H8 Water Resources Development Plans for Municipal Water Supply to Major Cities

H8.1 Metro Manila, Metro Cebu and Davao City

H8.1.1 Shortage of Municipal and Industrial Water in Metro Manila, Metro Cebu and Davao City

It was envisaged in the early stage of this study that the shortage of municipal and industrial water would become serious in the future at the three major cities in the Philippines, namely Metro Manila, Metro Cebu and Davao city.

The municipal and industrial water demand projection including examination on the availability of groundwater resources has clarified that the greater parts of the municipal and industrial water supply at the said three cities would have to depend on the surface water in order to meet the future water demand as shown below:

Future Water Demand and That to be Covered by Surface Water in Metro Manila, Metro Cebu and Davao City

Major City/Item		1995	2000	2005	2010	2015	2020	2025
Metro Manila								
Total water demand	(MCM/year)	1,068	1,351	1,596	1,928	2,262	2,468	2,883
Groundwater	(MCM/year)	103	102	121	182	263	388	579
Surface water	(MCM/year)	964	1,249	1,475	1,746	1,998	2,079	2,304
	(10^3 m^3/day)	2,641	3,422	4,041	4,784	5,474	5,696	6,313
	(m^3/sec)	30.6	39.6	46.8	55.4	63.4	65.9	73.1
Metro Cebu								
Total water demand	(MCM/year)	59	77	115	175	222	279	342
Groundwater	(MCM/year)	46	58	63	64	68	73	82
Surface water	(MCM/year)	-	19	53	111	155	205	261
	(10^3 m^3/day)	-	52	144	304	424	562	714
	(m^3/sec)	-	0.6	1.7	3.5	4.9	6.5	8.3
Davao City								
Total water demand	(MCM/year)	48	54	58	73	90	114	146
Groundwater	(MCM/year)	48	-	-	-	6	30	62
Surface water	(MCM/year)	-	54	58	73	84	84	84
	(10^3 m^3/day)	-	148	159	200	230	230	230
	(m^3/sec)	-	1.7	1.8	2.3	2.7	2.7	2.7

H8.1.2 Surface Water Sources for Metro Manila

In the service area of MWSS, the present groundwater production has exceeded the exploitable ground amount so that the saline water intrusion into groundwater tables is taking place, especially in some areas such as Cavite, Rizal and Pasig.

A large part of municipal and industrial water consumed in the Metro Manila district is now supplied from the surface water resources, mainly from the Angat dam/reservoir. Its amount has reached to 30 m^3/sec. It is estimated that, according to the previous study results, the maximum water supply capacity of the Angat dam/reservoir to Metro Manila would be about 35 m^3/sec. Hence, the water demand of Metro Manila would exceed the supply capacity of the Angat dam/reservoir before the year 2000 although even now the habitual interruption of water supply has taken place in the urban area due to the extraordinary lowering of water level of the Angat reservoir. At present, the Umiray-Angat Transbasin project, which is to divert the streamflow of the Umiray river into the Angat reservoir, is under construction with finance of ADB. The project will be completed in 1999/2000. The project will develop additional water of about 12 m^3/sec for municipal water supply to Metro Manila. The Angat dam and reservoir together with the Umiray Angat Transbasin project could meet the water demand of Metro Manila up to the year 2005.

The total municipal and industrial water demand in the Metro Manila district, which is to be supplied from the surface water, is estimated to reach about 73 m^3/sec in 2025. Thus it is needed to newly develop the surface water resources of about 26 m^3/sec in the vicinity of Metro Manila in succession to the Umiray Angat Transbasin project.

The Manila Water Supply III Project was studied and formulated in 1979 in the course of the re-study of the Marikina River Project. The report identified and pre-qualified several alternative development schemes in the vicinity of Metro Manila as listed below:

(i) Marikina river basin (Wawa dam)
(ii) Kaliwa river basin (Laiban dam)
(iii) Kanan river basin (Kanan dam)
(iv) Umiray river basin (Umiray-Angat Transbasin, now under construction as aforesaid)
(v) Pampanga river basin (Ring dike around Candaba swamp)
(vi) Laguna de Bay
(vii) Others

The report recommended that the Laiban rockfill dam on the Kaliwa river be developed as the source of water supply for Metro Manila prior to the Umiray-Angat Transbasin project. The Kaliwa scheme, involves the Laiban rockfill dam with a height of 143 m. In the reservoir area, however, limestone formation is dominant. Thus, the Laiban dam seems to have the geological problem, although the technical viability needs to be verified through the detailed geological investigation. The location of the Laiban dam is schematically shown in Figure H-67 together with the existing and proposed water supply facilities for Metro Manila.

The report also suggested that the Kanan Dam should be developed as the second stage to the Kaliwa scheme and to be linked to the Laiban reservoir. However, since the Umiray-Angat Transbasin project has already been implemented, it is considered to be a promising alternative plan that the water exploited by the Kanan dam be diverted to the Angat reservoir through the Umiray river basin. Since the Umiray transbasin tunnel has a capacity to discharge about 30 m^3/sec, it is anticipated that about 18 m^3/sec could be augmented for water supply to Metro Manila through provision of the Kanan dam. Otherwise, the water released from the Kanan dam is planned to be conveyed to Metro Manila through a small concrete weir to be constructed on the Kaliwa river instead of the Laiban dam.

In the WRDP, four (4) dam schemes were identified on the small tributaries of the Pampanga river as shown in Figure H-68. Their sites are all located on the western hilly region of the watershed of the Angat dam. Out of the four small dams, two dams are recommended to be promising ones as a result of the prefeasibility study thereon in the WRDP. These two dams aim to supply irrigation water to Angat Maasim Rivers Irrigation System (AMRIS) in order to reallocate the water of the Angat reservoir to Metro Manila. The amount of available water from these dams is preliminarily estimated at about 5 m^3/sec. When these dams are realized, it is estimated that a mean discharge of about 5 m^3/sec can be additionally reallocated to municipal water supply for metro Manila out of the total discharge released from the Angat reservoir.

Further, it is conceivable to tap the discharge of the Pampanga river after the Casecnan Transbasin project be realized. The Casecnan Transbasin project was formulated to enhance the water supply capacity of the existing Pantabangan dam and reservoir by diverting the discharge of about 35 m^3/sec from the Cagayan river basin.

From the aforesaid examination, the following projects are taken up as the promising water supply projects to meet the future water demand in Metro Manila:

(i) Construction of two small dams in the tributary basins adjacent to the Angat basin, namely Massim dam and Bayabas dam, which are formulated through the previous WRDP study at a level of prefeasibility. The project is referred to as "the Massim and Bayabas Dam Project" in this study by combining these two dams into one project.
(ii) The Kanan-Umiray Transbasin Project (KUTP)
(iii) The Kanan-Cogeo Water Supply Project
(iv) The Pampanga Water Conveyance Project (PWCP)

Out of the aforesaid four water supply projects, the latter three (3) water supply projects are newly contemplated through the present master plan study.

In the latter part of the second stage home office work, on the other hand, it is informed that MWSS is planning to develop the Laguna Lake for municipal water supply to Metro Manila, although it was cancelled in the "Study on Water Supply and Sewerage Master Plan of Metro Manila, February 1996" because of the water quality problem. This Study takes up the two different development plans, namely the latest MWSS's development plan and the one formulated in the said JICA's master plan, as the development scenario-1 as illustrated in Figure H-69. The latest MWSS's development plan is tabulated below:

Latest MWSS's Development Plan of Water Supply Projects after Umilat-Angat Transbasin Project

Name of Project	Discharge to be Conveyed	
	(m3/sec)	(mld)
- Rizal Province Water Supply Project(RPWSP)*	0.56	48
- Laguna Lake – BOT*	3.47	300
- MWSP III (Laiban Dam)	21.0	1,900
- Kanan-Kaliwa Transbain Project	38.0	3,283

Note : * ; The water conveyed to the service area of MWSS is planned to be tapped from Laguna Lake.

The three development scenarios are worked out by combining the four water supply projects to meet the water demand in the year 2025 through incorporation of the latest MWSS's development plan as well as the one formulated under the JICA's master plan as shown in Figures H-69 to H-71.

Out of the three development scenarios for water supply to Metro Manila, the Scenario-1 comprises the two development plans, namely the development plan formulated under the JICA's master plan study and the latest MWSS's development plan, as shown in Figure H-69. While, the other two development scenarios are established in combination of the above new four projects preliminarily formulated in this study. It is common to these three development scenarios that the Agos river basin inclusive of the Kaliwa and Kanan tributaries of the Agos river is planned to be developed after the completion of the Angat-Umiray transbasin project.

H8.1.3 Surface Water Source for Metro Cebu

As clarified in the foregoing Subsection H7.1.1, municipal and industrial water consumed in the Metro Cebu district is now almost all supplied from the groundwater sources. Its amount is about 1.7 m^3/sec. Although there is one surface water resource developed, namely Buhisan dam, its supply capacity is as negligible small as 0.05 m^3/s or 4,000 m^3/day. Exploitation of the groundwater in Metro Cebu district has been already beyond its limit.

The Mananga project phase I is now under construction on the Mananga river. The project aims to pump up the river-bed water in the aquifer through 15 deep wells. The project comprises a 7.5 m high underground dam, infiltration fields in the upstream river bed of the dam and 15 deep wells. A catchment area at the dam site is 80 km^2. According to the original development plan, water supply capacity of the project is estimated at 33,000 m^3/day or 0.38 m^3/sec. Supply capacity of the Mananga project phase I could meet the water demand by around the year 2000. Water demand of the district depending on the surface water will sharply increase after 2000.

For the time being, the Metro Cebu Water District (MWCD) is planning to develop the aforesaid water supply projects and desalination plants as listed below:

i) Mananga Phase II dam
ii) Lusaran Dam
iii) Bohol-Cebu Water Supply Project
iv) Installation of Desalination Plants

In the field investigation, a group of small dams on the southeastern hilly region along the watershed of the Mananga and Cotcot river basins were formulated at a map study level. However, the total supply capacity of the small dams is roughly estimated at 80,000 m^3/day or 0.9 m^3/sec as shown in Table H-28. It appears that they are not so attractive schemes in consideration of their small water supply capacities.

In order to meet the water demand after the year 2000, several schemes with supply capacity of more than 100,000 m^3/day or 1.2 m^3/sec each are needed to be developed. There are three prospective candidates for the purpose:

- Mananga Phase II dam
- Lusaran Dam
- Heightening of existing Malubog dam

The Mananga phase II project is contemplated to be developed at a location of about 4 km upstream of the weir site of the Mananga project phase I on the Mananga river. The main component of the project is 90 m high roller compacted concrete gravity type dam. However, a catchment area at the dam site is as small as 68 km^2 in comparison with the large-scale dam. The WRC of the University of San Carlos installed several rain gages in and around the Mananga and Lusaran river basins in 1977. The hydrological analysis for the project was performed utilizing these records. According to the analysis results, the mean annual basin rainfall of project area is 1,770 mm and the annual mean river discharge at the dam site was estimated at 1.40 m^3/sec. The mean annual discharge is equivalent to the specific discharge of 2.06 m^3/sec/100 km^2, corresponding to a runoff coefficient of 36%. The sedimentation rate of 3,700 m^3/km^2/year was adopted for the Mananga Phase II reservoir with reference to the sediment measurement performed for the existing Malubog dam and reservoir located adjacent thereto. However, the dead storage capacity of the reservoir is only 7.4 million m^3, which corresponds to the sediment transport volume for about 30 years, assuming tentatively the horizontal deposition of sediment in the reservoir and a trap efficiency of 100%. The total water supply capacity of the Mananga Phase I and II projects are evaluated to be 123,000 m^3/day or 1.42 m^3/sec.

The Lusaran dam has been studied and proposed for further augmentation of water supply to the Metro Cebu. The initial study on the dam project was carried out in 1997, before the installation of rain gages in the basin. The updating of the hydrological analysis of the scheme

needs to be performed in the future. The dam is planned to be of rockfill type dam with a height of 100 m. A catchment area at the dam site is 67 km^2. According to the rainfall record in the basin, the mean annual rainfall is 1,400 mm to 1,500 mm, which is slightly smaller than that of the Mananga basin. According to the principal features of the current study report, the mean annual runoff is 2.05 m^3/sec which is equivalent to 3.06 m^3/sec/100 km^2. The water supply capacity of the Lusaran dam is estimated at 160,000 m^3/day or 1.85 m^3/sec.

The Malubog dam is a privately owned dam located on the Sapan Daku river. At present, the dam is being operated by the mining company, Atlas Consolidated Mining & Development Corporation, for its own use. The dam is of concrete gravity type with a height of 32 m. It covers a catchment area of 69 km^2. The Study Team got the information during the field reconnaissance that the mining company has an intention to supply municipal and industrial water to the Metro Cebu through MCWD in case the dam be heightened with a fund of MCWD. Since the catchment area of Malubog dam is almost same with that of the Mananga phase II dam, it appears that the dam heightening plan is one of the promising water resources development plans to augment the water supply to the Metro Cebu. But there are some problems to heighten the existing Malubog dam, that is, the left abutment ridge of the dam is not so massive and the geological formation of the ridge is the Cebu Formation consisting of limestone. Even if the problems were resolved, possible height of the dam would be more or less 60 m. About 100,000 m^3/day or 1.16 m^3/sec would be expected from the heightening of the existing Malubog dam. Besides, it is needed to clarify the water quality of the Sapan Daku river, since the river water might be adversely affected by the mining activities.

Even though the above three projects would be realized, the total water supply capacity would be 383,000 m3/day or 4.43 m3/sec. The water supply capacity would meet the water demand by the year 2015.

In addition to the aforesaid schemes, the Bohol-Cebu water supply project has been proposed. According to the original plan, about 130,000 m^3/day or 1.5 m^3/sec would be diverted from the Inabanga/Waig river basin on the Bohol island without any dam construction. There is one favorable dam site on the Inabanga/Waig river. That is the Tipolo dam, which is listed up in the Survey/Inventory on Water Impounding Reservoirs. A catchment area at the Tipolo dam site is about 500 km^2 and annual basin rainfall is approximated to be around 1,400 mm. Thus, the annual mean runoff at the dam site is roughly estimated at about 8.9 m^3/sec. Though the geological formations at the dam site and reservoir area are not clarified at present, construction of about 60 m high concrete gravity dam or rockfill dam would be possible from the topographic configurations based on 1 to 50,000 scaled topographic maps. The vast reservoir area would be realized in the upstream area. The location of the project is shown in Figure II-72. Within a reasonable range, an active storage capacity of about 120 million m^3 could be usable. Firm discharge of about 4 m^3/sec would be available. If this firm discharge could be conveyed to Metro Cebu, municipal and industrial water demand of the Metro Cebu district would be secured until the year 2025.

In case that the Bohol-Cebu water supply project will become impossible due to some reasons, the possible measure is to build the desalination plants along the coastal line of Metro Cebu. It is reported that the production cost of drinking water from saline water with the plants has lowered to about 1 to 2 US$/ m^3 at present through development of new technology.

From the aforesaid examination, the following water resources projects are taken up for the further study in order to meet the future water demand in Metro Cebu:

(i) Mananga Phase II Dam Project

(ii) Lusaran Dam Project
(iii) Heightening of existing Malubog Dam
(iv) Bohol-Cebu Water Supply Project including Tipolo Dam Project

It is considered that installation of the desalination plan is an alternative to other three surface water development projects. In addition to the above water supply projects, the master plan study contemplates the following ones as the alternatives of those projects:

v) Malubog-Mananga Transbasin Project (MMTP)
vi) Lusaran-Pulanbato Transbasin Project (LPTP)

The location and main features of the above water supply projects are discussed in Section D 7.2 "New Water Supply Projects for Metro Cebu" of Part-D of Supporting Report and their locations are illustrated in the corresponding figures in the Part-C. These transbasin projects aim at the augmentation of the originally proposed Mananga Phase II dam and Lusaran dam projects. The three (3) development scenarios are worked out by combining the aforesaid projects as shown in Figures H-73 to H-75. Out of those three development scenarios for the Metro Cebu water supply, the Scenario-1 shown in Figure H-73 is similar to that originally contemplated by the MWCD.

H8.1.4 Surface Water Source for Davao City

Municipal and industrial water of Davao city is now supplied from the groundwater sources. Main sources of the groundwater for the Davao city are the aquifer of the skirts of the Mt. Apo and Mt. Talomo, where more than 30 deep wells have been provided. Only small amount of surface water, 36 litters/sec, is now withdrawn from the Malagos creek, which is a small right tributary of the Davao river. Its intake site is located about 36 km distant from the city.

The Davao City Water District (DCWD) now intends to alter the water resources from groundwater to surface water owing to the fear of contamination of groundwater by pesticide used in the extensive banana and coconut plantations on the skirts of Mt. Talomo and along the Davao river. The sites proposed for the surface water sources are Talomo river and Tamugan river. The Talomo river originates from Mt. Talomo and running in parallel with the Davao river. The Tamugan river is a large right-side tributary of the Davao river. The intake site on the Tamugan river is far from the Davao city, more than 40 km apart. Both the Talomo and Tamugan rivers run on the steep slope of the skirts of Mt. Talomo. DCWD made up their minds to lay a long waterway for water supply to the city. The minimum discharge of the Davao river upstream of the confluence with the Tamugan river is estimated to be over the water demand of Davao city in 2025, which is estimated to be more or less 3 m^3/sec. The water supply project is going to be implemented in a form of BOT.

