take the lead in the Sub-PMO for evacuation system, resettlement area development and tree zone construction. Furthermore, for the irrigation project component, Sub-PMOs will be established each for irrigation system development and conducting a livelihood program. The livelihood program will be conducted by all the DPWH, NIA and LGUs, among which LGUs should be the leading agencies.

52.3 Land acquisition, tree zone construction, evacuation system and resettlement area development relating to the flood control project will be implemented by LGUs as a leading agencies, however it should be supported by DPWH and NIA regional Office R-2 in terms of finance and engineering.

## XV. PROJECT EVALUATION

### Natural Environmental Assessment

53. The vegetation clearance accompanying implementation of the projects would disturb the habitat of terrestrial flora and fauna, which may cause the decrease of their population. The Ludong, a vulnerable species of the Cagayan River system, goes downstream during October to December and upstream during February to March. Therefore, turbid water flow and siltation, which may be caused by excavation work, should be minimized during their migration period in particular.

The impacts on air pollution and noise will occur during the construction phase in and around the construction site and along the transportation routes. These impacts will be confined to the construction phase and should be mitigated by consideration of an implementation plan of construction. As a conclusion, the proposed projects will not generate serious negative impacts. Therefore, it is considered that they have an environmental validity.

### Social Environmental Assessment

54. The number of households to be relocated will be 2,766 in total, composed of 343 households for the alignment of the flood control structures and 2,433 households being incorporated in the river area between right and left banks. The irrigation projects will also cause small-scale resettlement with nine (9) households. The consultation meetings were held several times with the LGUs concerned and the staff of the DPWH. The LGUs prepared their preliminary resettlement plans and have principally agreed on the project implementation with the required resettlement of all the affected people within the administrative areas in each LGU. The necessary actions including resettlement area development are to be undertaken by the concerned LGUs in cooperation with DPWH, NIA and the relevant government agencies such as NHA as well as further consultation meetings for understanding benefits and impacts of the projects.

As for other impacts on navigation, fisheries, water rights and public health, the magnitude of effects is considered minimal. On the contrary, the proposed projects will bring about lots of positive impacts such as boosting the local economy accompanied by contracts on construction works and the employment of local laborers.

As a conclusion, the proposed projects have an environmental validity, but further consultation meetings with LGUs and local communities should be held.

## Economic Evaluation

55.1 Flood Control Plan

This F/S adopts the following damage components for project benefits taking account of data availability: (1) direct damages, (2) infrastructure damages and (3) indirect damages. In the study, the project benefits were estimated through the bottom-up estimation method. The flood damages were estimated on the basis of the actual distribution of damageable assets in the flood prone areas and hydrologic analysis of the Cagayan River basin.

The projects are proposed to be implemented in four phases. Flood damages of a 25-year flood for the four phases of implementation are shown in the following table:

(Unit: Billion Pesos)

| Socio-Economic Condition | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Under Present Conditions | 1.4 | 3.3 | 5.5 | 8.4 |
| Under Future Conditions | 4.8 | 10.7 | 17.9 | 27.9 |

Based on the estimates of flood damages, the annual benefits of the respective phases are calculated as shown in the table below.

(Unit: Billion Pesos)

| Socio-Economic Condition | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Under Present Conditions | 0.3 | 0.6 | 1.2 | 2.4 |
| Under Future Conditions | 1.1 | 2.0 | 3.5 | 4.8 |

The economic cost of the respective phases was calculated from the corresponding financial cost applying conversion factors for the respective cost items, as recommended in "ICC Project Evaluation Procedures and Guidelines". They are summarized as follows. The costs of the respective phases are estimated as accumulation from the beginning.

(Unit: Billion Pesos)

| Initial Cost | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| Financial Cost | 2.8 | 5.6 | 10.0 | 15.3 |
| Economic Cost | 2.0 | 4.3 | 7.9 | 12.1 |

The EIRR of the respective phases was estimated at 27.1%, 25.4%, 26.8% and 27.3%. Thus, the EIRRs are much higher than the social discount rate of 15%.

For the Phase-1 scheme, a sensitivity test was introduced by varying different aspects of the estimates as follows: a) 5% or 10% higher than the estimated cost, b) 5% or 10% lower than the expected benefit, and c) combination of both aspects

at the same time. The EIRRs of all cases exceeded 15%. Thus, the proposed project is sufficiently feasible from an economic point of view.

55.2 Irrigation Development Plan

In irrigation development projects, Alcala-Amulung West Project was proposed for the feasibility study. It is to be implemented in two phases, i.e., Phase1 and Phase 3. The economic annual benefit of the proposed project was estimated at 266 million pesos for Phase 1 and 435 million pesos for the entire project. On the other hand, the economic cost of the project was estimated at 1.12 billion pesos for Phase 1 and 1.89 billion pesos for the entire project, which was converted from 1.57 billion pesos and 2.64 billion pesos in financial terms applying conversion factors. In addition, the O/M cost and the replacement cost for components such as pumping system in every 15 years need for management. The EIRR of the respective phases was estimated at 15.6% for Phase 1 and 15.2% for the entire project. Thus, the proposed project is judged as viable from an economic point of view. Furthermore, the values of crops produced in the project sites will rise in accordance with changes in the international and the domestic markets. When these prospects were included, the EIRRs were calculated at 16.4% for Phase 1 and 16.1% for the entire project. Thus, the economic efficiency is expected to improve in the future.

# XVI. CONCLUSIONS AND RECOMMENDATIONS

## Conclusions and Recommendations

56.1 The Lower Cagayan Flood Control Project, including non-structural measures, and the Alcala-Amulung West Pump Irrigation Project have been attested to meet the National and Local Governments policies for the basin development and been found to be feasible technically, economically and environmentally. Therefore, urgent implementation of these projects, especially the first phase, is recommended. The first phase consists of the following:

1) Flood control structural measures including urgent bank protection at 21 sites, riverbank tree zone for a length of 70 km, left dike system from river mouth to Magapit (17.3 km), and right dike system from river mouth to Magapit (26.0 km),
2) Flood control non-structural measures consisting of improvement of evacuation system including flood forecasting and warning system and evacuation center, and resettlement area development,
3) Alcala-Amulung West Pump Irrigation Project, first stage with a service area of 4,090 ha, and
4) Agricultural supporting measures such as rice mill plant and drying yard.

56.2 Prior to implementation of the proposed Lower Cagayan Flood Control Project and Alcala-Amulung West Pump Irrigation Project, the following actions are to be taken by the agencies concerned:

1) Designation of the river area and flood control area for river administration,
2) Preparation of land use regulation in the river area to allow the people to cultivate for agricultural purpose and promulgation thereof to the public,
3) Preparation of Agreements for the project implementation and signing by the agencies concerned,
4) Survey on land owners in the project area and preparation of land acquisition and compensation programs,
5) Obtaining concurrence of the local people on the implementation of the projects and resettlement,
6) Organizing farmers for implementation of agricultural supporting measures such as rice mill plant and drying yards,
7) Conducting environmental impact assessment,
8) Necessary arrangement for receiving approval for the project implementation such as ECC, ICC clearance, and preparation on Implementation Program,
9) Arrangement of financial support by foreign aid, if necessary, and

10) Prior arrangement of operation, maintenance and management system for the projects be made in advance of the project completion.

56.3 Bank erosions in the middle and upper Cagayan River and the major tributaries are very serious. The DPWH Regional Office R-2 has conducted the feasibility study thereof with the technical assistance of the Study Team. These bank protection works are not included in the proposed first phase works, however it is recommended to implement urgently these bank protection works.

56.4 Implementation of the following economically feasible projects is also recommended, although the budgets of these projects are above the targeted strategic investment amount of 30 billion Pesos, considering allocation of regular budget of the agencies concerned and / or looking for private investment:

1) Watershed management including reforestation of 3,188 $km^2$ and construction of 26 sabo dams,
2) Irrigation projects identified in the Reviewed Master Plan beside the Alcala-Amulung West Pump Irrigation Project,
3) Implementation of dam and hydropower projects such as Alimit No.1 Dam Project including provision of flood control space to the existing Magat Dam, and
4) Implementation of the Matuno multipurpose dam project.

56.5 Taking the long-term view, the following actions by the agencies concerned are recommended to advance the economic development of the Cagayan River basin:

1) Review of Water Code and strict application of the Code,
2) Collection of data and establishment of databases for socio-economic data and technical/engineering data for water resources development,
3) Study on the most appropriate organizational arrangements for implementation of basin water resources development and river management. For this purpose, recommended strongly is to formulate a Master Plan of the Nation-wide Flood Control Project.