Main stream of the Davao river from the downstream of the junction of the Tamugan meanders on the plains, where the vast plantations are developed. The lower Davao river itself could not be the sources for the municipal and industrial water supply to the city.

Municipal and industrial water demand of Davao city is not so big, that is, more or less 3 m^3/sec in the year 2025 as aforesaid, though it is a serious problem for DCWD to secure it.

The Davao river is a big river and categorized into one of the major rivers of the Philippines. The Davao river should be developed not only for the water supply for Davao city, but for multi-purpose schemes including flood control, power generation, municipal water supply and irrigation water supply.

In the Davao river basin, on the other hand, there are some dam sites suitable for large dam construction. The Survey/Inventory on Water Impounding Reservoirs lists two dam schemes on the Davao river, namely Calinan #1 and #2, as shown in Figure H-76. In the Davao river basin, however, there are some other sites suitable for large dam construction. Although the geological conditions of the dam foundation and reservoir area should be scrutinized in the successive study stages, Davao I, II and IIIR (Calinan #2) dam schemes were formulated as shown in Table H-28. Out of the three dams, it is expected that the Davao II dam project is developed as a multi-purpose dam.

From the aforesaid consideration, the following two scenarios were contemplated in relation to municipal water supply to Davao city:

i) Water Supply Project in a form of BOT
ii) Development of Davao II Dam Project

The above two development scenarios are depicted in Figures H-77 and H-78.

H8.2 Other Major Cities Selected in Constraint of Water Supply and Demand Balance

H8.2.1 General

As mentioned above, the surface water development plans for municipal water supply to Metro Manila, Metro Cebu and Davao City were preliminarily examined.

In the second stage field investigation, a total of nine (9) major cities including the aforesaid three (3) cities are selected as the water-constraint cities which may require the urgent expansion of the water supply capacities. As a result, the following six (6) cities, were additionally selected as the major cities where the constraint in water supply and demand balance is likely to take place in the future and/or even at present:

i) Baguio City
ii) Zamboanga City
iii) Cagayan De Oro City
iv) Angeles City
v) Iloilo City
vi) Bacolod City

The above six major cities are additionally examined in this study with respect to the water supply and demand balance and necessity of new surface water development to meet the water demand until the year 2025.

In principle, the surface water resources development plans are examined and formulated for the cities where the water demand in the year 2025 is forecasted to exceed the exploitable groundwater amount in and around the city area. The new surface water development plans are worked out in the present study even in case that the exploitable groundwater amount is by far over the total demand in the year 2025, on the other hand, provided that the promising potentials of surface water resources are identified in the past study.

The water resources development plans for the selected 6 major cities are discussed in the succeeding Subsections.

II8.2.2 Baguio City

(1) Present Situation

Baguio city is located in the province of Benguet in the Cordillera Region, constituting the mountainous resort area situated north of Metro Manila. It is surrounded by the municipalities of the province. The Baguio Water District (BWD), that is a Government-owned corporation, is responsible for the municipal and industrial water supply to the people residing in its service area. The BWD has made the continuous efforts to expand the water supply capacity through implementation of water supply development programs. However, it has not been able to cope with the rapidly expanding population in the service area. It is reported that of the total 21,500 service connection about 80 % are provided with potable water only for four (4) hours thrice a week.

At present, population of Baguio city is projected to reach about 240 thousand people, increasing at an annual average rate of 4.4 %. Although the city and its surrounding areas suffered from severe damage in 1990 due to the large-scale earthquake, which hit the northern part of the Philippines, the rehabilitation program has been steadily progressed up to date. As a result, it is said that the present number of tourists has restored to the original level recorded before the occurrence of the earthquake. However, some of existing water supply facilities damaged by the earthquake have been left as they were. Based on the present situation of the tourism, it is foreseen that the water demand in the city would increase steadily from now on with the tourism, commercial and industrial development. Therefore, it is considered necessary to formulate the long-term water resources rehabilitation and development plan to cope with the future water demand in Baguio City.

Since no detailed data required to design dams and other facilities were available, the new surface water development plans to meet the future water demand was preliminarily worked out primarily based on the 1 to 50,000 scaled topographic maps.

(2) Existing Rehabilitation and Development Plans of Surface Water Resources

In connection with municipal and industrial water supply to Baguio City, a lot of studies were carried out so far. Out of the water supply projects formulated through those studies, the following rehabilitation and development plans are on-going or intended to be implemented at earlier stage by the BWD in order to increase the water supply capacity for Baguio City:

i) Rehabilitation and expansion of existing water supply facilities including Stage I, Amliang and KM8 reservoir as well as St. Thomas rain basin
ii) Australian Aid Project including rehabilitation of distribution network in the city
iii) Bulk Water Supply Project in a form of BOT

In addition to the on-going and urgent projects above-mentioned, the following water resources development plans were formulated in relation to the municipal and industrial water supply to Baguio City:

iv) Wangal Dam Project
v) Water Conveyance Project from existing Ambuklao Reservoir

The aforesaid projects were explained hereunder and their locations are illustrated in the respective Figures in the Par-D of the Supporting Report.

(3) Rehabilitation and Expansion of Existing Water Supply Facilities

The damaged water supply facilities have hampered the operation of the water supply

facilities owned by BWD and brought about the present serious situation. The BWD has a strong intention to rehabilitate existing water supply facilities in order to improve the present water supply condition in its service area. Thus, these plans are regarded as the urgent measures and the fundamental conditions to expand the water supply capacity, including rehabilitation of the following facilities:

a. Rehabilitation of Stage I, Amliang and Km8 Reservoir

At present, potable water for residential areas of Baguio city is supplied from Stage I intake and Amliang spring through KM8 reservoir. These two water intake sites lie on a tributary of the Bued river. The surface water off-taken at the Stage I weir site is being conveyed to KM 8 reservoir by gravity, while that taken from the Amliang spring is pumped up to the same. Owing to the earthquake in 1990, these intake facilities had been much deteriorated. Under the present condition, it is approximated that the Stage I and Amliang yield 5,400 m^3/day. It is expected that the maximum water production capacity of Stage I and Amliang would increase to 14,600 m^3/day after the completion of the rehabilitation works. The locations of the Stage I, Amilong and KM 8 are shown in Figure H-79.

b. Rehabilitation of St. Thomas Rain Basin

The rain basin is located in elevated area of Mount Kabuyao, north of the aforesaid Stage I and Amliang reservoir. The rain basin is covered by vinyl sheet to avoid seepage loss. At present, the vinyl sheet in the bottom portion is torn by uplift pressure of groundwater acting thereon. As long as the 1 to 50,000 scaled topographic map shows, a catchment area covered by the rain basin is as small as less than 1 km^2. According to the BWD office, however, the rain basin contributed to supply of portable water for the residential area not only in the wet season, but also in the dry season. Usually, the rain basin was easily filled up with rainwater in the wet season, enabling to supply portable water for the initial three months of the dry season. The location of the St. Thomas Rain Basin is shown in Figure H-79.

c. Australian Aid Project (Exploitation of Groundwater)

The Australian aid project comprises construction of 22 wells and rehabilitation of existing 10 wells as well as installation of new distribution pipelines to reduce water loss in the service area of the BWD. It is expected that the water supply capacity with groundwater will increase from 25,000 m^3/day to 68,000 m^3/day after the completion of the project. The project is scheduled to be completed in 2000 according to the original plan.

(4) Bulk Water Supply Project

The bulk water supply project is now on-going under the BWD as of the middle of December 1997. It is going to be implemented in a form of BOT and the BWD is to participate in the consortium. The BWD imposes the basic condition of the BOT as follows:

- Supply capacity	: 50,000 m^3/day
- Water charge for initial 5 years	: 22 pesos/m^3

In principle, the water exploited by the bulk water supply project is going to be supplied to the existing and planned industrial and commercial areas.

(5) Wangal Dam Project

There exists a small-scale dam on the Wangal river, which was identified in the previous

JICA's study. The dam site covers a small catchment area of about 5.5 km^2. The small-scale dam aims to supply irrigation water and domestic water for the La Trinidad City. The Wangal river originates from a watershed extending west of the La Trinidad City located adjacent to Baguio City northward.

The previous report estimates that the domestic water of about 1.824 million m^3/year or 13,000 m^3/day will be exploitable by means of constructing the small-scale dam. The main features of the Wangal dam are as follows:

- Catchment area at damsite : 5.5 (km^2)
- Mean inflow discharge : 0.483 (m^3/sec)
- Dam height : 37 (m)
- Full supply level of reservoir : 1,244 (El. m)
- Minimum operating level of reservoir : 1,222 (El. m)
- Effective storage volume : 2.52 (million m^3)

It appears that the Wangal dam project is very promising for the purpose of the domestic water supply to Baguio City from the geographic position as well as lower water head to pump up for water supply. It is located comparatively near to the service area and the required length of water transmission pipeline is about 8 km in total. The water head to be lifted from the reservoir for water supply to Baguio City is as comparatively small as about 300 m. However, the Wangal dam project is associated with the social and technical issues:

- Resettlement of residents in the proposed reservoir area
- Geological issue such as limestone in the reservoir area.

(6) Water Conveyance Project from Existing Ambuklao Reservoir (Tapping of Water from Ambuklao Dam for the Baguio City Water District)

The feasibility study for the Tapping of Water From Ambuklao Dam for the Baguio City Water District was completed by BECOM, a French Consultant, in July 1995. This project aims to supply the municipal and industrial water by pumping up water stored in existing Ambuklao reservoir to the Baguio City area. The Ambuklao dam was originally developed for the purpose of hydroelectric power generation. It was commissioned in 1957. The main features of the existing dam are as follows:

- Catchment area at damsite : 686 (km^2)
- Mean inflow discharge : 30.0 (m^3/sec)
- Dam height : 129 (m)
- Full supply level of reservoir : 752.2 (m)
- Minimum operating level of reservoir : 694.0 (m)
- Installed capacity : 75 (MW)

In the project, it is contemplated that the raw water of the Ambuklao reservoir normally operated between 752.2 m (FSL) and 694 m (MOL) in the surface water level is pumped up to impounding reservoir planned to be provided at an elevation of 1,575 m in the Baguio city area. The potable water of 36.51 million m^3 or 100,000 m^3/day is planned to be produced by the project. The main facilities involved in the water conveyance project are as follows:

- Intake structure with three pumps, each having a capacity of 1,800 kW, on right bank of the Ambuklao reservoir
- Water treatment plant on the "Dynamite Hill", located about 300 m distant from the Ambuklao reservoir: Capacity ; 1.00 m^3/sec

- Three booster-pumping stations along pipeline, each of which accommodates five identical pumps. Capacity of one unit for the first and second booster stations is 1,030 kW and 980 kW, respectively. The third station has the similar capacity to the second one.
- Two (2) balancing tanks, each with a capacity of 500 m^3, and impounding reservor in Baguio city with a capacity of 5,000 m^3
- Transmission pipeline of 27,960 m in total, having a diameter of pipe of 700 and 800 mm

In the feasibility study, the present-day initial investment cost of the project is estimated at 1,270 million Pesos including cost for power facilities including power lines and sub-stations as well as land acquisition cost. Besides, the project requires the considerably high operation and maintenance cost attributed to high water head to be lifted, which amounts to about 900 m. The present-day annual O&M cost in 2020 when the project is projected to reach the full stage in terms of the sold water is estimated to be 384.22 million Pesos, which is equivalent to 30.0 % of the initial investment cost. As a result, the feasibility study reveals that the project does not meet the financial criteria of full recovery cost.

(7) Surface Water Development Plan

It is judged through the examination on the aforesaid water supply projects that the following projects are considered to be realized sooner or later.

i) Australian Aid Project
ii) Rehabilitation of Amilang Spring, Stage I and St. Thomas Reservoir
iii) Bulk Water Supply Project in a form of BOT

In the course of the study, it is informed that the contract of the Bulk Water Supply Project is awarded to the bidder who proposes to supply water of the Laboy river to Baguio City. Furthermore, the intake site is planned to be located adjacent to the existing Laboy bridge. The Study Team was also planning to develop the Laboy river for the purpose of municipal water supply to Baguio City. Since there are no promising surface water resources in and around the Baguio City except for the Laboy river basin, the BWD's decision is considered to be reasonable.

After the aforesaid contents of the successful bidder for the BOT schemes was notified, the Study Team contemplated the intensive development of the Laboy river to suffice the water demand of Bagui City in the year 2025. Consequently, it is proposed that the Aboy river water will be utilized effectively for the Bulk Water supply Project and the following two new projects identified in this study:

i) Laboy Dam Project
ii) Laboy Weir and Ponds Project

In case of i) above, however, it is estimated as a result of the water balance study that it could not suffice the water demand of Baguio City until the year 2025. Therefore, the water of existing Ambuklao would need to be pumped up to the Laboy weir site. The two development scenarios for the water supply to Baguio City taking the hydrologic condition into account as shown in Figures H-80 and H-81.

H8.2.3 Zamboanga City

The municipal water for Zamboanga City is now supplied from the Tumaga river by utilizing

existing intake weir thereon without any seasonal regulation. The maximum intake discharge is as small as about 1.0 m^3/sec. On the other hand, the exploitable groundwater is estimated to be about 58.8 MCM/year, which is insufficient for meeting the water demand in the year 2025. The Zamboanga Water District is planning to collect the additional surface water from the nearby small streams, but it is considered that the surface water thereon would not meet the water demand until the year 2025. Therefore, the reservoir type dam project on the Tumaga river has been formulated to meet the water demand of Zamboanga City. It is estimated that the municipal water of about 3.0 m^3/sec could be supplied to the City by means of providing the reservoir type dam. The development scenario for the municipal water supply to Zamboanga City is depicted in Figure H-82.

H8.2.4 Cagayan De Oro City

The Cagayan De Oro Water District is planning to develop the Cagayan De Oro river in a form of BOT for the purpose of municipal water supply. It is informed that the Bulanog-Batang hydroelectric project situated on the upstream reach of the Cagayan De Oro river is to be implemented by NPC. The water source of the BOT project relies on the Cagayan de Oro river whose streamflow is to be seasonally regulated by the upstream reservoir type dam project. The development scenario for the municipal water supply to Cagayan De Oro City is depicted in Figure H-83.

H8.2.5 Angeles, Iloilo and Bacolod Cities

Concerning the cities of Angeles, Iloilo and Bacolod, it is forecasted that the municipal water demand could be sufficed by groundwater resources until the year 2025 as shown in Figures H-84 to H-86. Thus, any necessity of surface water development in these cities would not take place until the year 2025.

On the other hand, in case of the Bacolod City, another alternative would be to develop the Bago dam as the multi-purpose project. In the past, the storage type dam project was formulated as a single-purpose dam project for hydropower generation. It is considered that the project needs to be reformulated as the multi-purpose dam project for hydropower and municipal and irrigation water supply. The alternative development scenario for the municipal water supply to Bacolod City is shown in Figure H-87.

H9 Priority Projects to be Implemented at Earlier Stage

H9.1 Some Consideration Taken in Selection of Priority Projects

As discussed in the foregoing Chapters H6 and H7, a lot of water resources development projects are picked out to meet the water demand of the major river basins as well as the selected major cities. In general, a huge investment cost is required to implement those projects. Hence, the promising water resources development projects will be realized in a long term to cope with the financial capability of the country. It is recommended that the water supply projects for Metro Manila, Metro Cebu and Baguio City are selected as the priority projects taking into consideration the following aspects therein:

i) The municipal water supply is given a first priority among the various water use sectors in view of the human basic need. During the study period of this master plan, Metro Manila and Baguio City suffer from the severe shortage of municipal water supply. Also in case of Metro Cebu, there is a possibility that a chronic water shortage will take place in near future.

ii) If the water supply capacity for these cities were not augmented in harmony with the water demand, the economic activity in this country would be stagnated and slow down to a considerable extent. Also in view of water supply, these cities need to keep the qualification as the international cities, since these cities are famous worldwide. Furthermore, it is recommended that the water supply in these economic centers of the country be augmented to have some allowance for the future water demand.

H9.2 Proposed Action Plans

It is proposed that the following studies are to be performed in relation to the municipal water supply to Metro Manila, Metro Cebu and Baguio City:

H9.2.1 Municipal Water Supply for Metro Manila

The following studies are recommended to be carried out in the successive stage with respect to the water supply to metro Manila:

- Master plan study on the Agos river basin
- Feasibility study on the priority project(s) selected through the master plan study
- Feasibility study on the Maasim and Bayabas Dam Project

It is generally accepted that the additional municipal water would have to rely on the supply from the Agos river basin consisting two main tributaries, namely the Kanan and Kaliwa basins, after the completion of the Umiray-Angat transbasin project.