# *Tables*

# Table 1 Assumed Cost Disbursement for Reviewed Master Plan

(Unit : Million Pesos)

| | | | | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Multipurpose Dam Project** | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Siffu No.1 Dam Project | | | | | | | | | | | 317.2 | 713.7 | 713.7 | 713.7 | 713.7 | | | | | | | | **3,172.0** |
| ***Subtotal (1.)*** | | | | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **317.2** | **713.7** | **713.7** | **713.7** | **713.7** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **3,172.0** |
| **2. Flood Control Project** | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Lower Reach Dike | | | | | 284.4 | 426.6 | 426.6 | 426.6 | 426.6 | 426.6 | 426.6 | | | | | | | | | | | | **2,844.0** |
| (2) Alcala Buntun Dike | | | | | | | | | 208.3 | 234.3 | 234.3 | 234.3 | 234.3 | 234.3 | 234.3 | 234.3 | 234.6 | | | | | | **2,083.0** |
| (3) Gabut Cut-off Channel | | | | | | | | | 100.8 | 226.8 | 226.8 | 226.8 | 226.8 | | | | | | | | | | **1,008.0** |
| (4) San Isidro Cut-off Channel | | | | | | | | | | | | 172.2 | 310.0 | 310.0 | 310.0 | 310.0 | 309.8 | | | | | | **1,722.0** |
| (5) Tuguegarao and Enrile Dike | | | | | | | | | | | | | | | | 80.8 | 121.2 | 121.2 | 121.2 | 121.2 | 121.2 | 121.2 | **808.0** |
| (6) Tuguegarao Cut-off Channel | | | | | | | | | | | | | | | | 466.2 | 699.3 | 699.3 | 699.3 | 699.3 | 699.3 | 699.3 | **4,662.0** |
| (7) Bank Protection | | | | | 640.0 | 640.0 | 640.0 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | 164.2 | **4,383.0** |
| (8) FFWS/Evacuation Center | | | | | 78.8 | 78.8 | 78.8 | 78.8 | 78.8 | | | | | | | | | | | | | | **394.0** |
| (9) Resettlement | | | | | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 65.9 | 64.7 | **1,185.0** |
| (10) Supporting Measures | | | | | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.9 | **150.0** |
| ***Subtotal (2.)*** | | | | **0.0** | **1,077.4** | **1,219.6** | **1,219.6** | **743.8** | **1,052.9** | **1,126.1** | **1,126.1** | **871.7** | **1,009.5** | **782.7** | **782.7** | **1,329.7** | **1,603.3** | **1,058.9** | **1,058.9** | **1,058.9** | **1,058.9** | **1,058.3** | **19,239.0** |
| **3. Irrigation Project** | | | | | | | | | | | | | | | | | | | | | | | |
| **3.1 Irrigation Project to be Implemented by New Funding Source** | | | | | | | | | | | | | | | | | | | | | | | |
| NIP/NIS | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Reh. of CIADP (Iguig-Alcala-Amulung PIS & Magapit PIS) | N | P | * | | 40.0 | 150.0 | 186.0 | | <As JICA Grant, on list of NIA IDP 2001-2010 (Draft)> | | | | | | | | | | | | | | **376.0** |
| (2) Tumauini Multipurpose P | | | | | | 50.0 | 375.0 | 500.0 | 600.0 | 450.0 | 374.0 | | <JBIC, on list of NIA IDP 2001-2010 (Draft)> | | | | | | | | | | **2,349.0** |
| (3) Alcala Amulung West PIP | N | P | | | | 152.7 | 229.0 | 229.0 | 229.1 | | F/S Review | | | | 114.6 | 229.0 | 229.0 | 114.6 | | | | | **1,527.0** |
| (4) Nueva Vizcaya Bagabag IS | N | G | * | | | | | | | 12.5 | 37.4 | 37.4 | 37.4 | | | | | | | | | | **124.7** |
| (5) Mallig RIS | N | G | * | | | | | | | 16.6 | 49.8 | 49.8 | 49.7 | | | | | | | | | | **165.9** |
| (6) Solana PIS-REP | N | P | | | | | | | | | | 107.1 | 160.6 | 160.7 | | 160.6 | 160.7 | 160.6 | 160.7 | | | | **1,071.0** |
| (7) Dabubu IP | N | G | | | | | | | | | | 31.2 | 93.6 | 93.6 | 93.6 | | | | | | | | **312.0** |
| (8) Delfin Albano PIP | N | P | | | | | | | | | | 50.2 | 150.6 | 150.6 | 150.6 | | <FS/DE made by NIA, R-2> | | | | | | **502.0** |
| (9) Enrile PIP | N | P | | | | | | | | | | | | | | | 58.8 | 176.4 | 176.4 | 176.4 | | | **588.0** |
| (10) Sto. Nino PIP | N | P | | | | | | | | | | | | | 24.0 | 55.2 | 72.0 | 72.0 | | | | | **223.2** |
| (11) Pinacanauan RIS | N | G | * | | | | | | | | | | | | | | | 9.1 | 27.1 | 27.2 | 27.2 | | **90.6** |
| (12) San Pablo-Cabagan IS | N | G | * | | | | | | | | | | | | | | | 10.8 | 32.5 | 32.5 | 32.4 | | **108.2** |
| (13) Zinundungan Irr. Ext. P | N | G | | | | | | | | | | | | | | | | | 92.0 | 276.0 | 276.0 | 276.0 | **920.0** |
| CIP/CIS | | | | | | | | | | | | | | | | | | | | | | | |
| (14) Nassiping PIP | C | P | | | 14.9 | 44.7 | 44.7 | 44.7 | | <FS/DE made by NIA, R-2> | | | | | | | | | | | | | **149.0** |
| (15) Lallo West PIP | | | | | | | | | | 19.6 | 58.8 | 58.8 | 58.8 | | | | | | | | | | **196.0** |
| (16) Supporting Measures | | | | | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.2 | **367.0** |
| ***Subtotal (3.1)*** | | | | **0.0** | **75.3** | **417.8** | **855.1** | **794.1** | **849.5** | **519.1** | **540.4** | **354.9** | **571.1** | **425.3** | **403.2** | **465.2** | **540.9** | **563.9** | **509.1** | **532.5** | **356.0** | **296.2** | **9,069.6** |
| ***Total (1.~3.1)*** | | | | **0.0** | **1,152.7** | **1,637.4** | **2,074.7** | **1,537.9** | **1,902.4** | **1,645.2** | **1,983.7** | **1,940.3** | **2,294.3** | **1,921.7** | **1,899.6** | **1,794.9** | **2,144.2** | **1,622.8** | **1,568.0** | **1,591.4** | **1,414.9** | **1,354.5** | **31,480.6** |
| **3.2 Irrigation Project to be Implemented by NIA and Other Agencies' Regular Fund** | | | | | | | | | | | | | | | | | | | | | | | |
| (1) San Mariano PIP | | | | | 8.8 | 26.4 | 26.4 | 26.4 | | | | | | | <FS/DE made by NIA, R-2> | | | | | | | | **88.0** |
| (2) Rizal IP | | | | | | 50.0 | 100.0 | 191.0 | 125.0 | | | | | | | | | | | | | | **466.0** |
| (3) Debibi Groundwater IP | | | | | | | | 100.0 | 150.0 | 200.0 | 190.0 | | | | | | | | | | | | **640.0** |
| (4) Dibuluan IP | | | | | | | | | | 91.0 | 100.0 | 200.0 | 200.0 | 147.0 | | | | | | | | | **738.0** |
| (5) Villa verde IP | | | | | | | | | | | | | 70.0 | 80.0 | 100.0 | 100.0 | 100.0 | | | | | | **450.0** |
| (6) Lower Chico RIS | | | | | | | | | | | | | | 13.4 | 40.2 | 40.2 | 40.3 | | | | | | **134.1** |
| (7) Upper Ilagan Western BPIP | | | | | | | | | | | | | | | | 64.8 | 194.4 | 194.4 | 194.4 | | | | **648.0** |
| (8) Ilagan PIP | | | | | | | | | | | | | | | | | | | 118.4 | 355.1 | 355.0 | 355.0 | **1,183.5** |
| (9) Santa Maria PIS | | | | | | | | | | | | | | | | | | | 5.8 | 17.3 | 17.3 | 17.2 | **57.6** |
| (10) Supporting Measures | | | | | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.4 | 52.2 | **943.0** |
| (11) Other projects | | | | 500.0 | 438.8 | 371.2 | 321.2 | 130.2 | 172.6 | 156.6 | 157.6 | 247.6 | 177.6 | 207.2 | 307.4 | 242.6 | 112.9 | 253.2 | 129.0 | 75.2 | 75.3 | 75.6 | **4,151.8** |
| ***Subtotal (3.2)*** | | | | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **500.0** | **9,500.0** |
| **4. Watershed Management Project** | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Reforestation | | | | | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.8 | 277.4 | **5,000.0** |
| (2) Sabo Works | | | | | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | 547.2 | | | | | | | | | **5,472.0** |
| ***Subtotal (4.)*** | | | | **0.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **825.0** | **277.8** | **277.8** | **277.8** | **277.8** | **277.8** | **277.8** | **277.8** | **277.4** | **10,472.0** |
| **5. Hydropower Project** | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Ibulao Project | | | | | | | | | | | | 165.3 | 371.9 | 371.9 | 371.9 | 372.0 | | | | | | | **1,653.0** |
| (2) Tanudan Project | | | | | | | | | | | | | | | 193.8 | 436.0 | 436.0 | 436.0 | 436.2 | | | | **1,938.0** |
| (3) Diduyon Project | | | | | | | | | | | | | | | | | | 2,674.5 | 6,017.6 | 6,017.6 | 6,017.6 | 6,017.7 | **26,745.0** |
| (4) Matuno No.1 Dam Project (multipurpose) | | | | | | | | | 1,756.5 | 3,161.7 | 3,161.7 | 3,161.7 | 3,161.7 | 3,161.7 | | | | | | | | | **17,565.0** |
| ***Subtotal (5.)*** | | | | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **1,756.5** | **3,161.7** | **3,161.7** | **3,327.0** | **3,533.6** | **3,533.6** | **565.7** | **808.0** | **436.0** | **3,110.5** | **6,453.8** | **6,017.6** | **6,017.6** | **6,017.7** | **47,901.0** |
| ***Total (1.~5.)*** | | | | **500.0** | **2,477.7** | **2,962.4** | **3,399.7** | **2,862.9** | **4,983.9** | **6,131.9** | **6,470.4** | **6,592.3** | **7,152.9** | **6,780.3** | **3,243.1** | **3,380.7** | **3,358.0** | **5,511.1** | **8,799.6** | **8,386.8** | **8,210.3** | **8,149.6** | **99,353.6** |