Until now, several reservoir type dam projects were identified in the Kanan and Kaliwa river basins and examined at different study levels. However, no reliable streamflow data are available on the Kaliwa and Kanan rivers, while there exists a stream gauging station on the Agos river. It is strongly recommended to install a stream gauging station on each of these tributaries as soon as possible so as to enable the accurate estimate of their hydrological condition in the proposed master plan stage. In addition, the detailed geological investigation including core drilling at the proposed dam sites on those tributaries needs to be performed in the master plan stage of the next study in order to select the most favorable dam site from the technical aspect. Especially, limestone zone spreads over the reservoir area of the Laiban dam

on the Kaliwa dam, which are prioritized for the purpose water supply to Metro Manila in the past study. This implies that the significant seepage might occur after completion of the Laiban dam. Hence, its technical viability needs to be verified through the geological investigation.

It is expected that the Maasim and Bayabas dams, which are originally identified and examined at a level of prefeasibility study for the purpose of irrigation water supply to the downstream paddy fields of the Angat dam, contribute to the augmentation of the municipal water supply capacity of the Angat dam. Therefore, it is recommended that a feasibility study on those dams be carried out in one package.

H9.2.2 Municipal Water Supply for Metro Cebu

In the field investigation, it was attempted to identify the reservoir type dams on the rivers that drain the comparatively large areas in and around the Metro Cebu area. Consequently, it was found that there are no reservoir type dams with a catchment area of more than 100 km^2 and that most of those identified occupy small catchment areas. In addition, the annual rainfall in these catchments is not in general over 2,000 mm. Thus, the surface water resources in and around the Metro Cebu area are very limited because of its topographic condition as well as climatic condition.

As aforesaid, the present groundwater production exceeded its exploitable capacity. Accordingly, the new water source to meet the rapidly increasing water demand would have to be dependent on surface water sources in the neighboring small river basins. In this respect, it is recommended to carry out the following studies in the successive stage:

- Master plan study on municipal water supply to Metro Cebu, which includes carrying out the prefeasibility study on the specific water supply projects taken up in this master plan. These include:

  a) Lusaran dam project (Update the previous feasibility study)
  b) Malubog-Mananga transbasin project (MMTP)
  c) Lusaran-Pulanbato Transbasin project (LPTP)
  d) Bohol-Cebu Water Supply

- Feasibility study on the priority project(s) selected through the master plan study

H9.2.3 Municipal Water Supply for Baguio City

It is considered that at present Baguio City suffers from the most aggravated situation in terms of water supply as explained in Section H8.2. The Baguio City area spreads over a western divide of the Agno river basin with an altitude of 1,000 m to 1,500 m. Although some rivers originate from the city area, they flow down with steep river bed slopes. Due to the topographic condition, the pumping facilities are unexceptionally required to be installed to covey water from downstream intake site on those rivers to the city area, in case that the river water is intended to be utilized for the municipal water supply purpose. Owing to the topographic condition, it is foreseen that the unit water production cost comes to considerably high.

Taking into consideration the high cost required for exploitation of surface water, it might be preferred that the groundwater in the Baguio Water District be developed to the maximum extent and/or the surplus groundwater in the other neighboring Water Districts be supplied to

Baguio City, if any. According to the latest information, on the other hand, the groundwater production in wells dug under the on-going project dose not reach the initially expected level. Judging from the present circumstance, it is recommended to carry out the comprehensive study covering the neighboring municipalities such as La Trinidad City where the comparatively large groundwater resources are considered to be still exploitable. In the comprehensive master plan, it is recommended to perform the field investigation and survey on the rehabilitation projects such as Amliang spring, Stage I and St. Thomas Rain Basin so as to examine the necessity of urgent implementation thereof.

It is recommended to carry out the following studies:

- Master plan study on water supply to Baguio City
- Feasibility study on priority project(s) selected through the master plan study
- Examination of urgent rehabilitation projects

Part – H

Tables

Table H-1 WATER RIGHTS GRANTS BY NATIONAL WATER RESOURCES BOARD (NWRB)

REG NO.	SOURCE OF WATER SUPPLY	DOMESTIC		IRRIGATION		POWER		INDUSTRIAL		COMMERCIAL		LIVESTOCK		RECREATION		FISHERIES		TOTAL	
		NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)	NUMBER OF RANTEE	AMOUNT GRANTED (LPS)	NUMBER OF GRANTEE	AMOUNT GRANTED (LPS)
NCR	GW	785	3326.279	12	73.100			119	1064.750	16	22.893	1	1.000					933	4486.022
	SW	7				1	150000.000	2						1	126.200	1	2.000	20	16125.450
1	GW	309	4722.840	161	1968.330			13	227.050	1	6.660	1	0.130	3	0.750	1	0.080	486	6925.840
	SW	64	1160.200	985	102325.627	28	146881.090	21	1775.300							4	6.550	1102	252149.767
2	GW	92	456.115	111	586.110							1	2.500	1	2.500			205	1044.225
	SW	13	67.220	1222	15554.990	28	583726.240	10	1108.900			4	0.940	1	5.000	5	295.560	1283	600757.850
3	GW	398	3216.732	444	6423.390			64	1377.560	2	1.010	20	8.060	5	11.700	9	149.720	942	11190.212
	SW	11	13917.060	614	366389.530	5	191243.000	15	18722.600	1	31.740			2	24.000	26	171.290	674	590499.210
4	GW	770	6643.590	186	2492.320	5	579.000	139	2534.250	17	127.988	38	81.300	24	230.580	6	77.140	1185	12746.146
	SW	43	90326.134	1198	191262.790	28	506286.940	42	9765.730			2	41.600	10	1519.440	34	861.130	1345	791983.734
5	GW	150	3417.668	79	2722.740			7	52.340	1	0.167			3	900.860	1	4.140	241	7097.915
	SW	5	87.350	594	85618.960	14	18257.830	12	588.840	1	15.000			5	1254.050	8	191.220	640	106012.820
6	GW	186	2016.397	74	2059.570			51	1228.050	9	64.410	2	7.000	1	2.000	38	462.430	341	5839.857
	SW	10	65.650	766	269033.950	10	22350.680	27	16458.760							149	4198.280	962	332106.560
7	GW	489	2907.061	125	2162.750			34	1439.030	4	24.160	3	2.340	3	106.000	35	485.920	693	7127.311
	SW	7	748.060	384	59665.730	13	38615.150	15	2462.820					3	1141.000	48	3153.830	470	105786.400
8	GW	63	296.948	32	410.750			16	687.370	2	14.670			1	5.000			114	1414.738
	SW	12	25.680	375	85660.990	5	2913.000	20	363.300							7	55.570	419	89018.540
9	GW	126	465.620	4	164.220	1	173.000	10	41.280			5	66.010	1	0.500	1	1.000	148	851.630
	SW	5	3623.190	158	36289.290	3	4512.000	4	134.850							28	3757.140	199	50316.470
10	GW	187	769.849	23	983.960			18	150.450	1	946.000	1	0.060	4	26.890			232	2997.209
	SW	15	226.440	243	70451.310	7	103087.700	13	2398.800					1	7.000	13	235.330	292	176406.580
11	GW	116	2067.870	22	1951.530			13	256.830			11	4.630			6	262.840	166	4543.700
	SW	15	1377.100	329	18076.140	11	48700.000	14	6244.040							25	859.590	394	75250.870
12	GW	160	1298.870	99	2819.180			14	115.850	2	9.010	9	3.700	1	13.500	2	17.580	307	4278.170
	SW	9	446.860	437	237990.100	23	1223941.000	14	4146.500							11	726.100	494	1467353.560
SUB.	GW	393	31624.639	1372	24817.950	6	592.000	496	9174.660	55	1217.866	92	156.750	47	1300.280	99	1430.930	5998	70444.975
TOTAL	SW	217	107965.184	7443	1550848.747	174	2892582.690	210	64488.870	2	46.740	6	42.540	23	4076.690	359	14545.270	8434	4633666.831
TOTAL		4048	139589.823	8815	1575666.697	180	2893174.690	706	73663.530	57	1264.606	98	199.290	70	5376.970	458	15976.200	14432	4704111.666

Table H-2 DAMS ADOPTED AS THE CANDIDATES FOR WATER RESOURCES DEVELOPMENT SCHEMES (1/2)

No	WRR	Name of Dam	River System	Dam					Reservoir									Hydroelectric power		Irrigation	Cost	Consultant/Agency	Status
				CA (km^2)	Type	Height (m)	Crest Length (m)	Volume ($10^6 m^3$)	FWL (EL.m)	HWL (EL.m)	LWL (EL.m)	Tail WL (EL.m)	F/C Space ($10^6 m^3$)	Gross ($10^6 m^3$)	Active ($10^6 m^3$)	Dead ($10^6 m^3$)	Area (km^2)	(MW)	(GWh)	(ha)	(US$ 10^6)		
1	I	Cura-Tina-Gasgas	Laoag	233	Rockfill	85.0	254	1.5	188	178	140	-	-	34	33	1	1.6	6	24	8,600	140	Asiatic	F/S
2	I	Palsiguan/Nueva	Abra/Laoag	153	rockfill/Conc. grv	143.5	480	9.1	-	335	275	-		232	189	43	5	36	160	12,400	716	JICA	F/S
3	I	Binongan/Tineg	Abra	683	Rockfill/Conc. Weir	112.0	375	3.4	383	380	350	-	9	121	79	42	4	175	718	-	468	Shawinigan/ADB	F/S
4	I	Supo	Abra	1,293	Rockfill	138.0	440	6.0	325	320	280	-	300	1,132	832	300	32	120	340	-	368	NK/JICA	Master Plan
5	II	Agbulu	Abulug/Apayao	773	Rockfill	233.0	610	22.1	373	370	310	136	-	3,424	2,164	1,260	49	360	1,479	-	994	ELC	F/S
6	II	Gened	Abulug/Apayao	1,661	Conc. Arch	175.0	472	2.9	-	180	160	-	-	2,800	1,200	1,600	63	600	1,632	-	892	New JEC	D/D
7	II	Bantay	Cagayan	742	Earthfill	64.0	320	2.6	67	62	45	-	354	1,646	1,278	368	105	40	68	-	188	NK/JICA	Master Plan
8	II	Chico IV	Cagayan	1,410	Rockfill	160.0	890	17.8	-	451	411	-	-	740	430	310	14	360	955	-	758	Lahmeyer	D/D
9	II	Abuan	Cagayan	487	Rockfill	100.0		2.6	136	131	110	-	-	250	124	126	-	60	172	610	159	Lahmeyer/NK	F/S
10	II	Mallig II	Cagayan	362+1,951	Rockfill	84.0	300	2.4	185.5	180	160	-	112	1,037	545	-	41	-	-	-	90	NK/JICA	Master Plan
11	II	Siffu I	Cagayan	656	Earthfill	58.0	240	1.7	115.5	106	97	-	115	314	93	-	19	5.4	41	-	67	NK/JICA	Master Plan
12	II	Magat	Cagayan/Magat	4,143	Rock/Grs	114.0	2,925		197	193	158	-	210	1,254	969	210	17	300	991	104,600	-	Bu.Recla US	Existing(1983)
13	II	Matuno	Cagayan/Magat	593	Rockfill	147.0	580	10.0	525	520	480	-	-	137	97	40	-	180	528	13,600	668	NK/JICA	F/S
14	II	Addalam A	Cagayan/Addalam	849	RCC	60.0									32			45	102				F/S
15	II	Ilaguen B	Cagayan/Ilaguen		RCC										31			46	102				F/S
16	II	Didiyon	Cagayan	477	Conc. Gravity	111.0	375	1.2	-	648	620	162	-	579	454	125	-	352	957	-	664	New JEC	F/S
17	III	Malkong	Amburayan	100	Rockfill	147.0	400	9.5	-	900	885	-	-	102	26	76	1.9	-	-	-	400	JICA	Map Study
18	III	Amburayan	Amburayan	135	Rockfill	137.0	400	8.0	-	760	720	-	-	104	64	40	2.1	-	-	-	400	JICA	Map Study
19	III	Boloc II	Agno	306	Rockfill	177.0	570	20.0	-	1,030	1,015	870	-	280	64	216	4.6	30	99	-	614	JICA	Map Study
20	III	Mount Caas	Agno	390	Rockfill	142.0	400	9.0	-	880	860	750	-	120	46	74	2.8	40	73	-	326	JICA	Map Study
21	III	Ambuklao	Agno	612	Rockfill	129.0	452	5.8	-	752	694	574	-	327	258	69	-	75	300	-	-	Harza	Existing(1956)
22	III	Binga	Agno	854	Rockfill	107.4	215	1.9	-	575	555	417	-	91	33	58	-	100	516	-	-	Harza	Existing(1960)
23	III	Laboy II	Agno/Laboy	48.6	Rockfill	75.0	500	5.0		818	811			13.9	3.0	10.9	0.5	-	-	-		JICA	Map Study
24	III	Tebbo	Agno	1,072	Rockfill	142.0	320	7.0	-	415	395	280	-	285	110	175	6.6	120	219	-	287	JICA	Map Study
25	III	San Roque	Agno	1,235	Rockfill	200.0	1,130	38.5	290	280	225	-	140	850	530	140	13	345	1,050	87,000	1,050	ELC	On-Going
26	III	Mabini	Balincaguin	225	Rockfill	88.5	530	4.1	65	63	38			345	240	105	15			11,500			F/S
27	III	Balog-Balog	Agno/Tarlac	283	Rockfill	113.5	1,400	11.8	241	238	180	-	45	625	575	50	18	33	98	44,350	292	ELC	F/S
28	III	Pantabangan	Pampanga	853	Earthfill	107.0	1,615	12.0	230	221	177	128	-	2,310	1,973	337	-	100	230	102,000	-	USAID/IBRD	Existing(1977)
29	III	Aboca (Casecnan)	Cagayan/Pampanga	590	Rockfill	107.0	500	4.2	499	490	473	-	-	130	58	72	-	270	495	-	652	ELC/IBRD	On-going
30	III	Conwap (Casecnan)	Cagayan/Pampanga	1,150	Rockfill	168.5	913	19.4	394	390	375	-	-	1,207	321	888	-	-	442	66,500	591	ELC/IBRD	On-going
31	III	Angat	Pampanga/Angat	568	Rockfill	131.0	568	7.1	219	217	180	-	-	1,075	850	225	23	218	398	30,000	-	Harza/IBRD	Existing(1967)
32	III	Umiray-Angat	Umiray/Angat	160	Concrete Weir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C.Lord/ADB	On-going
33	III	Balintingon	Pampanga/Sumacbao	228	Rockfill	128.0	490	8.6						559	463	96	14	40	132	18,800			F/S
34	III	Bayabas	Pampanga	50	Rockfill	107.0	620	-	191	187	120	-	48	-	148	-	4.8	-	-	-	-	ELC/Asiatic/World Bank	Pre-F/S
35	III	Mussim	Pampanga	54	Rockfill	52.0	1,400	-	82	80	55	-	10	-	100	-	9.0	-	-	-	-	ELC/Asiatic/World Bank	Pre-F/S
36	IV	Laiban	Agos/Kaliwa	276	Rockfill	141.0	588	9.7	278	270	235	134	-	-	472	-	20	21		-	1,104	Electrowatt	D/D
37	IV	Kanan	Agos/Kanan	286	Rockfill	157.7	400	2.0	-	316	267	-	-	1,526	1,137	389	49	-	-	-	245	JICA	Map Study
38	IV	Caliraya	Caliraya	92	Earthfill	42.0			-	-	-	-	-	-	-	-		300		-	-		Existing(1947)
39	IV	Amnay	Amnay-Patric	145	Rockfill	97.0	1,400	14.0	204	200	180	98	20	155	80	75	4	15	26	-	445	JICA	Map Study
40	V	Sipocot	Bicol/Sipocot	447	Rockfill	64.0	600	2.3	60	57	35	-	150	1,270	870	400	52	30	55	18,000	133	JICA	Map Study
41	V	Talisay	Bicol/Talisay	100	Rockfill	58.0	400	1.2	90	85	70	-	125	315	231	84	25	4.4	8	3,000	56	JICA	Map Study
42	VI	Panay	Panay	239	Con. Gravity	52.4	160	-	75	65	57	-	-	96	31	-	-	7	31	-	40	NK/JICA	F/S
43	VI	Jalaur	Jalaur	109	Arch	145.0	405			221	158.7			370	337	33	10	20	58	22,000		ELC/NK	D/D
44	VI	Bago	Bago	402	Rockfill	125.0	605	5.3	-	300	255	-	-	-	64	-	-	180	497	-	267	Shawinigan/ADB	F/S
45	VI	Ilog No.1	Ilog-Hilabangan	1,389	Rockfill	81.0	750	5.0	80	75	55	-	110	650	370	280	25	52	95	24,000	237	JICA	F/S
46	VII	Buhisan	Buhisan	5.9	Conc Arch	26.0			-	-	-	-	-	-	9.26	-	-	-	-	-	-		Existing(1910)
47	VII	Malubog	Sapang Daku	70	Rockfill	65.0	520	-	-	180	162	-	-	81	47	21	3	-	-	-	148	JICA	Map Study
48	VII	Manonga II	Manonga	68	Rockfill	90.0	240	0.5	161	154	110	-	-	48	41	7	1.5	-	-	-	130	Electrowatt/ADB	F/S
49	VII	Lussran	Balamban	67	Rockfill	100.0	315	3.2	232	228	163	-	-	126	116	10	-	-	-	-	83	Camp Dresser/Mckee	D/D
50	VII	Cebu F6 (Pulambato)	Butuanon	21	Rockfill	55.0	300	-	98	95	85	-	1	6	2	1	0.3	-	-	-	82	JICA	Map Study
51	VII	Tipolo	Inabanga	500	Con. Gravity	60.0		-	-	75	65	-	-	210	120	90	15	-	-	-	159	JICA	Map Study
52	IX	Pasonoca	Tumaga	101	Rockfill	86.0		-	-	109	95	-	-	-	13.7	30.3	1.3	-	-	-	-	JICA	Map Study
53	X	Bulanog-Batang	Cagayan de Oro	533	RCC	126.0		1.4	-	475	460	-	-	-	28.3	-	-	132	290	-	-	ELC	D/D
54	X	Tagoloan	Tagoloan	288	Rockfill	117.0	500	8.0	524	520	500	412	16	184	83.0	101	5.6	22	38		282	JICA	Map Study
55	XI	Bubonao	Tagum-Libuganon	666	Rockfill	80.0	400	2.5	129	125	100	58	150	1,020	720.0	300	46	63	100		180	JICA	Map Study

Note: Map Study in the column of Status means that the scheme was formulated in this study at a map study level.

Table H-2 DAMS ADOPTED AS THE CANDIDATES FOR WATER RESOURCES DEVELOPMENT SCHEMES (2/2)

No	WRR	Name of Dam	River System	Dam					Reservoir									Hydroelectric power		Irrigation	Cost	Consultant/Agency	Status
				CA (km^2)	Type	Height (m)	Crest Length (m)	Volume ($10^6 m^3$)	FWL (EL.m)	HWL (EL.m)	LWL (EL.m)	Tail WL (EL.m)	F/C Space ($10^6 m^3$)	Gross ($10^6 m^3$)	Active ($10^6 m^3$)	Dead ($10^6 m^3$)	Area (km^2)	(MW)	(GWh)	(ha)	(US$ 10^6)		
56	XI	Davao I	Davao	367	Rockfill	90.0	450	4.0	455	450	430	380	135	740	405	135	26	36	66	-	189	JICA	Map Study
57	XI	Davao II	Davao	820	Rockfill	112.0	350	5.0	385	380	360	285	-	436	224	212	14	100	180	-	265	JICA	Map Study
58	XI	Davao III_a	Davao	163	Rockfill	132.0	430	7.5	-	465	445	-	-	111	56	55	3.5	24	44	-	268	JICA	Map Study
59	XI	Dimuloc	Buayan-Malungun	90	Rockfill	120.0	430	6.0	384	380	350	-	45	293	193	100	9	-	-	-	200	JICA	Map Study
60	XII	Agus I	Agus(Lake Lanao)	1,645	-										1,715			80	456				Existing(1992)
61	XII	Agus II	Agus		Earthfill	29.0												180	756				Existing(1979)
62	XII	Agus III	Agus	1,844	Rockfill	58.0				524	516				8.7			225	1,065			FLC -> Lavalin	F/S
63	XII	Agus IV	Agus		Rockfill	32.0									24			158	762				Existing(1985)
64	XII	Agus V	Agus		Conc.gravity													55	265				Existing(1985)
65	XII	Agus VI	Agus(Maria Cristina)		Rockfill	12.5				203					1.2			200	1,016				Existing(1977)
66	XII	Agus VII	Agus		Conc.gravity													54	274				Existing(1983)
67	XII	Pulangi I	Mindanao/Pulangi	376	Rockfill	100.0				660	626				1,715			24	105			Sofrelex	Pre-F/S
68	XII	Pulangi II	Mindanao/Pulangi	737	Rockfill	110.0				557	523				535			70	257			Sofrelex	Pre-F/S
69	XII	Pulangi III	Mindanao/Pulangi	1,339	Rockfill	90.0	632	7.6	-	417	380	-	-	-	1,156	-	71	90	382	-	472	MERALCO	F/S
70	XII	Pulangi IV	Mindanao/Pulangi	3,633		115.0												255	1,012				Existing(1985)
71	XII	Pulangi V	Mindanao/Pulangi	4,652	Gravity	125.0	228			160	123				1,100			348	1,310			Sofrelex	Pre-F/S
72	XII	Pulangi VI	Mindanao/Pulangi	5,216	Gravity	30.0	139											70	340			Sofrelex	Pre-F/S
73	XII	Maganoy	Mindanao/Cabilanan	550	Earthfill	45.0	226		-	687	660	-	-	-	62	-	10	66	315	13,000		3d Asiatic	F/S

Note: Map Study in the column of Status means that the scheme was formulated in this study at a map study level.

Table II-3 SHORT-TERM AND MID-TERM POWER DEMAND FORECAST

Year	Energy Sales by Grid System (GWh/year)			Whole Philippines	
	Luzon	Visayas	Mindanao	Total	Increase Ratio (%)
1995	3,877	585	837	5,299	-
1996	4,239	657	959	5,855	10.5
1997	4,744	739	1,130	6,613	12.9
1998	5,397	832	1,359	7,588	14.7
1999	6,079	955	1,587	8,621	13.6
2000	6,779	1,080	1,822	9,681	12.3
2001	7,484	1,254	2,059	10,797	11.5
2002	8,266	1,405	2,321	11,992	11.1
2003	9,135	1,556	2,610	13,301	10.9
2004	10,102	1,676	2,930	14,708	10.6
2005	11,177	1,796	3,283	16,256	10.5
Average Annual Growth Ration (%)					
i) between 1996 and 2000	11.8	13.0	16.8	12.8	
ii) between 2001 and 2005	10.5	10.7	12.5	10.9	
iii) between 1996 and 2005	11.2	11.9	14.6	11.9	

Data Source : 1996 PDP by NPC

Table II-4 SHORT-TERM AND MID-TERM ENERGY DEMAND FORECAST

Year	Energy Sales by Grid System (GWh/year)			Whole Philippines	
	Luzon	Visayas	Mindanao	Total	Increase Ratio (%)
1995	23,161	3,024	4,251	30,436	-
1996	24,415	3,482	5,635	33,532	10.2
1997	27,331	3,918	6,641	37,890	13.0
1998	31,088	4,406	7,989	43,483	14.8
1999	35,019	5,062	9,330	49,411	13.6
2000	39,054	5,794	10,711	55,559	12.4
2001	43,111	6,727	12,102	61,940	11.5
2002	47,616	7,536	13,640	68,792	11.1
2003	52,623	8,348	15,339	76,310	10.9
2004	58,191	8,995	17,219	84,405	10.6
2005	64,383	9,636	19,294	93,313	10.6
Average Annual Growth Ration (%)					
i) between 1996 and 2000	11.0	13.9	20.3	12.8	
ii) between 2001 and 2005	10.5	10.7	12.5	10.9	
iii) between 1996 and 2005	10.8	12.3	16.3	11.9	

Data Source : 1996 PDP by NPC

Table II-5 HYDRO POWER POTENTIALS IN THE PHILIPPINES

Grid System	Status of Scheme	Installed Capacity (MW)	(Share)	Energy Output (GWh)	(Share)
(1) Luzon	Existing	1,273	15 (%)	3,818	12 (%)
	Prefeasibility	3,444	40 (%)	14,895	47 (%)
	Feasibility	1,922	22 (%)	6,907	22 (%)
	Definite Design	1,950	23 (%)	6,185	19 (%)
	Subtotal (1)	8,589	100 (%)	31,805	100 (%)
(2) Visayas	Existing	13	3 (%)	51	3 (%)
	Prefeasibility	95	22 (%)	403	27 (%)
	Feasibility	226	53 (%)	833	55 (%)
	Definite Design	96	22 (%)	229	15 (%)
	Subtotal (1)	430	100 (%)	1,516	100 (%)
(3) Mindanao	Existing	992	30 (%)	4,571	32 (%)
	Prefeasibility	1,193	36 (%)	4,799	34 (%)
	Feasibility	1,104	34 (%)	4,768	34 (%)
	Definite Design	-	-	-	-
	Subtotal (1)	3,289	100 (%)	14,138	100 (%)
Whole Philippines	Existing	2,278	19 (%)	8,440	18 (%)
	Prefeasibility	4,732	38 (%)	20,097	42 (%)
	Feasibility	3,252	26 (%)	12,508	26 (%)
	Definite Design	2,046	17 (%)	6,414	14 (%)
	Subtotal (1)	12,308	100 (%)	47,459	100 (%)

Data source : 1996 Power Development Program by NPC

Table H-6 POWER CAPACITY NEEDED TO BE ADDED BETWEEN 1996 AND 2025

Year	Indigenous Energy Resources							Imported Enery Resources				Total
	Hydoro (1)	NRE/SM.HY (2)	(1)+(2)	Geo-thermal	Coal	Natural Gas	Subtotal	Coal	Oil	Other fuels	Subtotal	
1996	0	0	0	0	0	0	0	0	50	0	50	50
1997	0	0	0	220	0	0	220	0	100	0	100	320
1998	0	0	0	480	0	0	480	300	550	0	850	1330
1999	140	0	140	80	0	0	220	1550	0	0	1550	1770
Sub-total-1	(140)	(0)	(140)	(780)	(0)	(0)	(920)	(1,850)	(700)	(0)	(2,550)	(3,470)
2000	29	0	29	40	0	900	969	0	0	0	0	969
2001	32	0	32	0	0	900	932	300	0	150	450	1382
2002	68	0	68	0	250	600	918	0	0	950	950	1868
2003	0	0	0	0	250	600	850	0	0	450	450	1300
2004	750	0	750	0	100	0	850	0	0	950	950	1800
2005	569	0	569	120	0	0	689	0	0	1350	1350	2039
(Subtotal-2)	(1,448)	(0)	(1,448)	(160)	(600)	(3,000)	(5,208)	(300)	(0)	(3,850)	(4,150)	(9,358)
2006-2010	473	579	1,052	720	600	1,500	3,872	0	0	9,701	9,701	13,573
2011-2015	984	860	1,844	230	610	0	2,684	0	0	16,549	16,549	19,233
2016-2020	427	548	975	40	0	2,000	3,015	0	0	19,485	19,485	22,500
2021-2025	261	460	721	80	0	0	801	0	0	23,199	23,199	24,000
(Subtotal-3)	(2,145)	(2,447)	(4,592)	(1,070)	(1,210)	(3,500)	(10,372)	(0)	(0)	(68,934)	(68,934)	(79,306)
Total (1996-2025)	3,733	2,447	6,180	2,010	1,810	6,500	16,500	2,150	700	72,784	75,634	92,134

Source : 1996 PDP by NPC
Note : Short-term : 1996 - 1999, Medium term : 2000 - 2005, Long-term : 2006 - 2025

Table H-7 BALANCE OF WATER RESOURCES POTENTIALS AND WATER DEMAND IN YEAR 2025

i) Case 1 : High Economic Growth Scenario Based on NEDA's Projection

No.	Water Resources Region	Water Resources Potentials (MCM/year)					Water Demand (MCM/year)*								Ratio of Potential to Demand		Water Balance (MCM/year)	
		Ground-Water	Surface Water		Total		M&I Water Demand			Agricultural Water Demand				Total	Surface Water		Surface Water	
			50% Depend.	80% Depend.	Surface Water		Municipal	Industrial	Subtotal-1	Irrigation	Livestock/ Poultry	Fishery	Subtotal-2		50% Depend.	80% Depend.	50% Depend.	80% Depend.
					50 % Depend.	80 % Depend.			(8)=				(12)=(9)+	(13)=				
		(1)	(2)	(3)	(4)=(1)+(2)	(5)=(1)+(3)	(6)	(7)	(6)+(7)	(9)	(10)	(11)	(10)+(11)	(8)+(13)	(4)/(13)	(5)/(13)	(4) - (13)	(5) - (13)
1	WRR I	1,248	10,100	3,250	11,348	4,498	170	120	290	2,653	16	82	2,752	3,041	3.73	1.48	8,307	1,457
2	WRR II	2,825	16,800	8,510	19,625	11,335	140	27	168	12,170	31	98	12,299	12,466	1.57	0.91	7,159	-1,131
3	WRR III	1,721	10,800	7,890	12,521	9,611	955	758	1,713	12,546	72	3,837	16,455	18,168	0.69	0.53	-5,647	-8,557
4	WRR IV	1,410	19,700	6,370	21,110	7,780	3,101	1,929	5,030	4,184	68	770	5,022	10,052	2.10	0.77	11,058	-2,272
5	WRR V	1,085	9,960	3,060	11,045	4,145	261	41	302	3,492	24	348	3,864	4,167	2.65	0.99	6,878	-22
6	WRR VI	1,144	19,500	14,200	20,644	15,344	500	609	1,110	3,784	36	2,665	6,486	7,595	2.72	2.02	13,049	7,749
7	WRR VII	879	3,770	2,060	4,649	2,939	564	541	1,105	945	38	641	1,624	2,729	1.70	1.08	1,920	210
8	WRR VIII	2,557	15,900	9,350	18,457	11,907	237	196	432	1,343	28	152	1,524	1,956	9.44	6.09	16,501	9,951
9	WRR IX	1,082	16,200	12,100	17,282	13,182	381	78	458	1,491	29	2,620	4,140	4,598	3.76	2.87	12,684	8,584
10	WRR X	2,116	42,100	29,000	44,216	31,116	389	325	714	2,671	20	278	2,969	3,682	12.01	8.45	40,534	27,434
11	WRR XI	2,375	16,300	11,300	18,675	13,675	258	263	521	2,913	42	665	3,620	4,141	4.51	3.30	14,534	9,534
12	WRR XII	1,758	25,100	18,700	26,858	20,458	475	111	586	11,691	29	500	12,220	12,806	2.10	1.60	14,052	7,652
	Total	20,200	206,230	125,790	226,430	145,990	7,430	4,998	12,428	59,885	434	12,655	72,973	85,401	2.65	1.71	141,029	60,589

Notes : 1. * ; The water demand in high economic growth scenario which is estimated based on the NEDA's projection is applied.

2. The potentials for surface water were estimated for the two cases, in which the maximum available discharges are a daily discharge with 80% and 50 % dependability, respectively.

ii) Case 2 : Low Economic Growth Scenario

No.	Water Resources Region	Water Resources Potentials (MCM/year)					Water Demand (MCM/year)**								Ratio of Potential to Demand		Water Balance (MCM/year)	
		Ground-Water	Surface Water		Total		M&I Water Demand			Agricultural Water Demand				Total	Surface Water		Surface Water	
			50% Depend.	80% Depend.	Surface Water		Municipal	Industrial	Subtotal-1	Irrigation	Livestock/ Poultry	Fishery	Subtotal-2		50% Depend.	80% Depend.	50% Depend.	80% Depend.
					50 % Depend.	80 % Depend.			(8)=				(12)=(9)+	(13)=				
		(1)	(2)	(3)	(4)=(1)+(2)	(5)=(1)+(3)	(6)	(7)	(6)+(7)	(9)	(10)	(11)	(10)+(11)	(8)+(12)	(4)/(13)	(5)/(13)	(4) - (13)	(5) - (13)
1	WRR I	1,248	10,100	3,250	11,348	4,498	170	93	263	2,532	9	70	2,611	2,874	3.95	1.57	8,474	1,624
2	WRR II	2,825	16,800	8,510	19,625	11,335	140	21	162	7,357	16	83	7,457	7,618	2.58	1.49	12,007	3,717
3	WRR III	1,721	10,800	7,890	12,521	9,611	955	433	1,387	9,920	35	3,276	13,231	14,618	0.86	0.66	-2,097	-5,007
4	WRR IV	1,410	19,700	6,370	21,110	7,780	3,101	1,154	4,255	2,423	33	658	3,113	7,368	2.87	1.06	13,742	412
5	WRR V	1,085	9,960	3,060	11,045	4,145	261	29	291	2,241	13	297	2,551	2,841	3.89	1.46	8,204	1,304
6	WRR VI	1,144	19,500	14,200	20,644	15,344	500	565	1,065	2,846	19	2,276	5,141	6,206	3.33	2.47	14,438	9,138
7	WRR VII	879	3,770	2,060	4,649	2,939	564	303	867	793	19	547	1,359	2,226	2.09	1.32	2,423	713
8	WRR VIII	2,557	15,900	9,350	18,457	11,907	237	101	337	1,164	14	130	1,307	1,644	11.22	7.24	16,813	10,263
9	WRR IX	1,082	16,200	12,100	17,282	13,182	381	40	421	944	15	2,237	3,195	3,616	4.78	3.65	13,666	9,566
10	WRR X	2,116	42,100	29,000	44,216	31,116	389	244	632	1,373	10	237	1,620	2,253	19.63	13.81	41,963	28,863
11	WRR XI	2,375	16,300	11,300	18,675	13,675	258	230	488	1,314	20	567	1,902	2,390	7.81	5.72	16,285	11,285
12	WRR XII	1,758	25,100	18,700	26,858	20,458	475	98	573	5,930	16	427	6,373	6,946	3.87	2.95	19,912	13,512
	Total	20,200	206,230	125,790	226,430	145,990	7,430	3,310	10,740	38,837	218	10,806	49,860	60,600	3.74	2.41	165,830	85,390

Notes : 1. ** ; The water demand in low economic growth scenario is applied.