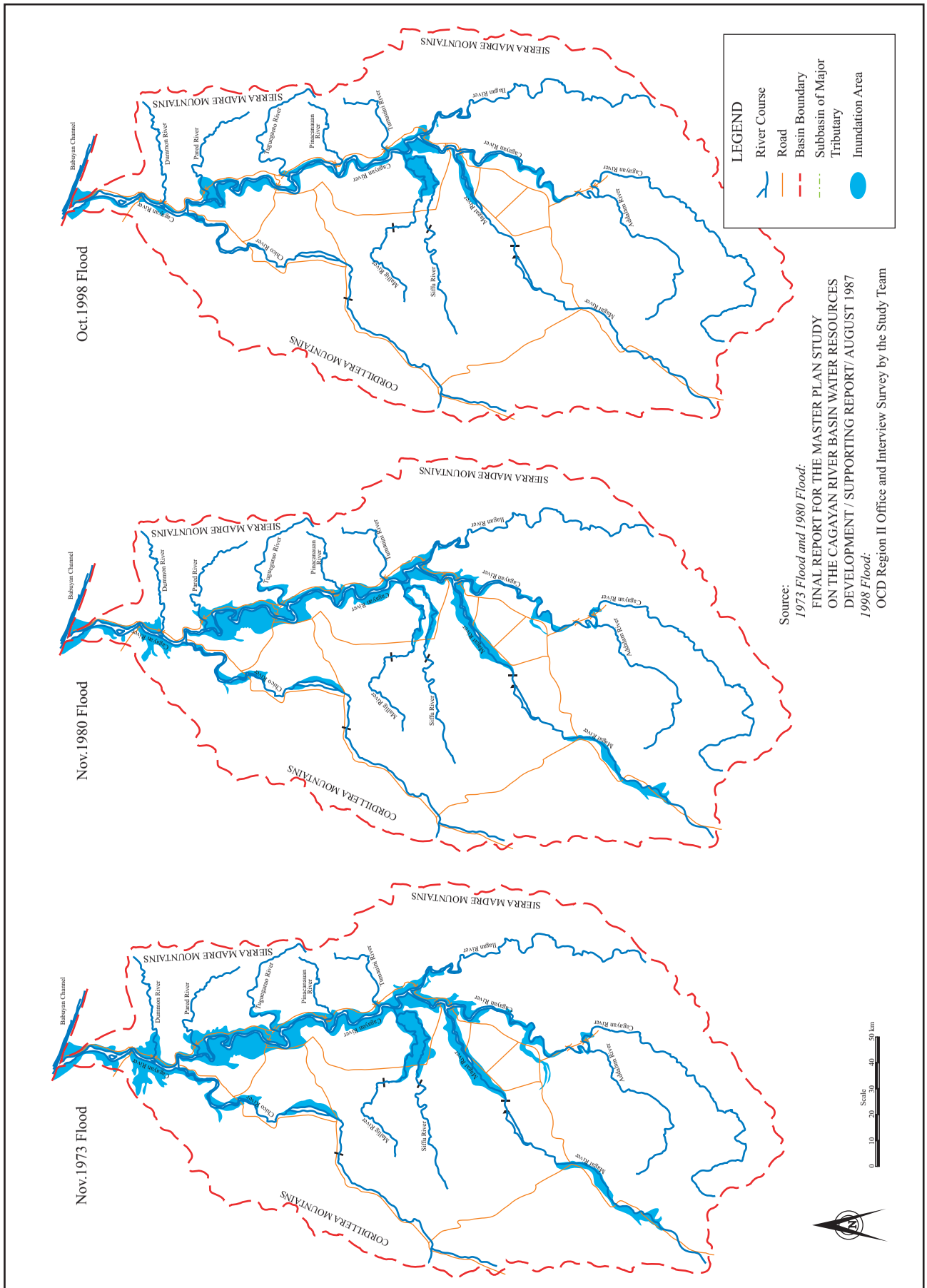
Note : N : National C : Communal P : Pump G : Gravity * : Rehabilitation

## Table 2 Disbursement Schedule for the Lower Cagayan Flood Control Project, Phase 1 (2002-2007) in 4 Phases (including AAWPIP stage 1)

US$ 1.0=Pesos 50.0 unit: Pesos millior

| | Cost items | Total | | | 2002 | 2002 | 2003 | 2003 | 2004 | 2004 | 2005 | 2005 | 2006 | 2006 | 2007 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC |
| **A** | **Flood Control Project** | | | | | | | | | | | | | | | |
| 1 | Direct Construction Cost w/VAT | 1,744.0 | 960.0 | 784.0 | 0.0 | 0.0 | 96.0 | 78.4 | 288.0 | 235.2 | 192.0 | 156.8 | 192.0 | 156.8 | 192.0 | 156.8 |
| | (disbursement rate %, assumed | | | | 0 | 0 | 10 | 10 | 30 | 30 | 20 | 20 | 20 | 20 | 20 | 20 |
| 2 | Land Acquisition and Compensation Cos | 376.0 | 153.0 | 223.0 | 0.0 | 89.2 | 0.0 | 66.9 | 0.0 | 26.8 | 153.0 | 0.0 | | | | |
| | including non-structural & supporting measure | | | | | | | | | | | | | | | |
| | (disbursement rate %, assumed | | | | 0 | 40 | 0 | 30 | 0 | 30 | | 0 | | | | |
| 3 | Administration Expense | 48.0 | 0.0 | 48.0 | 0.0 | 4.8 | 0.0 | 9.6 | 0.0 | 9.6 | 0.0 | 9.6 | 0.0 | 9.6 | 0.0 | 4.8 |
| | (disbursement rate %, assumed | | | | 0 | 10 | 0 | 20 | 0 | 20 | 0 | 20 | 0 | 20 | 0 | 10 |
| 4 | Engineering Services Expense | 192.0 | 154.0 | 38.0 | 30.8 | 7.6 | 30.8 | 7.6 | 15.4 | 3.8 | 30.8 | 7.6 | 30.8 | 7.6 | 15.4 | 3.8 |
| | (disbursement rate %, assumed | | | | 20 | 20 | 20 | 20 | 10 | 10 | 20 | 20 | 20 | 20 | 10 | 10 |
| 5 | Sub Total, 1+2+3+4 | 2,360.0 | 1,267.0 | 1,093.0 | 30.8 | 101.6 | 126.8 | 162.5 | 303.4 | 275.4 | 375.8 | 174.0 | 222.8 | 174.0 | 207.4 | 165.4 |
| 6 | Price Contingency | 219.6 | 75.8 | 143.8 | 0.0 | 0.0 | 2.5 | 8.1 | 12.1 | 27.5 | 22.5 | 26.1 | 17.8 | 37.4 | 20.7 | 44.7 |
| | (2 % for FC, 5 % for LC) | | | | 0.00 | 0.00 | 1.02 | 1.05 | 1.04 | 1.10 | 1.06 | 1.15 | 1.08 | 1.20 | 1.10 | 1.26 |
| 7 | Sub Total, 5+6 | 2,579.6 | 1,342.8 | 1,236.8 | 30.8 | 101.6 | 129.3 | 170.6 | 315.5 | 302.9 | 398.3 | 200.1 | 240.6 | 211.4 | 228.1 | 210.1 |
| 8 | Physical Contingency, 8 % | 206.4 | 107.4 | 98.9 | 2.5 | 8.1 | 10.3 | 13.7 | 25.2 | 24.2 | 31.9 | 16.0 | 19.2 | 16.9 | 18.3 | 16.8 |
| 9 | **Total, 7+8** | 2,786.0 | 1,450.2 | 1,335.8 | 33.3 | 109.7 | 139.7 | 184.3 | 340.8 | 327.1 | 430.2 | 216.1 | 259.9 | 228.3 | 246.4 | 226.9 |
| | | | | | | | | | | | | | | | | |
| **B** | **Irrigation Project** | | | | | | | | | | | | | | | |
| 1 | Direct Construction Cost w/VAT | 992.0 | 450.0 | 542.0 | 0.0 | 0.0 | 0.0 | 0.0 | 135.0 | 162.6 | 135.0 | 162.6 | 90.0 | 108.4 | 90.0 | 108.4 |
| | (disbursement rate %, assumed | | | | 0 | 0 | 0 | 0 | 30 | 30 | 30 | 30 | 20 | 20 | 20 | 20 |
| 2 | Land Acquisition and Compensatio | 230.0 | 126.0 | 104.0 | 0.0 | 31.2 | 0.0 | 20.8 | 0.0 | 6.2 | 50.4 | 10.4 | 37.8 | 10.4 | 37.8 | 10.4 |
| | Cost including supporting measure | | | | | | | | | | | | | | | |
| | (disbursement rate %, assumed | | | | 0 | 30 | 0 | 20 | 0 | 20 | 40 | 10 | 30.0 | 10.0 | 30.0 | 10 |
| 3 | Administration Expense | 26.8 | 0.0 | 26.8 | 0.0 | 2.7 | 0.0 | 5.4 | 0.0 | 5.4 | 0.0 | 5.4 | 0.0 | 5.4 | 0.0 | 2.7 |
| | (disbursement rate %, assumed | | | | 0 | 10 | 0 | 20 | 0 | 20 | 0 | 20 | 0 | 20 | 0 | 10 |
| 4 | Engineering Services Expense | 109.0 | 87.0 | 22.0 | 17.4 | 4.4 | 17.4 | 4.4 | 8.7 | 2.2 | 17.4 | 4.4 | 17.4 | 4.4 | 8.7 | 2.2 |
| | (disbursement rate %, assumed | | | | 20 | 20 | 20 | 20 | 10 | 10 | 20 | 20 | 20 | 20 | 10 | 10 |
| 5 | Sub Total, 1+2+3+4 | 1,357.8 | 663.0 | 694.8 | 17.4 | 38.3 | 17.4 | 30.6 | 143.7 | 176.4 | 202.8 | 182.8 | 145.2 | 128.6 | 136.5 | 123.7 |
| 6 | Price Contingency | 148.0 | 43.5 | 104.4 | 0.0 | 0.0 | 0.3 | 1.5 | 5.7 | 17.6 | 12.2 | 27.4 | 11.6 | 25.7 | 13.7 | 32.2 |
| | (2 % for FC, 5 % for LC) | | | | 0.00 | 0.00 | 1.02 | 1.05 | 1.04 | 1.10 | 1.06 | 1.15 | 1.08 | 1.20 | 1.10 | 1.26 |
| 7 | Sub Total, 5+6 | 1,505.8 | 706.5 | 799.2 | 17.4 | 38.3 | 17.7 | 32.1 | 149.4 | 194.0 | 215.0 | 210.2 | 156.8 | 154.3 | 150.2 | 155.8 |
| 8 | Physical Contingency, 8 % | 120.5 | 56.5 | 63.9 | 1.4 | 3.1 | 1.4 | 2.6 | 12.0 | 15.5 | 17.2 | 16.8 | 12.5 | 12.3 | 12.0 | 12.5 |
| 9 | **Total, 7+8** | 1,626.2 | 763.1 | 863.2 | 18.8 | 41.3 | 19.2 | 34.7 | 161.4 | 209.6 | 232.2 | 227.0 | 169.4 | 166.6 | 162.2 | 168.3 |
| | **Grand Total A+B** | 4,412.2 | 2,213.3 | 2,198.9 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

# *Figures*




*The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines*

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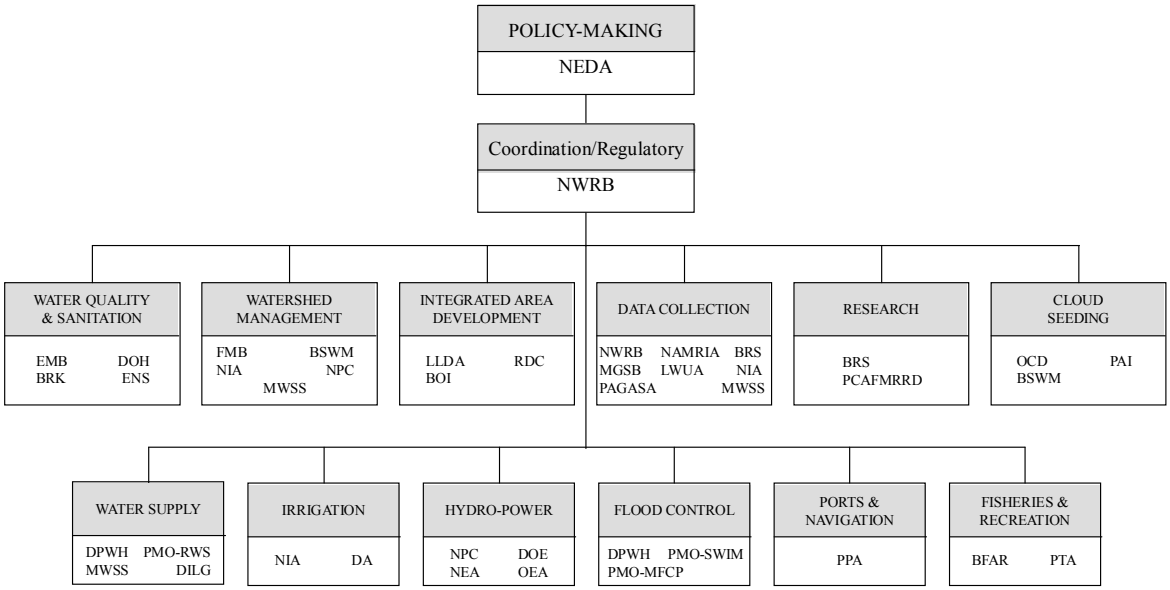
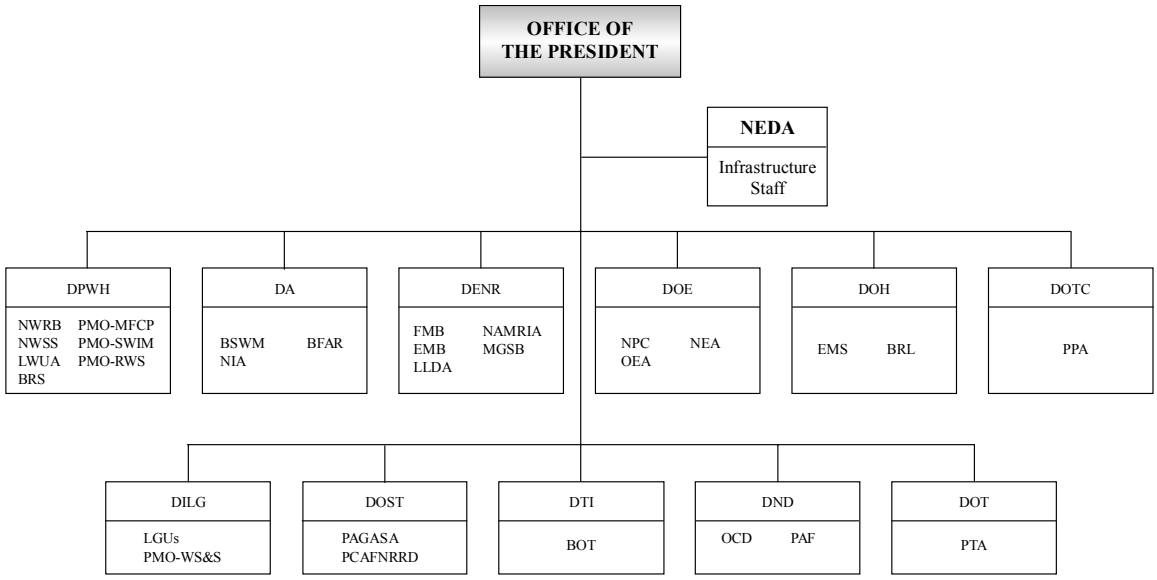
**Figure 1**
**Inundation Areas of Recorded Major Floods**

## 1 Functional Relationship for Water Related Works




## 2 Organizational Relationship for Water Related Works




*The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines*

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**Figure 2**
**Functional and Organizational Relationships among Water Related Works**