2. The potentials for surface water were estimated for the two cases, in which the maximum available discharges are a daily discharge with 80% and 50 % dependability, respectively.

Table H-8 SURFACE WATER DEMAND FOR LOAG RIVER BASIN :WRR I

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.1	0.2	0.3	0.4	0.6	0.8	1.0	0.1
	Industry	3.4	6.1	8.4	11.8	16.6	23.5	33.4	2.1
ii)Agriculture	Irrigation	1,329.8	1,341.1	1,514.1	1,515.8	1,515.8	1,533.0	1,551.5	97.5
	Livestock	1.4	1.8	2.1	2.6	3.2	4.0	5.2	0.3
	(Fishery)	(10.2)	(17.2)	(18.4)	(19.2)	(19.9)	(20.2)	(22.2)	-
Grand Total		1,344.9	1,366.4	1,543.3	1,549.8	1,556.1	1,581.4	1,613.3	
Total (Excluding water demand for fishery		1,334.7	1,349.2	1,524.9	1,530.5	1,536.1	1,561.3	1,591.1	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.1	0.2	0.3	0.4	0.6	0.8	1.0	0.1
	Industry	3.4	5.4	7.6	9.7	11.9	14.2	16.2	1.9
ii)Agriculture	Irrigation	1,329.8	1,306.8	1,364.5	1,230.5	1,108.8	981.8	843.6	97.7
	Livestock	1.4	1.7	1.8	2.0	2.1	2.2	2.3	0.3
	(Fishery)	(10.2)	(16.5)	(17.3)	(17.9)	(18.4)	(18.7)	(18.9)	-
Grand Total		1,344.9	1,330.6	1,391.5	1,260.5	1,141.8	1,017.7	882.0	
Total (Excluding water demand for fishery		1,334.7	1,314.1	1,374.2	1,242.6	1,123.4	999.0	863.1	100.0

Table H-9 SURFACE WATER DEMAND FOR ABULOG RIVER BASIN : WRR I

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	5.1	17.0	23.9	33.0	45.2	62.4	87.2	8.1
ii)Agriculture	Irrigation	427.7	616.2	661.5	672.0	672.0	805.2	984.7	91.7
	Livestock	0.7	0.7	0.8	1.1	1.3	1.7	2.2	0.2
	(Fishery)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Grand Total		433.4	633.9	686.2	706.1	718.5	869.3	1,074.1	
Total (Excluding water demand for fishery		433.4	633.9	686.2	706.1	718.5	869.3	1,074.1	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	5.1	13.4	21.6	27.0	32.4	37.7	42.3	7.3
ii)Agriculture	Irrigation	427.7	600.4	596.1	545.5	491.6	515.7	535.4	92.5
	Livestock	0.7	0.7	0.7	0.8	0.9	0.9	1.0	0.2
	(Fishery)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	-
Grand Total		433.4	614.5	618.4	573.4	524.8	554.3	578.7	
Total (Excluding water demand for fishery		433.4	614.5	618.4	573.4	524.8	554.3	578.7	100.0

Table H-10 SURFACE WATER DEMAND FOR CAGAYAN RIVER BASIN :WRR II

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	1.1	1.1	1.1	1.1	1.1	1.1	18.0	0.1
ii)Agriculture	Irrigation	4,312.0	6,654.0	7,703.0	8,995.0	10,904.0	12,523.0	14,141.0	99.7
	Livestock	8.0	10.4	11.0	13.6	16.9	21.5	28.5	0.2
	Fishery	(54.6)	(74.9)	(80.2)	(83.8)	(86.8)	(87.8)	(96.7)	-
Grand Total		4,375.7	6,740.4	7,795.3	9,093.5	11,008.8	12,633.4	14,284.2	
Total (Excluding water demand for fishery		4,321.1	6,665.5	7,715.1	9,009.7	10,922.0	12,545.6	14,187.5	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.0
ii)Agriculture	Irrigation	4,312.0	6,654.0	7,703.0	7,996.0	8,286.0	8,286.0	8,286.0	99.8
	Livestock	8.0	10.4	10.8	11.0	12.3	13.6	14.9	0.2
	Fishery	(54.6)	(71.9)	(75.3)	(78.1)	(80.2)	(81.7)	(82.6)	-
Grand Total		4,375.7	6,737.4	7,790.2	8,086.2	8,379.6	8,382.4	8,384.6	
Total (Excluding water demand for fishery		4,321.1	6,665.5	7,714.9	8,008.1	8,299.4	8,300.7	8,302.0	100.0

Table H-11 SURFACE WATER DEMAND FOR ABRA RIVER BASIN : WRR II

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	19.4	19.4	19.4	19.4	19.4	19.4	19.4	5.8
ii)Agriculture	Irrigation	215.0	248.0	284.0	295.0	306.0	308.0	311.0	93.5
	Livestock	0.7	0.9	0.9	1.1	1.4	1.7	2.3	0.7
	Fishery	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)	(0.4)	(0.4)	-
Grand Total		235.3	268.6	304.6	315.8	327.1	329.5	333.1	
Total (Excluding water demand for fishery		235.1	268.3	304.3	315.5	326.8	329.1	332.7	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	19.4	19.4	19.4	19.4	19.4	19.4	19.4	6.0
ii)Agriculture	Irrigation	215.0	248.0	284.0	293.0	302.0	302.0	302.0	93.6
	Livestock	0.7	0.9	0.9	1.0	1.0	1.1	1.2	0.4
	Fishery	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	-
Grand Total		235.3	268.6	304.6	313.7	322.7	322.8	322.9	
Total (Excluding water demand for fishery		235.1	268.3	304.3	313.4	322.4	322.5	322.6	100.0

Table II-12 SURFACE WATER DEMAND FOR AGNO RIVER BASIN : WRR III

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.0	18.2	40.3	75.1	129.4	225.5	336.9	5.9
	Industry	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0
ii)Agricuture	Irrigation	1,281.0	2,314.0	3,270.0	3,677.0	4,329.0	4,833.0	5,377.0	93.8
	Livestock	4.3	6.0	6.5	7.9	9.6	12.1	15.8	0.3
	Fishery	(249.8)	(330.7)	(353.9)	(369.7)	(383.2)	(387.7)	(426.8)	-
Grand Total		1,536.8	2,669.6	3,671.4	4,130.4	4,851.9	5,459.0	6,157.2	
Total (Excluding water demand for fishery		1,287.0	2,338.9	3,317.5	3,760.7	4,468.7	5,071.3	5,730.4	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.0	18.3	40.6	71.9	122.2	211.1	307.4	9.5
	Industry	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0
ii)Agricuture	Irrigation	1,281.0	2,254.7	2,946.9	2,985.0	3,166.6	3,095.1	2,923.7	90.3
	Livestock	4.3	5.8	5.7	6.1	6.4	6.7	7.0	0.2
	Fishery	(249.8)	(317.5)	(332.4)	(344.6)	(353.8)	(360.6)	(364.5)	-
Grand Total		1,536.8	2,597.0	3,326.3	3,408.3	3,649.7	3,674.2	3,603.2	
Total (Excluding water demand for fishery		1,287.0	2,279.5	2,993.9	3,063.7	3,295.9	3,313.6	3,238.7	100.0

Table II-13 SURFACE WATER DEMAND FOR PAMPANGA RIVER BASIN :WRR III

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	4.2	10.8	64.0	123.1	177.3	266.2	4.2
	Industry	14.1	14.1	14.1	14.1	14.1	14.1	14.1	0.2
ii)Agricuture	Irrigation	2,205.0	3,859.0	4,973.0	5,234.0	5,634.0	5,803.0	5,972.0	94.7
	Livestock	10.0	14.7	16.0	21.0	27.5	36.7	50.8	0.8
	Fishery	1,559.8	2,234.7	2,391.5	2,498.3	2,589.1	2,619.6	2,884.1	-
Grand Total		3,788.9	6,126.7	7,405.4	7,831.4	8,387.8	8,650.7	9,187.2	
Total (Excluding water demand for fishery		2,229.1	3,892.0	5,013.9	5,333.1	5,798.7	6,031.1	6,303.1	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	4.9	12.3	48.4	88.1	107.0	122.8	2.2
	Industry	14.1	14.1	14.1	14.1	14.1	14.1	14.1	0.3
ii)Agricuture	Irrigation	2,205.0	3,859.0	4,973.0	5,121.0	5,352.0	5,352.0	5,352.0	97.1
	Livestock	10.0	14.6	15.4	16.1	18.6	21.1	23.5	0.4
	Fishery	(1,559.8)	(2,145.2)	(2,246.0)	(2,328.4)	(2,390.3)	(2,436.2)	(2,462.6)	-
Grand Total		3,788.9	6,037.8	7,260.8	7,528.0	7,863.1	7,930.4	7,975.0	
Total (Excluding water demand for fishery		2,229.1	3,892.6	5,014.8	5,199.6	5,472.8	5,494.2	5,512.4	100.0

Table H-14 SURFACE WATER DEMAND FOR PASIG-LAGUNA BAY BASIN : WRR IV

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	223.3	200.0	150.0	100.0	50.0	25.0	0.0	0.0
ii)Agricuture	Irrigation	149.0	255.0	278.0	300.0	337.0	363.0	390.0	97.6
	Livestock	1.7	2.7	3.0	3.9	5.2	6.9	9.6	2.4
	Fishery	85.9	113.0	120.9	126.3	130.9	132.4	145.8	-
Grand Total		459.9	570.7	551.9	530.2	523.1	527.3	545.4	
Total (Excluding water demand for fishery		374.0	457.7	431.0	403.9	392.2	394.9	399.6	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	0.0	200.0	150.0	100.0	50.0	25.0	0.0	0.0
ii)Agricuture	Irrigation	149.0	255.0	278.0	283.0	293.8	293.8	293.8	98.5
	Livestock	1.7	2.7	2.8	3.0	3.4	3.9	4.4	1.5
	Fishery	(85.9)	(108.4)	(113.5)	(117.7)	(120.8)	(123.2)	(124.5)	-
Grand Total		236.6	566.1	544.3	503.7	468.0	445.9	422.7	
Total (Excluding water demand for fishery		150.7	457.7	430.8	386.0	347.2	322.7	298.2	100.0

Table H-15 SURFACE WATER DEMAND FOR AMNAY-PATRICK : WRR IV

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
ii)Agricuture	Irrigation	53.0	116.0	134.0	238.0	397.0	549.0	702.0	99.6
	Livestock	0.8	1.1	1.1	1.3	1.6	2.0	2.6	0.4
	Fishery	(65.3)	(86.4)	(92.5)	(96.6)	(100.1)	(101.3)	(111.5)	-
Grand Total		119.2	203.6	227.7	336.0	498.8	652.4	816.2	
Total (Excluding water demand for fishery		53.9	117.2	135.2	239.4	398.7	551.1	704.7	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ii)Agricuture	Irrigation	53.0	116.0	134.0	137.0	144.0	144.0	144.0	99.0
	Livestock	0.8	1.1	1.1	1.1	1.2	1.3	1.4	1.0
	Fishery	(65.3)	(83.0)	(86.9)	(90.1)	(92.5)	(94.2)	(95.3)	-
Grand Total		119.2	200.2	222.1	228.3	237.8	239.6	240.8	
Total (Excluding water demand for fishery		53.9	117.2	135.2	138.2	145.3	145.4	145.5	100.0

Table H-16 SURFACE WATER DEMAND FOR BICOL RIVER BASIN : WRR V

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.1
ii)Agricuture	Irrigation	616.0	794.0	997.0	1,170.0	1,397.0	1,570.0	1,742.0	99.2
	Livestock	3.5	4.5	4.7	5.8	7.3	9.3	12.4	0.7
	Fishery	(59.8)	(83.3)	(89.1)	(93.1)	(96.5)	(97.6)	(107.4)	-
Grand Total		681.4	883.9	1,092.9	1,271.0	1,502.9	1,679.0	1,863.9	
Total (Excluding water demand for fishery		621.6	800.6	1,003.8	1,177.9	1,406.4	1,581.4	1,756.5	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.2
	Industry	2.1	2.1	2.1	2.1	2.1	2.1	14.8	1.3
ii)Agricuture	Irrigation	616.0	794.0	997.0	1,099.0	1,155.0	1,155.0	1,155.0	98.0
	Livestock	3.5	4.5	4.6	4.7	5.3	5.8	6.4	0.5
	Fishery	(59.8)	(79.9)	(83.7)	(86.8)	(89.1)	(90.8)	(91.8)	-
Grand Total		681.4	880.5	1,087.4	1,192.6	1,251.5	1,253.7	1,270.2	
Total (Excluding water demand for fishery		621.6	800.6	1,003.7	1,105.8	1,162.4	1,162.9	1,178.4	100.0

Table H-17 SURFACE WATER DEMAND FOR PANAY RIVER BASIN :WRR VI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	2.3	4.4	7.2	10.8	15.2	20.3	26.2	8.1
	Industry	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.6
ii)Agricuture	Irrigation	52.0	156.0	226.0	249.0	267.0	280.0	293.0	90.3
	Livestock	0.9	1.2	1.3	1.6	2.0	2.6	3.4	1.0
	Fishery	(203.2)	(275.7)	(295.2)	(308.4)	(319.6)	(323.4)	(356.0)	-
Grand Total		260.3	439.2	531.6	571.7	605.7	628.2	680.5	
Total (Excluding water demand for fishery		57.1	163.5	236.4	263.3	286.1	304.8	324.5	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	2.3	4.4	7.2	10.8	15.2	20.3	26.2	9.5
	Industry	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.7
ii)Agricuture	Irrigation	52.0	156.0	226.0	241.0	246.0	246.0	246.0	89.2
	Livestock	0.9	1.2	1.3	1.3	1.4	1.6	1.8	0.7
	Fishery	(203.2)	(264.8)	(277.3)	(287.4)	(295.1)	(300.7)	(304.0)	-
Grand Total		260.3	428.3	513.7	542.4	559.6	570.5	579.9	
Total (Excluding water demand for fishery		57.1	163.5	236.4	255.0	264.5	269.8	275.9	100.0

Table H-18 SURFACE WATER DEMAND FOR JALAUR RIVER BASIN :WRR VI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
ii)Agricuture	Irrigation	216.0	319.0	456.0	593.0	746.0	878.0	1,010.0	98.6
	Livestock	3.3	4.7	5.1	6.4	8.0	10.3	13.7	1.3
	Fishery	(244.7)	(337.5)	(361.2)	(377.4)	(391.1)	(395.7)	(435.6)	-
Grand Total		464.2	661.4	822.5	977.0	1,145.3	1,284.2	1,459.5	
Total (Excluding water demand for fishery		219.5	323.9	461.3	599.6	754.2	888.5	1,023.9	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0
ii)Agricuture	Irrigation	216.0	319.0	456.0	593.0	614.0	614.0	614.0	99.0
	Livestock	3.3	4.5	4.5	5.0	5.4	5.7	6.0	1.0
	Fishery	(244.7)	(324.0)	(339.3)	(351.7)	(361.1)	(368.0)	(372.0)	-
Grand Total		464.2	647.7	800.0	949.9	980.7	987.9	992.2	
Total (Excluding water demand for fishery		219.5	323.7	460.7	598.2	619.6	619.9	620.2	100.0

Table H-19 SURFACE WATER DEMAND FOR ILOG-HILABANGAN : WRR VI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	140.7	140.7	140.7	140.7	140.7	140.7	140.7	22.0
ii)Agricuture	Irrigation	2.0	2.0	73.0	193.0	294.0	396.0	497.0	77.6
	Livestock	0.8	1.0	1.1	1.4	1.8	2.3	3.1	0.5
	Fishery	(173.4)	(254.3)	(272.1)	(284.3)	(294.6)	(298.1)	(328.2)	-
Grand Total		316.9	398.0	486.9	619.4	731.1	837.1	969.0	
Total (Excluding water demand for fishery		143.5	143.7	214.8	335.1	436.5	539.0	640.8	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	140.7	140.7	140.7	140.7	140.7	140.7	140.7	52.7
ii)Agricuture	Irrigation	2.0	2.0	73.0	125.0	125.0	125.0	125.0	46.8
	Livestock	0.8	1.0	1.0	1.1	1.2	1.3	1.4	0.5
	Fishery	(173.4)	(244.1)	(255.6)	(264.9)	(272.0)	(277.2)	(280.2)	-
Grand Total		316.9	387.8	470.3	531.7	538.9	544.2	547.3	
Total (Excluding water demand for fishery		143.5	143.7	214.7	266.8	266.9	267.0	267.1	100.0

Table H-20 SURFACE WATER DEMAND FOR AGUSAN RIVER BASIN : WRR X

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	1.8	1.8	1.8	1.8	1.8	1.8	1.8	0.1
ii)Agricuture	Irrigation	310.0	495.0	859.0	1,099.0	1,421.0	1,730.0	2,040.0	99.6
	Livestock	1.8	2.4	2.5	3.2	4.1	5.4	7.3	0.4
	Fishery	(66.3)	(94.3)	(100.9)	(105.4)	(109.3)	(110.6)	(121.7)	-
Grand Total		379.9	593.5	964.2	1,209.4	1,536.2	1,847.8	2,170.8	
Total (Excluding water demand for fishery		313.6	499.2	863.3	1,104.0	1,426.9	1,737.2	2,049.1	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	1.8	1.8	1.8	1.8	1.8	1.8	1.8	0.2
ii)Agricuture	Irrigation	310.0	495.0	859.0	893.0	906.0	906.0	906.0	99.4
	Livestock	1.8	2.3	2.2	2.5	2.7	3.0	3.2	0.4
	Fishery	(66.3)	(90.5)	(94.8)	(98.3)	(100.9)	(102.8)	(103.9)	-
Grand Total		379.9	589.6	957.8	995.6	1,011.4	1,013.6	1,014.9	
Total (Excluding water demand for fishery		313.6	499.1	863.0	897.3	910.5	910.8	911.0	100.0

Table H-21 SURFACE WATER DEMAND FOR TAGOLOAN RIVER BASIN : WRR X

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.8	4.7	8.2	12.9	17.2	22.0	33.9	19.4
	Industry	29.7	29.7	29.7	29.7	29.7	29.7	29.7	17.0
ii)Agricuture	Irrigation	7.0	40.0	58.0	70.0	82.0	94.0	105.0	60.1
	Livestock	1.5	2.2	2.4	2.9	3.6	4.6	6.0	3.4
	Fishery	(27.0)	(39.8)	(42.6)	(44.5)	(46.1)	(46.7)	(51.4)	-
Grand Total		66.0	116.4	140.9	160.0	178.6	197.0	226.0	
Total (Excluding water demand for fishery		39.0	76.6	98.3	115.5	132.5	150.3	174.6	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.8	4.7	8.2	12.9	17.2	21.8	29.8	23.5
	Industry	29.7	29.7	29.7	29.7	29.7	29.7	29.7	23.4
ii)Agricuture	Irrigation	7.0	40.0	58.0	62.0	64.0	64.0	64.0	50.5
	Livestock	1.5	2.2	2.3	2.4	2.7	2.9	3.2	2.5
	Fishery	(27.0)	(38.2)	(40.0)	(41.5)	(42.6)	(43.4)	(43.9)	-
Grand Total		66.0	114.8	138.2	148.5	156.2	161.8	170.6	
Total (Excluding water demand for fishery		39.0	76.6	98.2	107.0	113.6	118.4	126.7	100.0

Table H-22 SURFACE WATER DEMAND FOR CAGAYAN DE ORO RIVER BASIN : WRR X

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.8	10.4	18.1	28.4	37.7	47.9	71.1	24.7
	Industry	39.4	39.4	39.4	39.4	39.4	39.4	39.4	13.7
ii)Agriculture	Irrigation	3.0	39.0	73.0	95.0	121.0	148.0	174.0	60.3
	Livestock	1.1	1.5	1.6	1.9	2.4	3.0	3.9	1.4
	Fishery	(1.2)	(1.6)	(1.7)	(1.8)	(1.9)	(1.9)	(2.1)	-
Grand Total		46.5	91.9	133.8	166.5	202.4	240.2	290.5	
Total (Excluding water demand for fishery		45.3	90.3	132.1	164.7	200.5	238.3	288.4	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.8	10.4	18.1	28.4	37.7	47.7	65.3	35.5
	Industry	39.4	39.4	39.4	39.4	39.4	39.4	39.4	21.4
ii)Agriculture	Irrigation	3.0	39.0	73.0	77.0	77.0	77.0	77.0	41.9
	Livestock	1.1	1.5	1.6	1.6	1.8	1.9	2.1	1.1
	Fishery	(1.2)	(1.5)	(1.6)	(1.7)	(1.7)	(1.7)	(1.8)	-
Grand Total		46.5	91.8	133.7	148.1	157.6	167.7	185.6	
Total (Excluding water demand for fishery		45.3	90.3	132.1	146.4	155.9	166.0	183.8	100.0

Table H-23 SURFACE WATER DEMAND FOR DAVAO RIVER BASIN : WRR XI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	7.6	15.5	27.0	40.5	55.6	72.3	90.6	25.2
	Industry	10.6	10.6	10.6	10.6	10.6	10.6	10.6	3.0
ii)Agriculture	Irrigation	17.0	50.0	91.0	125.0	165.0	203.0	241.0	67.1
	Livestock	3.8	5.4	5.8	7.4	9.5	12.4	16.9	4.7
	Fishery	(74.2)	(105.7)	(113.1)	(118.2)	(122.5)	(123.9)	(136.4)	-
Grand Total		113.2	187.2	247.5	301.7	363.2	422.2	495.5	
Total (Excluding water demand for fishery		39.0	81.5	134.4	183.5	240.7	298.3	359.1	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	7.6	15.5	27.0	40.5	55.6	72.3	90.6	43.1
	Industry	10.6	10.6	10.6	10.6	10.6	10.6	10.6	5.0
ii)Agriculture	Irrigation	17.0	50.0	91.0	99.0	101.0	101.0	101.0	48.0
	Livestock	3.8	5.3	5.6	5.8	6.6	7.4	8.2	3.9
	Fishery	(74.2)	(101.5)	(106.2)	(110.1)	(113.1)	(115.2)	(116.5)	-
Grand Total		113.2	182.9	240.4	266.0	286.9	306.5	326.9	
Total (Excluding water demand for fishery		39.0	81.4	134.2	155.9	173.8	191.3	210.4	100.0

Table H-24 SURFACE WATER DEMAND FOR TAGUM-LIBUGANON RIVER BASIN : WRR XI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	39.1	39.1	39.1	39.1	39.1	39.1	39.1	4.1
ii)Agriculture	Irrigation	224.0	230.0	238.0	359.0	543.0	725.0	906.0	94.9
	Livestock	2.1	2.9	3.1	4.0	5.1	6.7	9.1	1.0
	Fishery	(55.0)	(71.8)	(76.8)	(80.3)	(83.2)	(84.1)	(92.6)	-
Grand Total		320.2	343.8	357.0	482.4	670.4	854.9	1,046.8	
Total (Excluding water demand for fishery		265.2	272.0	280.2	402.1	587.2	770.8	954.2	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Industry	39.1	39.1	39.1	39.1	39.1	39.1	39.1	13.7
ii)Agriculture	Irrigation	224.0	230.0	238.0	239.0	241.0	241.0	241.0	84.7
	Livestock	2.1	2.9	3.0	3.1	3.5	4.0	4.4	1.5
	Fishery	(55.0)	(68.9)	(72.2)	(74.8)	(76.8)	(78.3)	(79.1)	-
Grand Total		320.2	340.9	352.3	356.0	360.4	362.4	363.6	
Total (Excluding water demand for fishery		265.2	272.0	280.1	281.2	283.6	284.1	284.5	100.0

Table H-25 SURFACE WATER DEMAND FOR BUAYAN-MALUNGUN RIVER BASIN : WRR XI

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.0	2.0	3.5	5.3	7.3	9.5	11.9	1.7
	Industry	129.1	129.1	129.1	129.1	129.1	129.1	129.1	18.4
ii)Agriculture	Irrigation	57.0	61.0	73.0	161.0	294.0	423.0	552.0	78.8
	Livestock	2.0	2.7	2.8	3.5	4.4	5.7	7.6	1.1
	Fishery	(3.4)	(4.4)	(4.8)	(5.0)	(5.2)	(5.2)	(5.7)	-
Grand Total		192.5	199.2	213.2	303.9	440.0	572.5	706.3	
Total (Excluding water demand for fishery		189.1	194.8	208.4	298.9	434.8	567.3	700.6	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	1.0	2.0	3.5	5.3	7.3	9.5	11.9	5.3
	Industry	129.1	129.1	129.1	129.1	129.1	129.1	129.1	57.9
ii)Agriculture	Irrigation	57.0	61.0	73.0	74.0	78.0	78.0	78.0	35.0
	Livestock	2.0	2.7	2.7	2.8	3.2	3.5	3.9	1.7
	Fishery	(3.4)	(4.3)	(4.5)	(4.6)	(4.8)	(4.8)	(4.9)	-
Grand Total		192.5	199.1	212.8	215.8	222.4	224.9	227.8	
Total (Excluding water demand for fishery		189.1	194.8	208.3	211.2	217.6	220.1	222.9	100.0

Table H-26 SURFACE WATER DEMAND FOR AGUS RIVER BASIN : WRR XII

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	9.0	21.6	57.3	103.5	7.0
	Industry	72.2	72.2	72.2	72.2	72.2	72.2	72.2	4.9
ii)Agricuture	Irrigation	71.0	315.0	553.0	715.0	920.0	1,114.0	1,308.0	87.9
	Livestock	1.6	2.2	2.3	2.7	3.2	3.8	4.8	0.3
	Fishery	(228.2)	(333.0)	(356.3)	(372.2)	(385.8)	(390.3)	(429.7)	-
Grand Total		373.0	722.4	983.8	1,171.1	1,402.8	1,637.6	1,918.2	
Total (Excluding water demand for fishery		144.8	389.4	627.5	798.9	1,017.0	1,247.3	1,488.5	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	9.0	21.6	57.3	103.5	13.3
	Industry	72.2	72.2	72.2	72.2	72.2	72.2	72.2	9.3
ii)Agricuture	Irrigation	71.0	315.0	553.0	587.0	597.0	597.0	597.0	77.0
	Livestock	1.6	2.2	2.3	2.3	2.5	2.7	2.9	0.4
	Fishery	(228.2)	(319.6)	(334.6)	(346.9)	(356.1)	(363.0)	(366.9)	-
Grand Total		373.0	709.0	962.1	1,017.4	1,049.4	1,092.2	1,142.5	
Total (Excluding water demand for fishery		144.8	389.4	627.5	670.5	693.3	729.2	775.6	100.0

Table H-27 SURFACE WATER DEMAND FOR MINDANAO RIVER BASIN : WRR XII

Case 1: High Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.9	1.2	0.0
	Industry	9.6	9.6	9.6	9.6	9.6	9.6	9.6	0.1
ii)Agricuture	Irrigation	2,387.0	4,082.0	6,203.0	7,613.0	9,558.0	11,557.0	13,456.0	99.8
	Livestock	6.1	7.7	8.0	9.8	12.1	15.3	20.2	0.1
	Fishery	(40.0)	(54.8)	(58.6)	(61.3)	(63.5)	(64.2)	(70.7)	-
Grand Total		2,442.7	4,154.1	6,279.2	7,693.7	9,643.2	11,647.0	13,557.7	
Total (Excluding water demand for fishery		2,402.7	4,099.3	6,220.6	7,632.4	9,579.7	11,582.8	13,487.0	100.0

Case 2: Low Economic Growth

(Unit : million m^3/year)

Sector of Water Use		Year							Ratio in 2025
		1996	2000	2005	2010	2015	2020	2025	(%)
i) M&I	Municipal	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.0
	Industry	9.6	9.6	9.6	9.6	9.6	9.6	9.6	0.1
ii)Agricuture	Irrigation	2,387.0	4,082.0	6,203.0	6,354.0	6,499.0	6,499.0	6,499.0	99.7
	Livestock	6.1	7.7	7.9	8.1	9.0	9.9	10.7	0.2
	Fishery	(40.0)	(52.6)	(55.1)	(57.1)	(58.6)	(59.7)	(60.4)	-
Grand Total		2,442.7	4,151.9	6,275.6	6,428.8	6,576.2	6,578.7	6,580.3	
Total (Excluding water demand for fishery		2,402.7	4,099.3	6,220.5	6,371.7	6,517.6	6,519.0	6,519.9	100.0

Table H-28 LIST OF THE ALTERNATIVE DAM SITE FOR WATER SUPPLY TO METRO CEBU AND DAVAO

Alternative Site	Catchment Area (km^2)	Proposed Dam Type (m)	Proposed Height (m)	Proposed Crest Length (m)	Effective Volume ($x\ 10^6 m^3$)	Dead Volume ($x\ 10^6 m^3$)	Supply Capacity (m^3/day)
For CEBU							
Cebu B (Buhisan Dam) (Existing on 1910)	5.9	Concrete Double Arch	26	-	0.26	-	4,000
Malubog Dam	70.0	Rockfill	65	520	47.00	21.0	123,600
Mananga II Dam	68.0	Rockfill	90	240	41.0	7.0	120,400
Lusaran Dam	67.0	Rockfill	100	315	116.0	10.0	36,000
Cebu Fo (Pulambato Dam	21.0	Rockfill	55	300	2.0	1.0	177,400
Tipolo Dam	500.0	Rockfill	60	300	120.0	90.0	259,000
						Total	720,400
For DAVAO							
Davao I	367	Rockfill	75	400	150	180	
Davao II	820	Rockfill	112	350	264	172	
Davao IIIR	163	Rockfill	132	430	56	55	