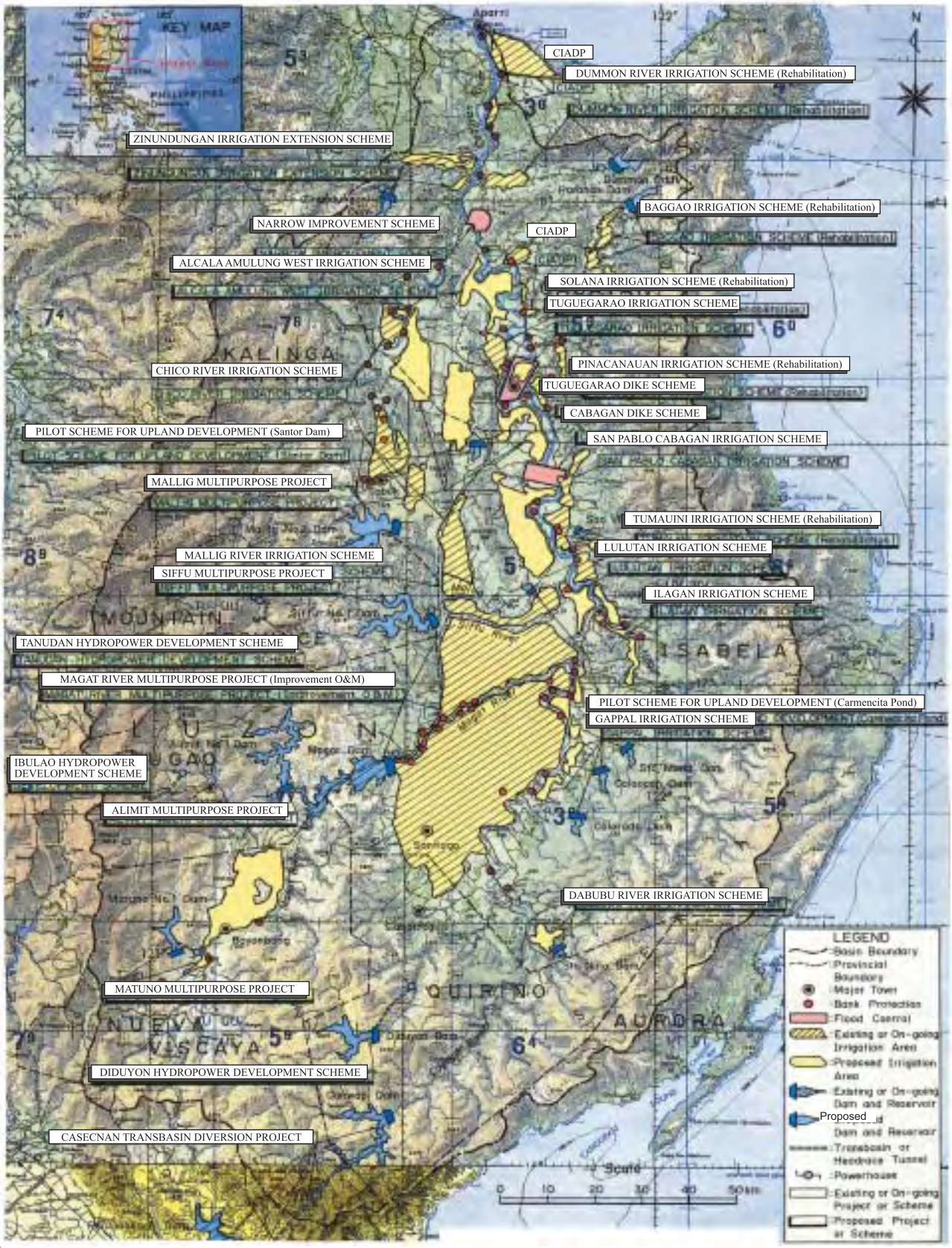


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**Figure 3**
**Project Location for 1987 Master Plan**

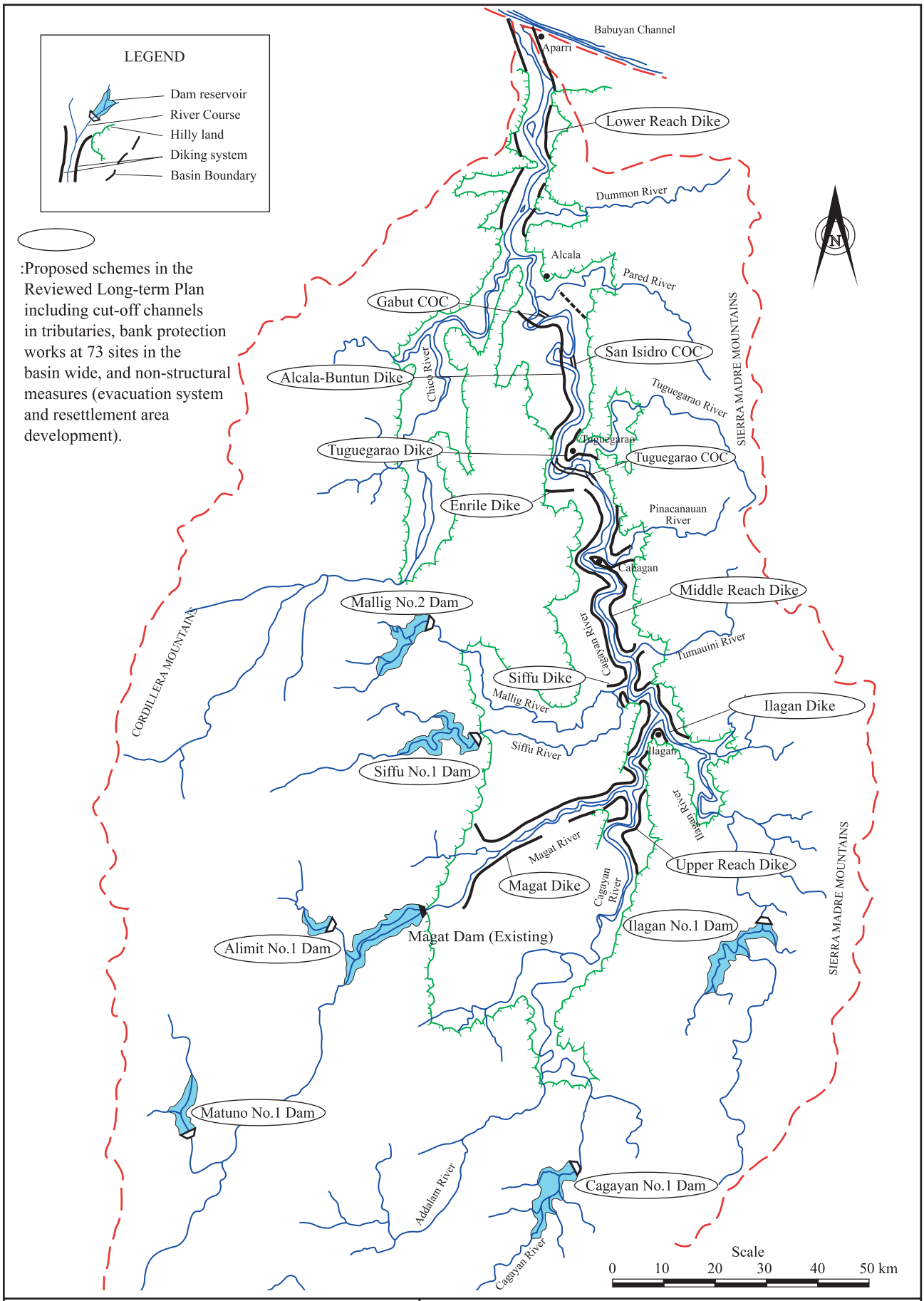


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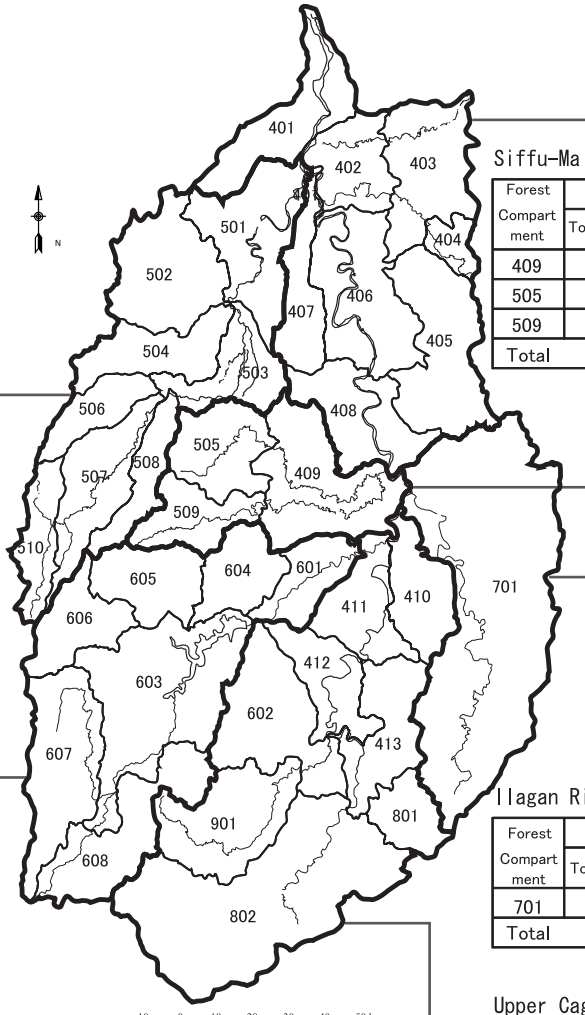
**Figure 4**
**Long Term Plan of Flood Control in the Cagayan River Basin**