Part – H

Figures

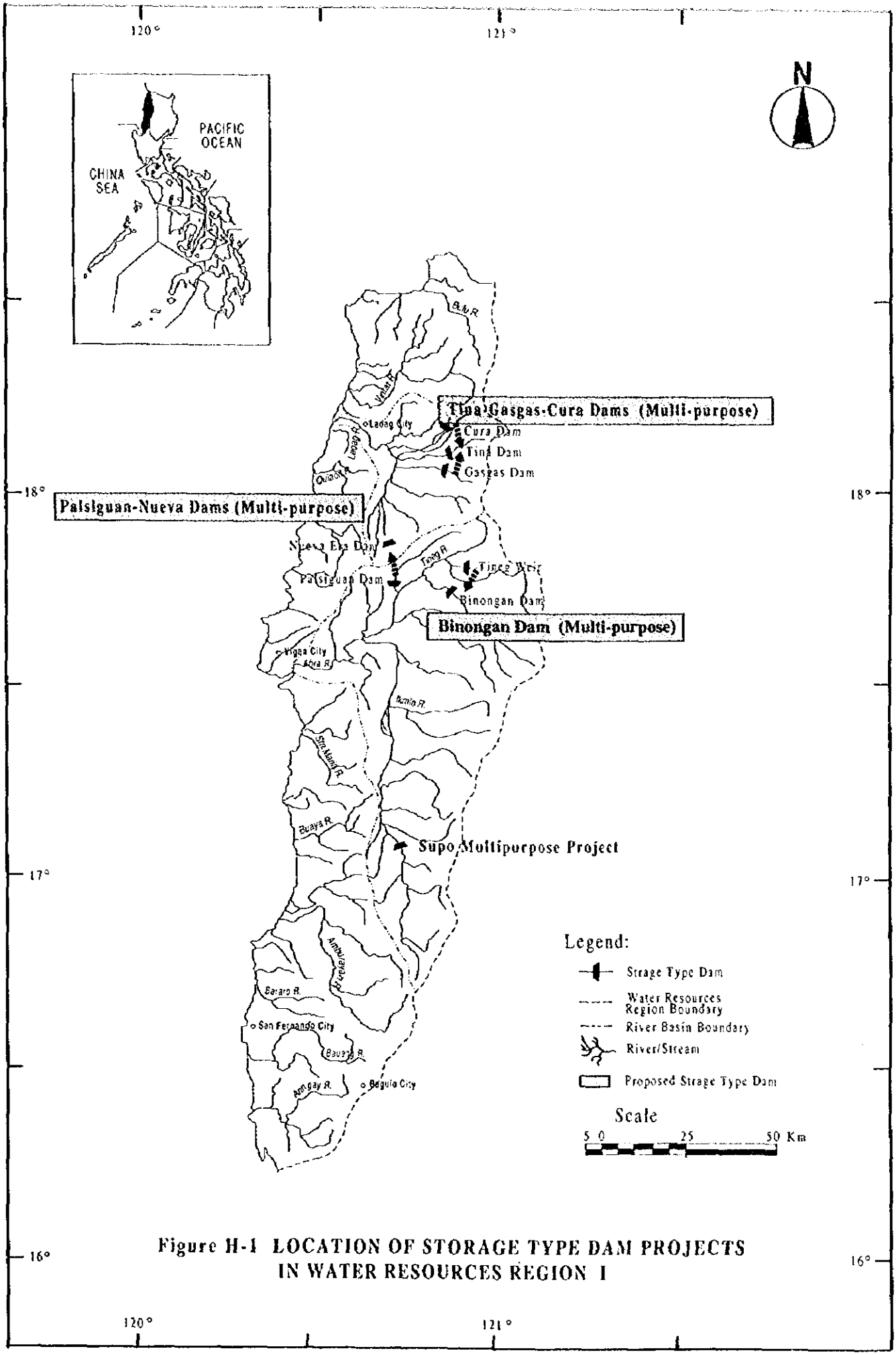


Figure H-1 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION I

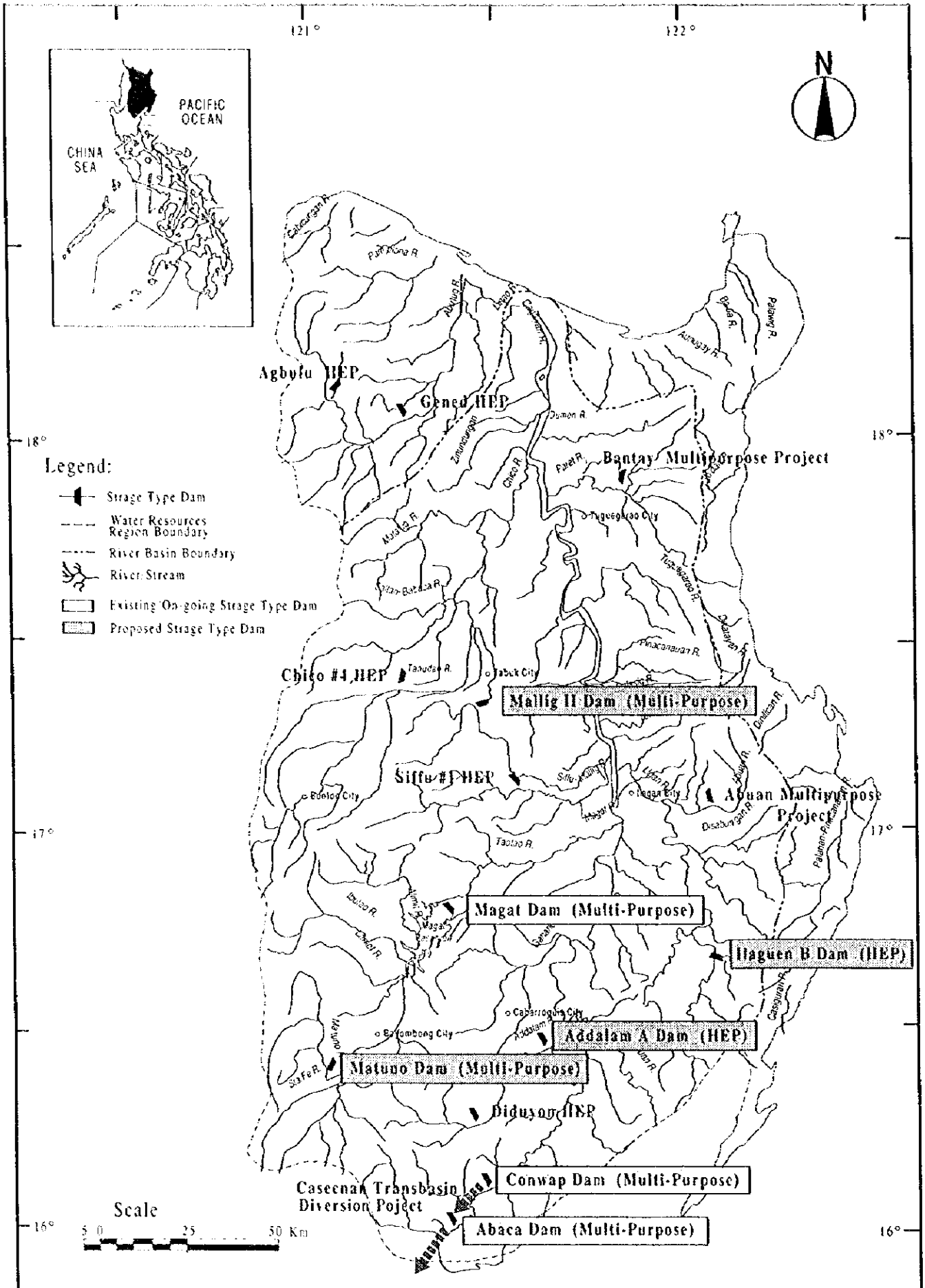


Figure II-2 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION II

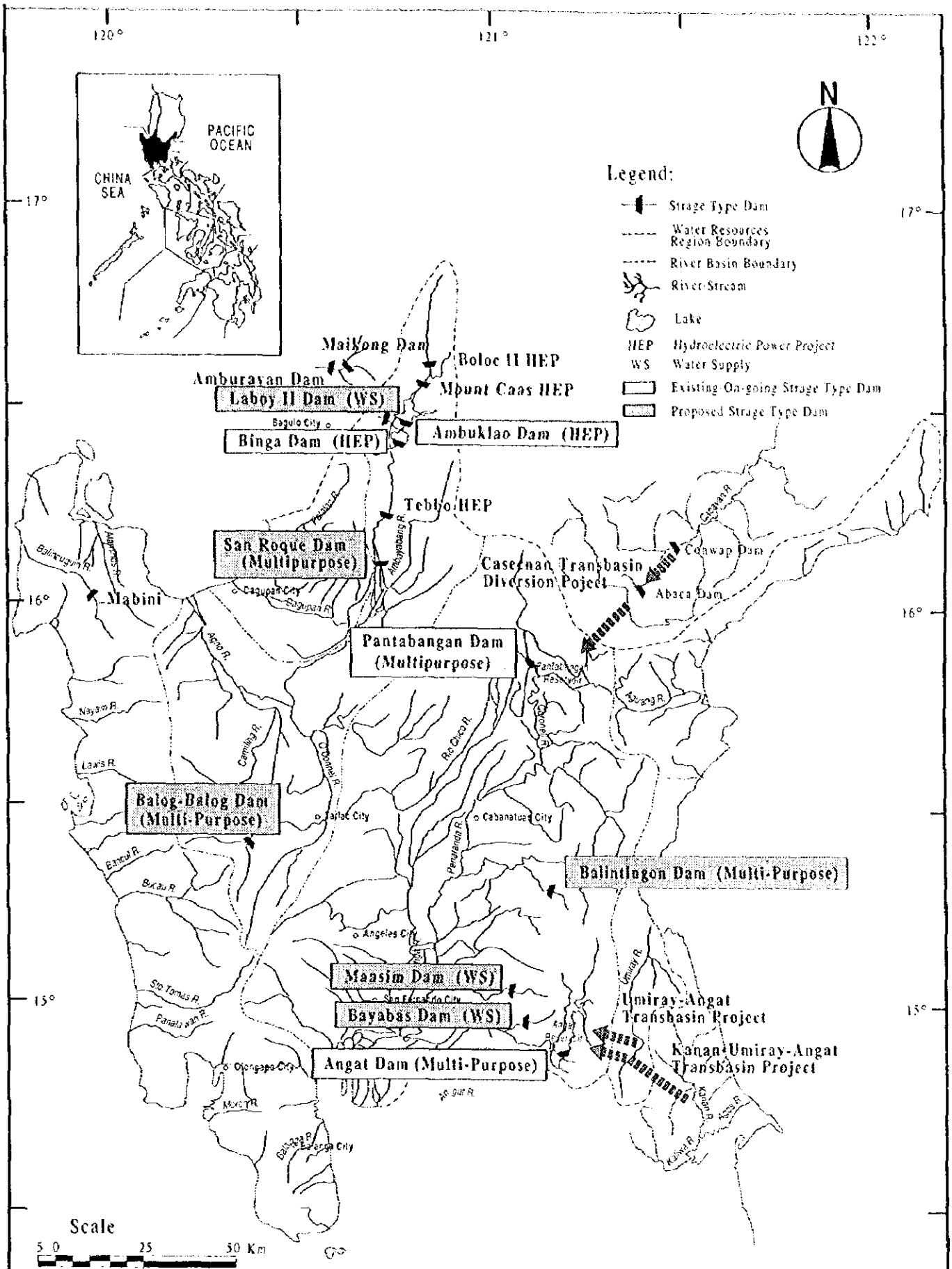


Figure II-3 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION III

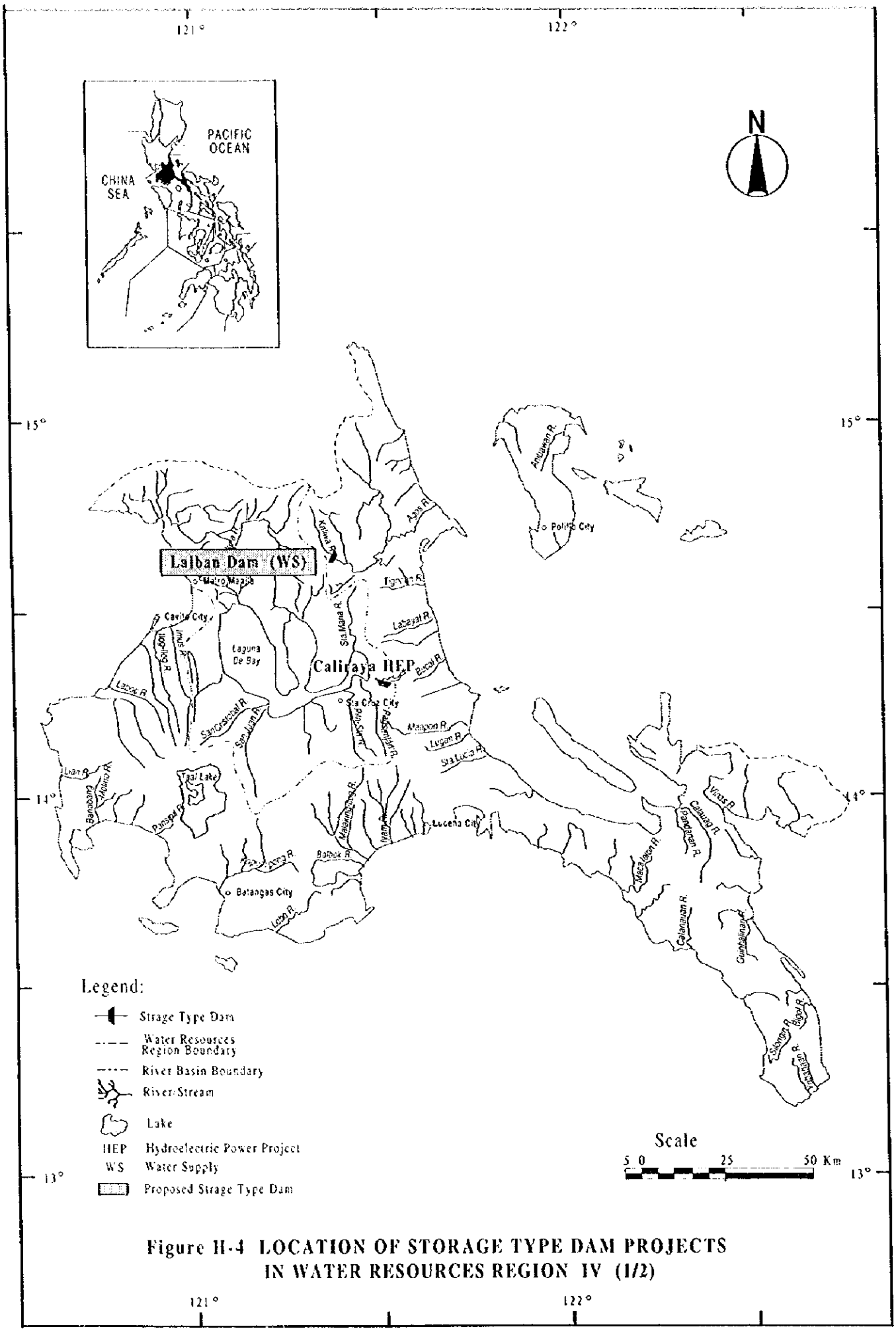


Figure H-4 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION IV (1/2)

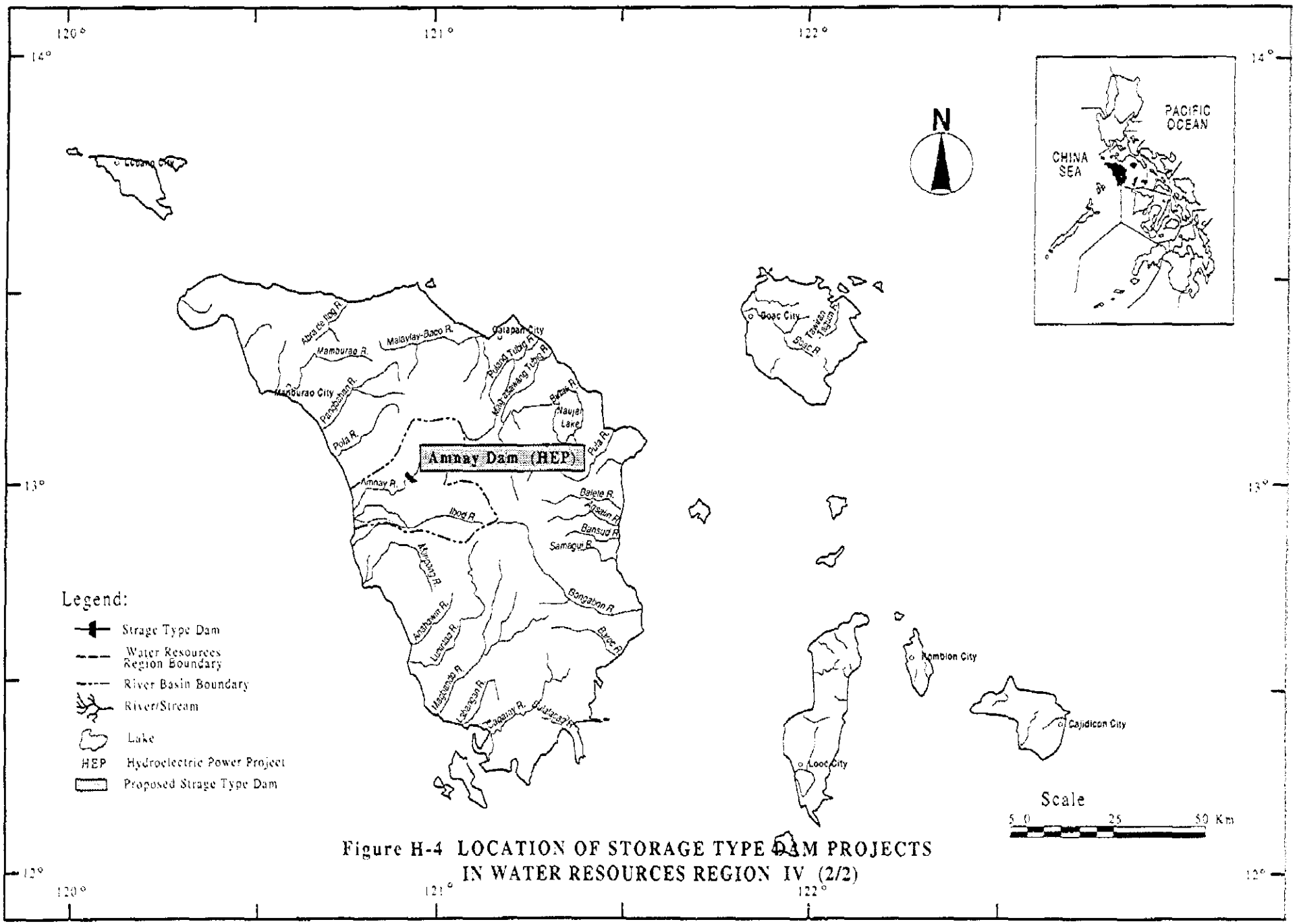


Figure H-4 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION IV (2/2)