Chico River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 501 | 884 | 504 | 437 | 274 | 27 | 203 |
| 502 | 917 | 881 | 881 | 854 | 0 | 28 |
| 503 | 509 | 270 | 231 | 163 | 27 | 80 |
| 504 | 580 | 551 | 540 | 528 | 0 | 23 |
| 506 | 372 | 372 | 342 | 338 | 0 | 33 |
| 507 | 676 | 608 | 522 | 507 | 2 | 99 |
| 508 | 368 | 357 | 353 | 353 | 0 | 4 |
| 510 | 379 | 345 | 232 | 231 | 0 | 114 |
| Total | | | | | | 584 |

Lower Cagayan River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 401 | 752 | 263 | 400 | 241 | 19 | 4 |
| 402 | 527 | 158 | 295 | 121 | 0 | 37 |
| 403 | 851 | 545 | 567 | 408 | 41 | 95 |
| 404 | 165 | 154 | 155 | 154 | 0 | 0 |
| 405 | 997 | 847 | 770 | 749 | 0 | 100 |
| 406 | 1,004 | 261 | 213 | 50 | 2 | 208 |
| 407 | 461 | 148 | 97 | 5 | 5 | 138 |
| 408 | 705 | 71 | 115 | 21 | 0 | 49 |
| Total | | | | | | 632 |




Siffu-Mallig River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 409 | 1,027 | 236 | 191 | 21 | 6 | 210 |
| 505 | 574 | 402 | 424 | 327 | 0 | 75 |
| 509 | 450 | 405 | 371 | 346 | 5 | 53 |
| Total | | | | | | 338 |

Ilagan River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 701 | 3,249 | 2,501 | 2,596 | 2,371 | 112 | 18 |
| Total | | | | | | 18 |

Magat River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 601 | 418 | 4 | 85 | 0 | 0 | 4 |
| 603 | 1,487 | 997 | 600 | 444 | 23 | 528 |
| 604 | 455 | 268 | 122 | 77 | 0 | 191 |
| 605 | 537 | 494 | 370 | 356 | 0 | 138 |
| 606 | 499 | 439 | 454 | 429 | 0 | 10 |
| 607 | 899 | 845 | 691 | 683 | 15 | 147 |
| 608 | 857 | 668 | 575 | 454 | 7 | 207 |
| Total | | | | | | 1,226 |

Upper Cagayan River Basin

| Forest Compartment | Land (km²) | | Present Forest (km²) | | Agricultural Land over 18% in Slope | Proposed Reforestation Area |
|---|---|---|---|---|---|---|
| | Total Area | Area over 18% | Total Area | Area over 18% | | |
| 410 | 526 | 184 | 197 | 32 | 4 | 148 |
| 411 | 550 | 0 | 154 | 0 | 0 | 0 |
| 412 | 511 | 0 | 137 | 0 | 0 | 0 |
| 413 | 638 | 191 | 444 | 166 | 0 | 26 |
| 602 | 963 | 250 | 484 | 164 | 51 | 36 |
| 801 | 327 | 324 | 325 | 324 | 0 | 0 |
| 802 | 2,310 | 2,033 | 2,174 | 1,901 | 1 | 130 |
| 901 | 860 | 731 | 796 | 678 | 0 | 52 |
| Total | | | | | | 392 |

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**Figure 5**
**Long Term Plan of Reforestation in the Cagayan River Basin**

**Figure 6**
**Long Term Plan of Land Use in the Cagayan River Basin**




Source: Present condition and SAFDZ=SAFDZ data 1999 BSWM

Note: Presented area is for the long term and reviewed master plan, except pasture and agro-forestry, where figure of long term plan is in the frame and that of the reviewed master plan is in the parenthesis.

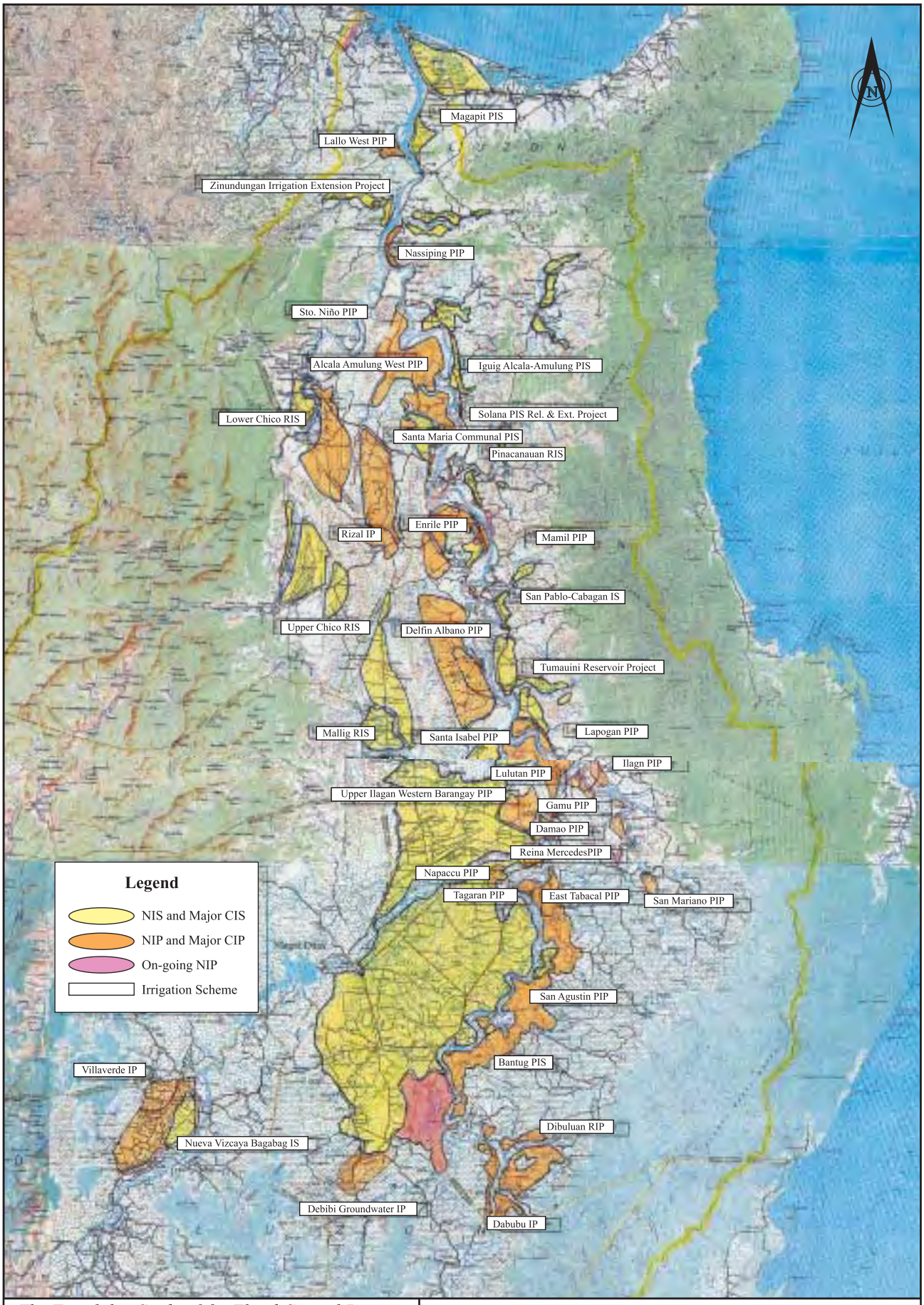


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**Figure 7 Long Term Plan of Irrigation Development in the Cagayan River Basin**

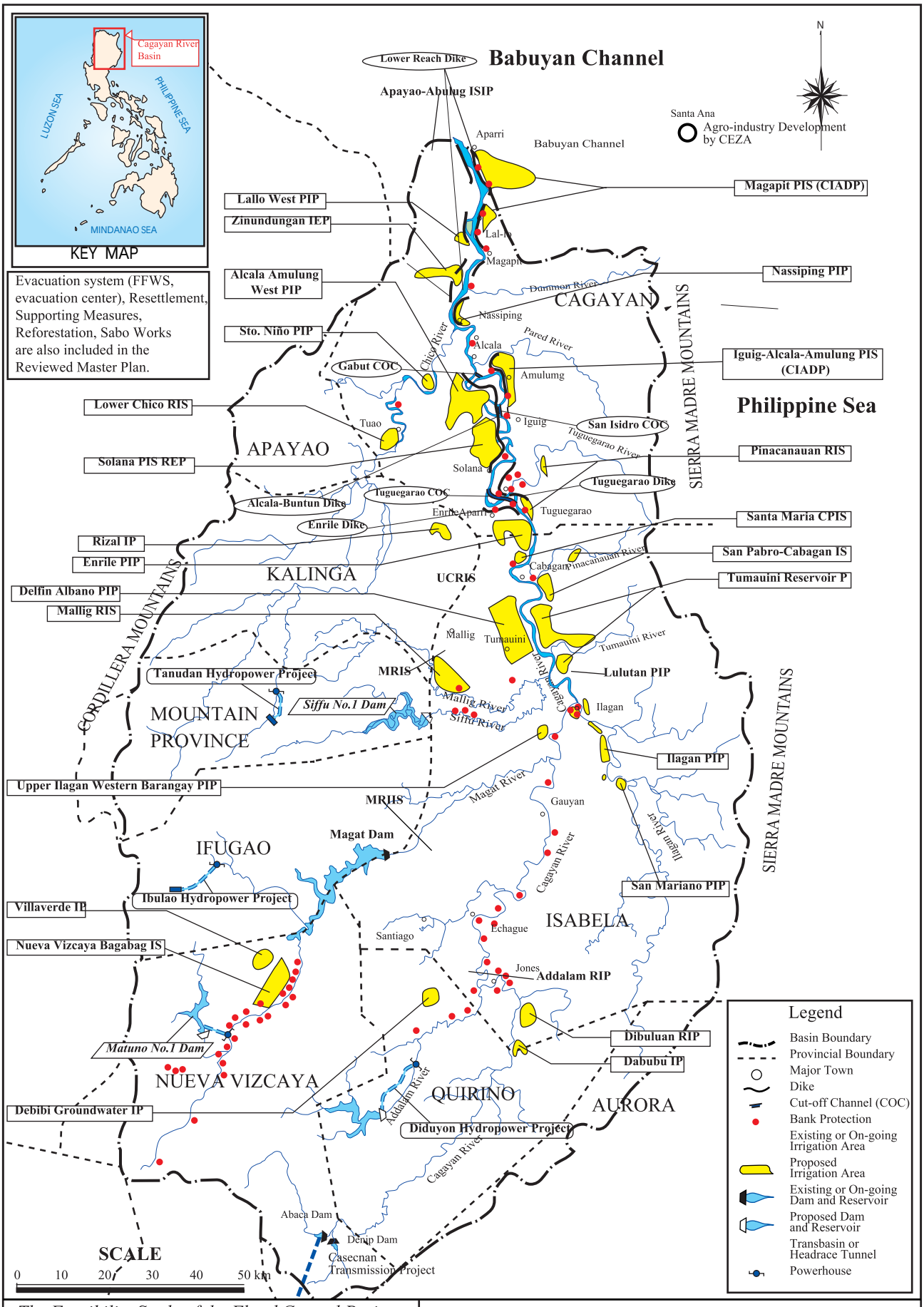


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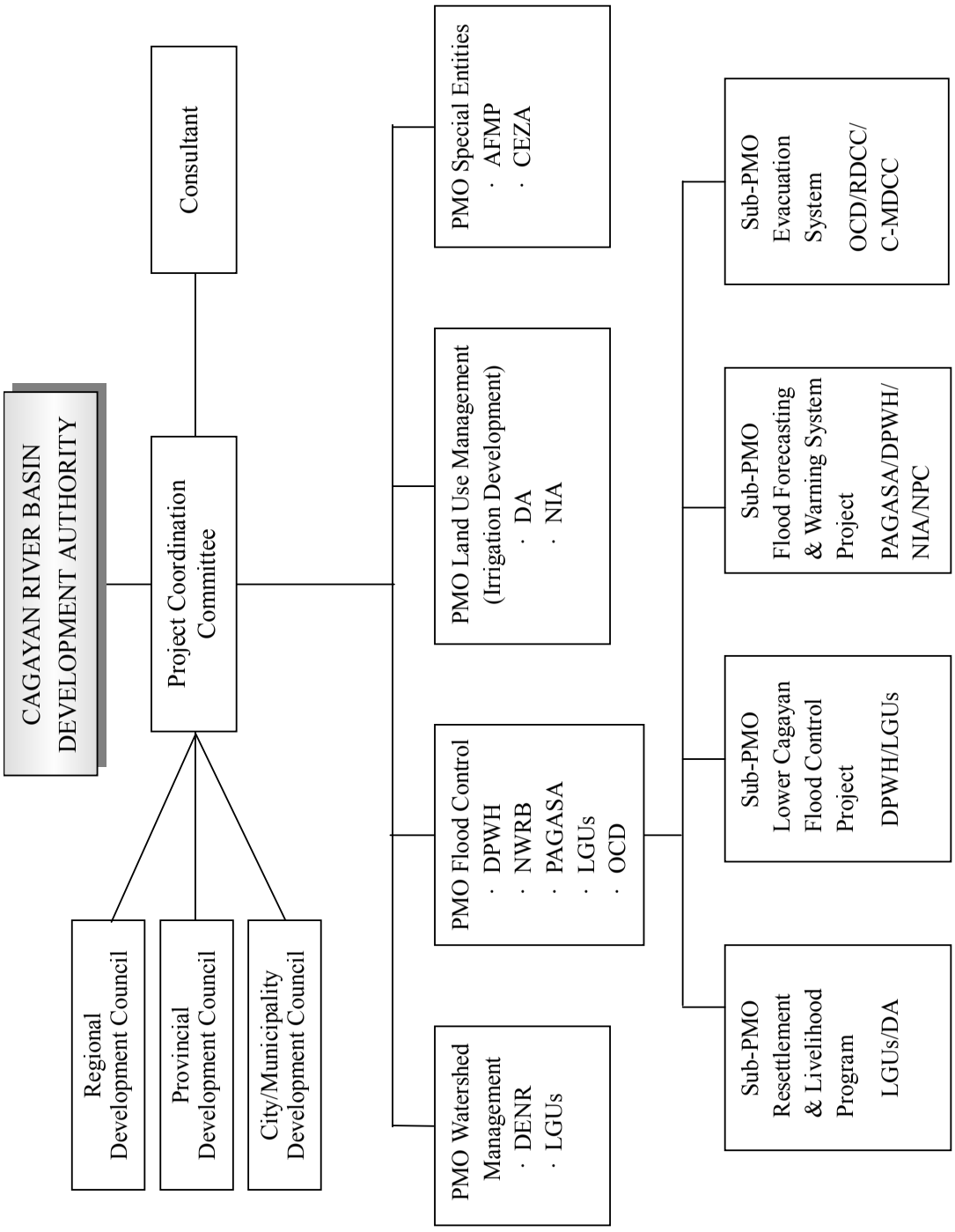
**Figure 8**
**Project Location for Reviewed Master Plan**

Notes: indicates projects to be implemented under the investment amount of Pesos 30 billion by the target year 2020.

**Figure 9**
**Implementation Schedule for Reviewed Master Plan**




*The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines*

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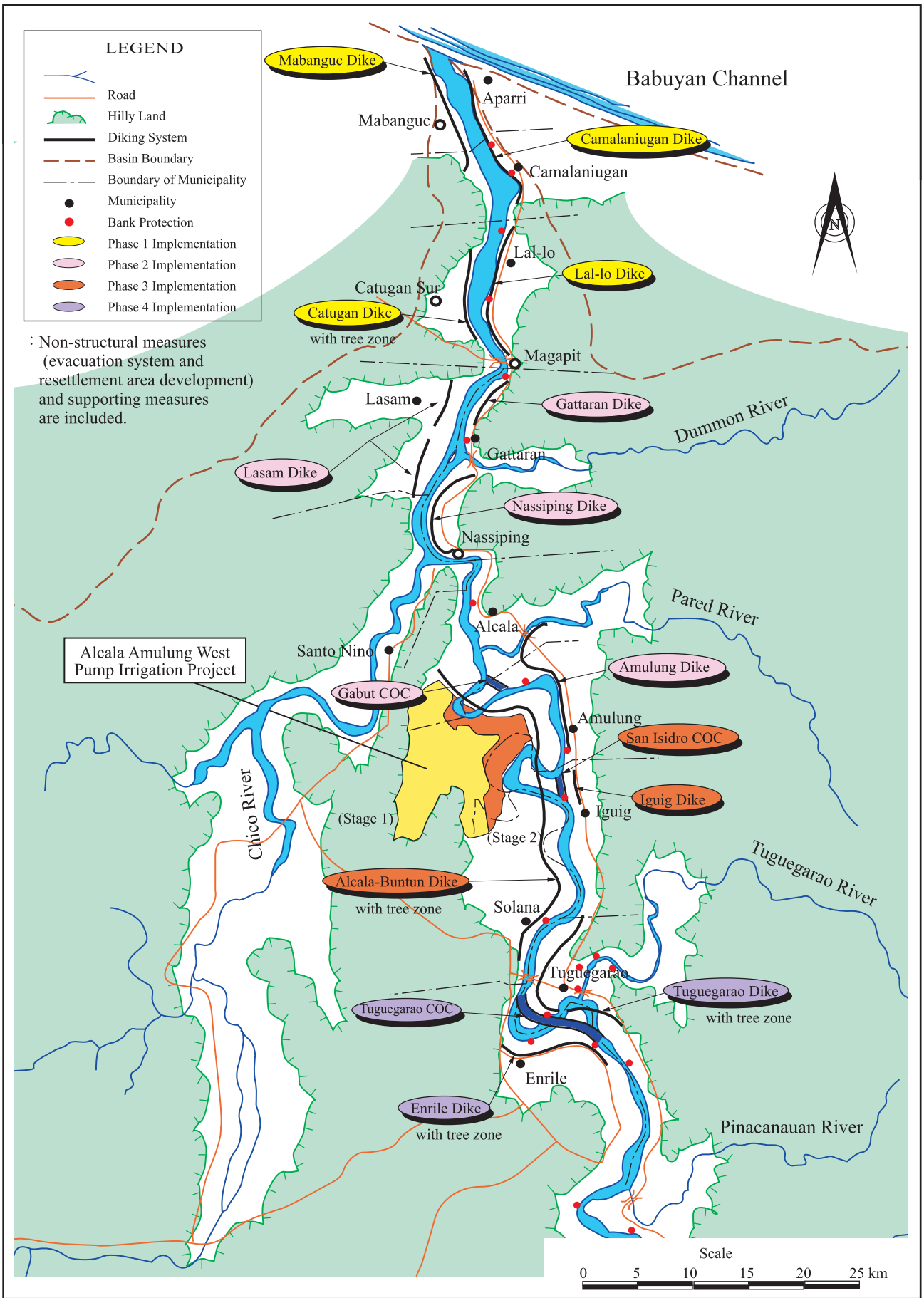
**Figure 10**
**Organization Chart of Cagayan River Basin Development**




*The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines*

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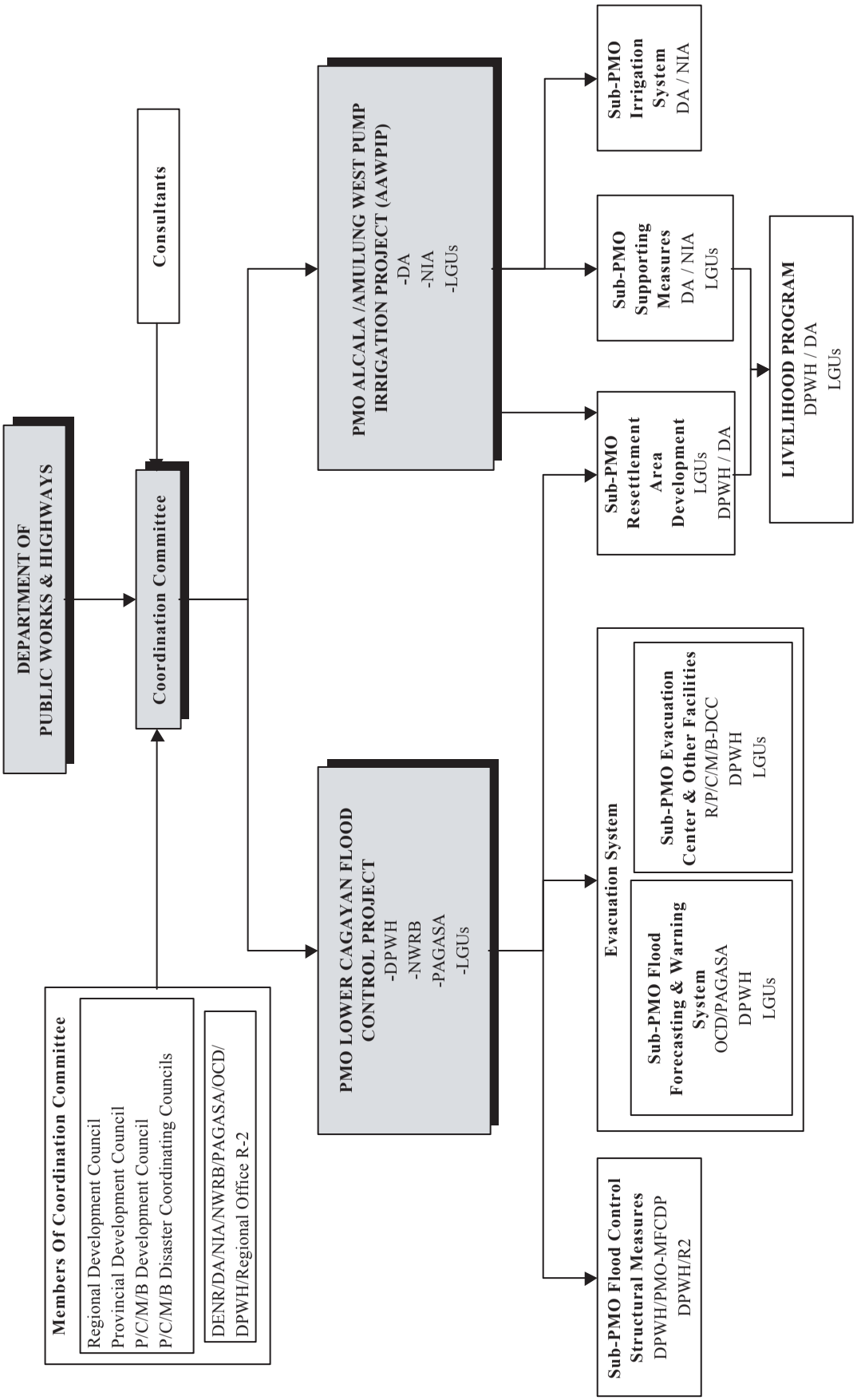
**Figure 11**
**Location of Projects for the Feasibility Study**

**Figure 12 Implementation Schedule for Phase 1 of Lower Cagayan Flood Control Project and Alcala-Amulung West Pump Irrigation Project**

| | Descriptions | Unit | Q`ty | 1 2002 | 2 2003 | 3 2004 | 4 2005 | 5 2006 | 6 2007 |
|---|---|---|---|---|---|---|---|---|---|
| A | Flood Control Projects | | | | | | | | |
| | 1 Feasibility Study | LS | 1 | | | | | | |
| | 2 Financial Arrangement | LS | 1 | | | | | | |
| | 3 Selection of Consultant | LS | 1 | | | | | | |
| | 4 Tender Design | LS | 1 | | | | | | |
| | 5 Tendering Procedures | LS | 1 | | | | | | |
| | 6 Development of Resettlement Area and Resettlement | LS | 1 | | | | | | |
| | 7 Land Acquisition and Compensation | LS | 1 | | | | | | |
| | 8 Construction Supervision | LS | 1 | | | | | | |
| | 9 Construction, Structural Measures | | | | | | | | |
| | 1) Urgent bank protection works | site | 21 | | | | | | |
| | 2) River bank tree zones | km | 70 | | | | | | |
| | 3) Left dike systems, river mouth to Magapit | km | 17.3 | | | | | | |
| | 4) Right dike systems, river mouth to Magapit | km | 26.0 | | | | | | |
| | 10 Related Non-structural & Supporting Measures | LS | 1 | | | | | | |
| | | | | | | | | | |
| B | Irrigation Project (AAWPIP stage 1) | | | | | | | | |
| | 1 Review of Feasibility Study | LS | 1 | | | | | | |
| | 2 Financial Arrangement | LS | 1 | | | | | | |
| | 3 Selection of Consultant | LS | 1 | | | | | | |
| | 4 Tender Design | LS | 1 | | | | | | |
| | 5 Tendering Procedures | LS | 1 | | | | | | |
| | 6 Development of Resettlement Area and Resettlement | LS | 1 | | | | | | |
| | 7 Land Acquisition and Compensation | LS | 1 | | | | | | |
| | 8 Construction Supervision | LS | 1 | | | | | | |
| | 9 Construction, Structural Measures | | | | | | | | |
| | 1) AAWPIP, stage 1 | ha | 4,090 | | | | | | |
| | 10 Related Supporting Measures | LS | 1 | | | | | | |
| | | | | | | | | | |




*The Feasibility Study of the Flood Control Project for the Lower Cagayan River in the Republic of the Philippines*

JAPAN INTERNATIONAL COOPERATION AGENCY

**Figure 13**
**Organization for Implementation of Projects for the Feasibility Study**