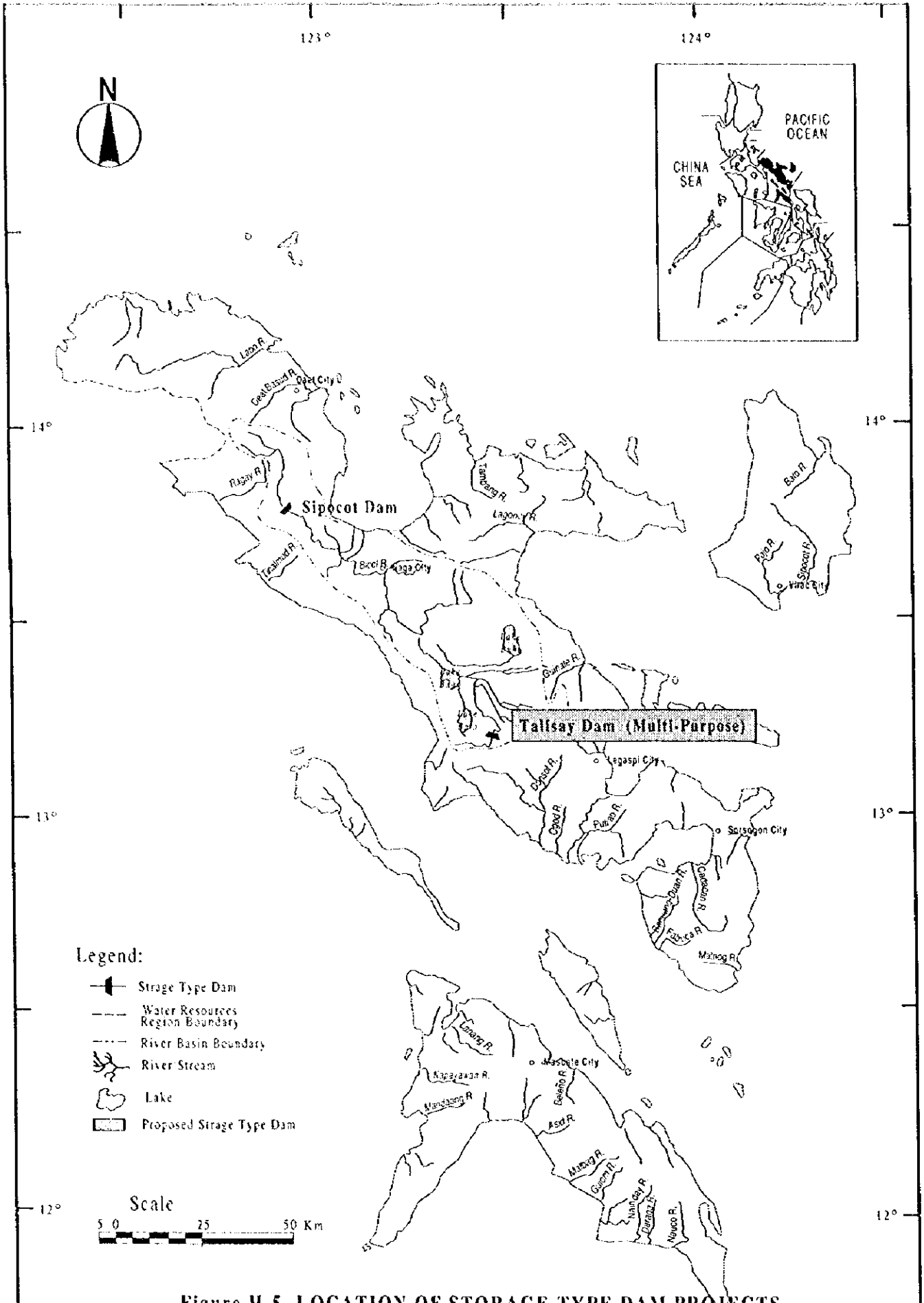


Figure H-5 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION V

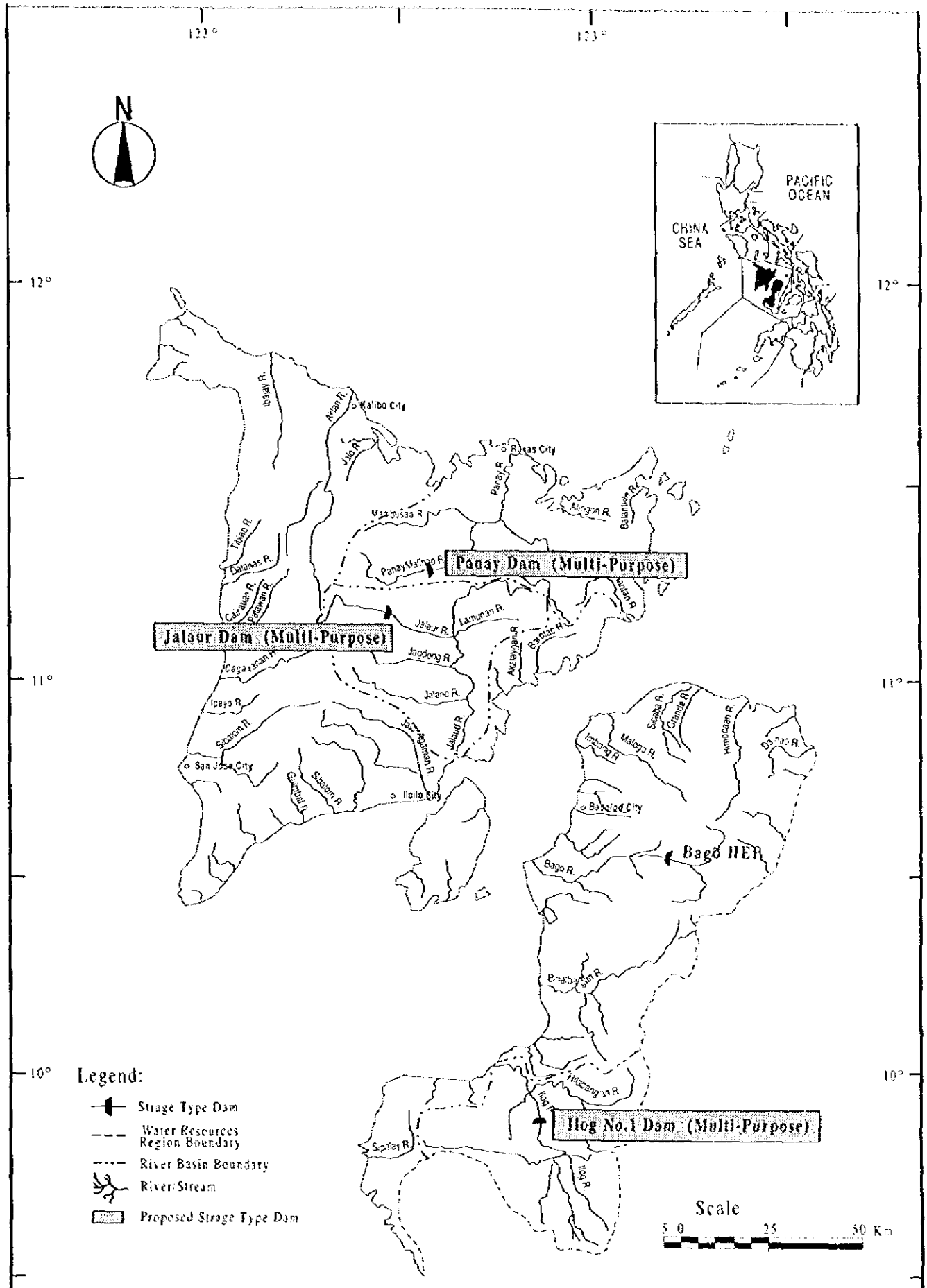


Figure H-6 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION VI

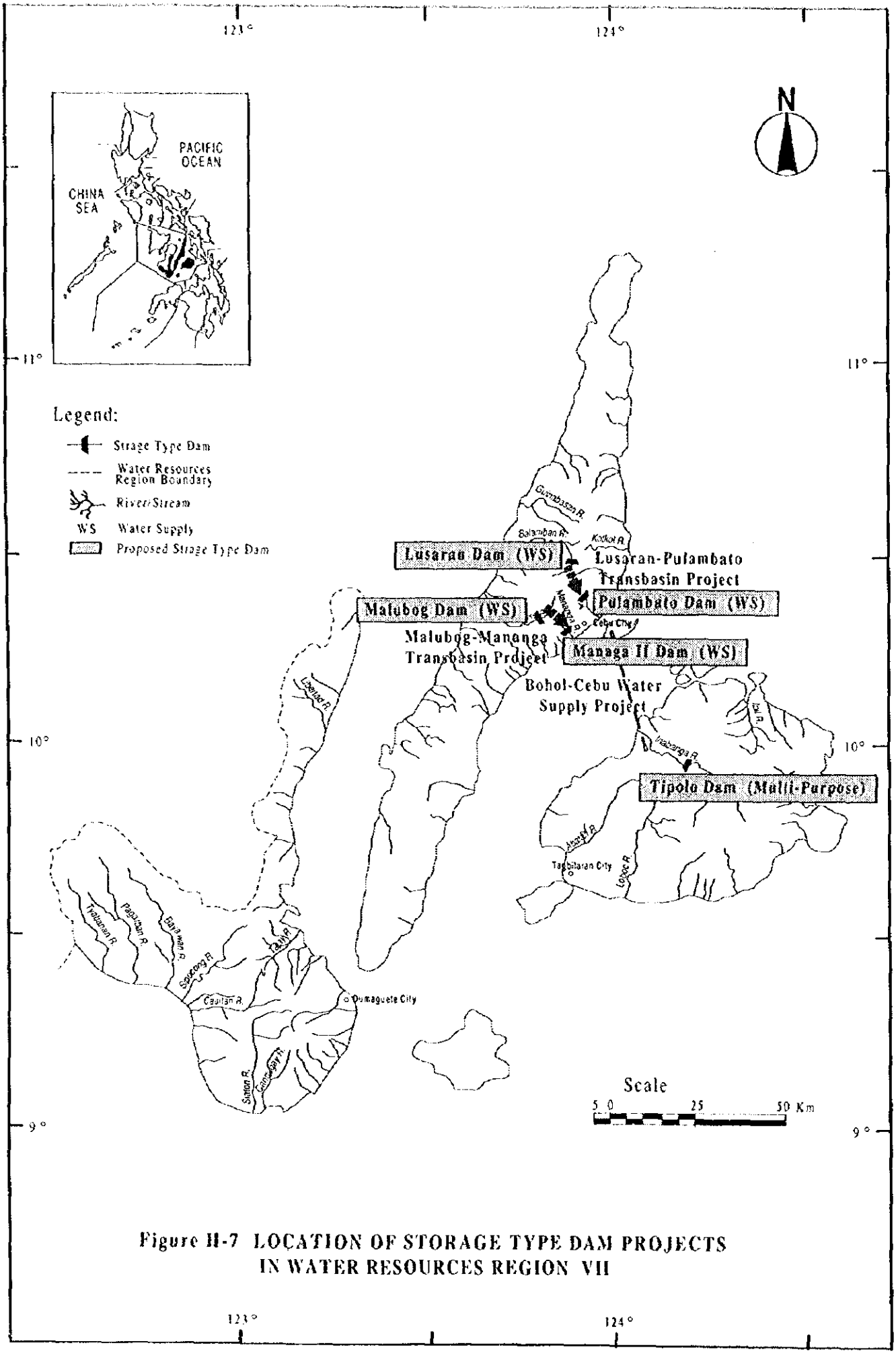


Figure H-7 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION VII

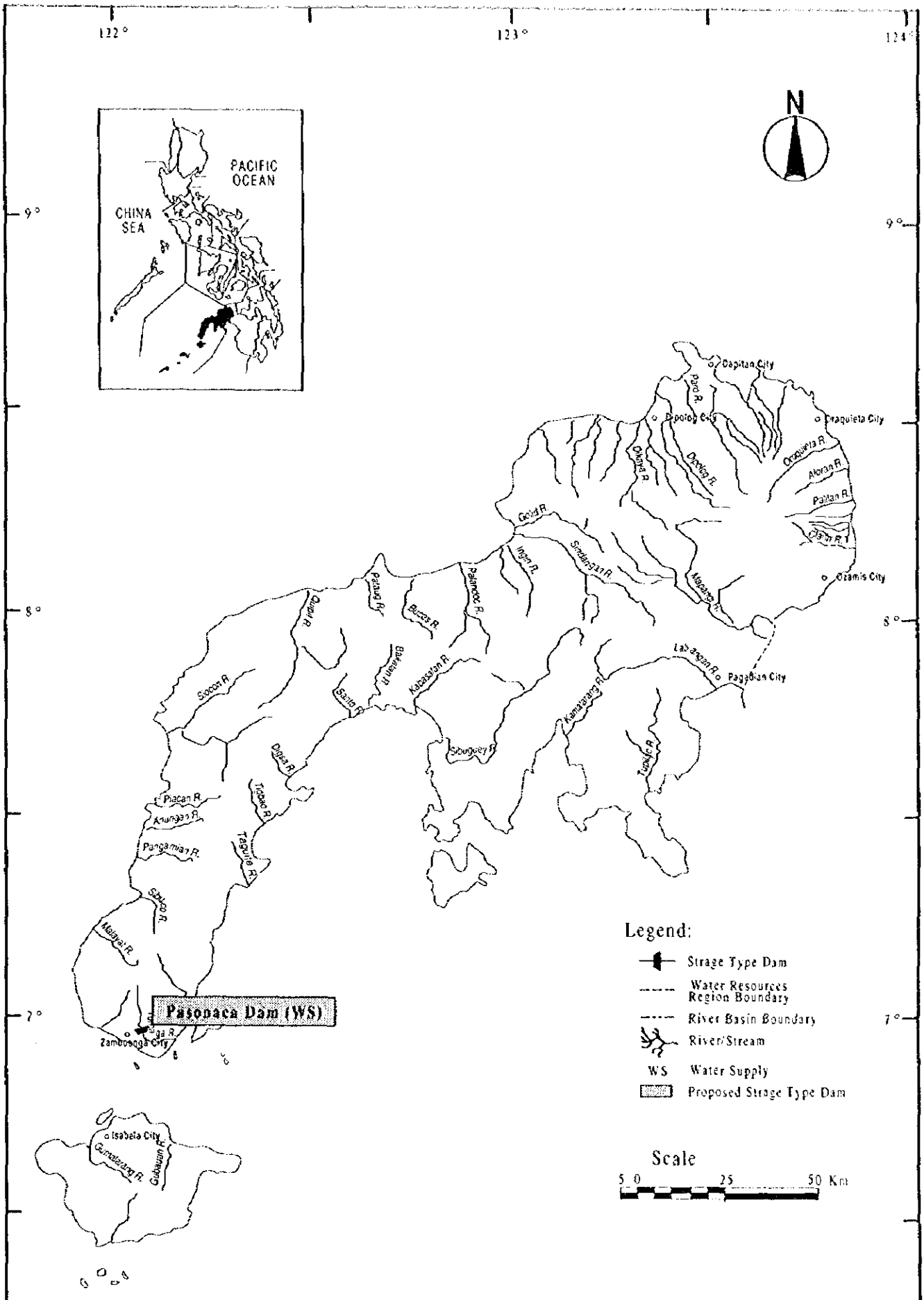


Figure H-8 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION IX

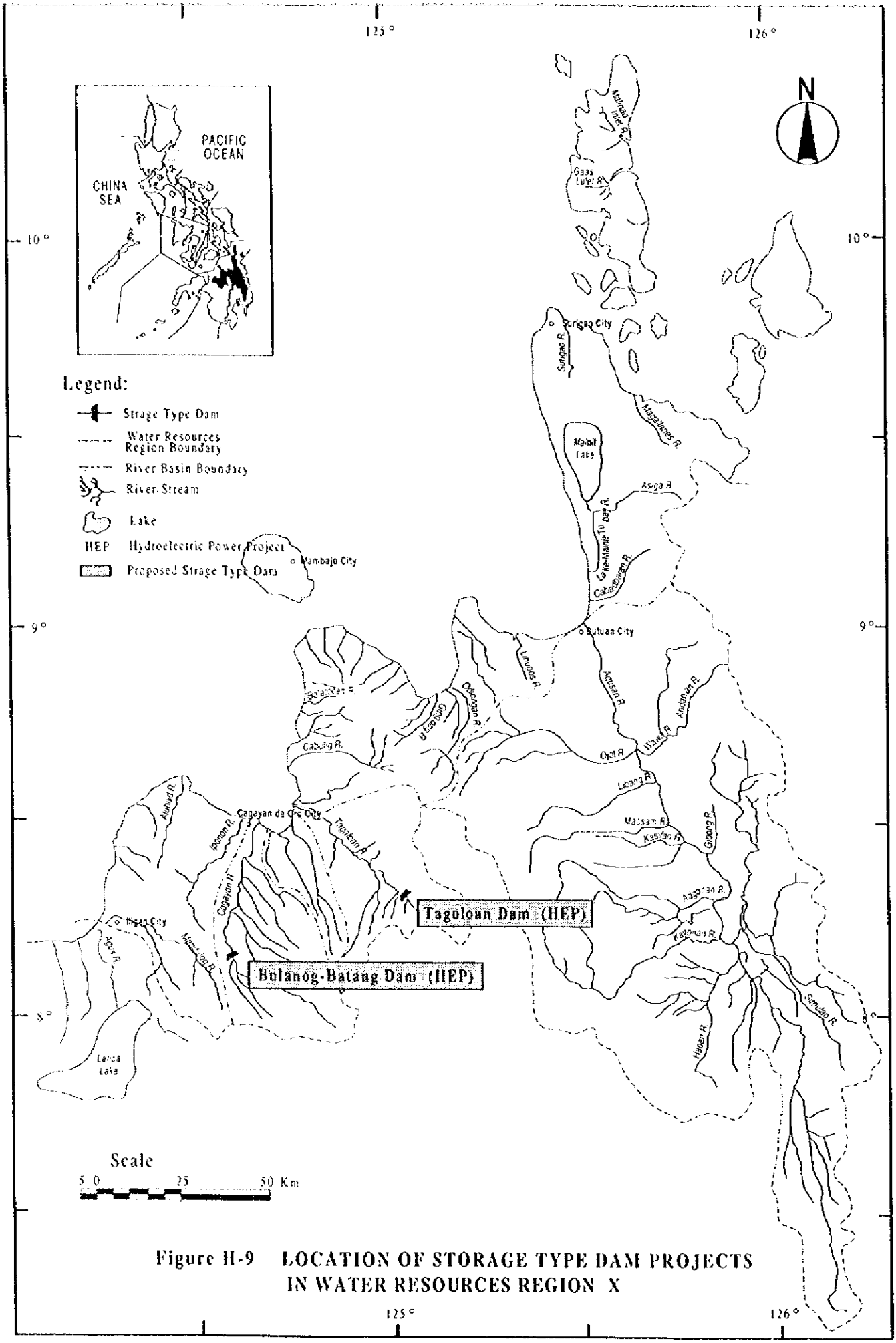


Figure H-9 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION X

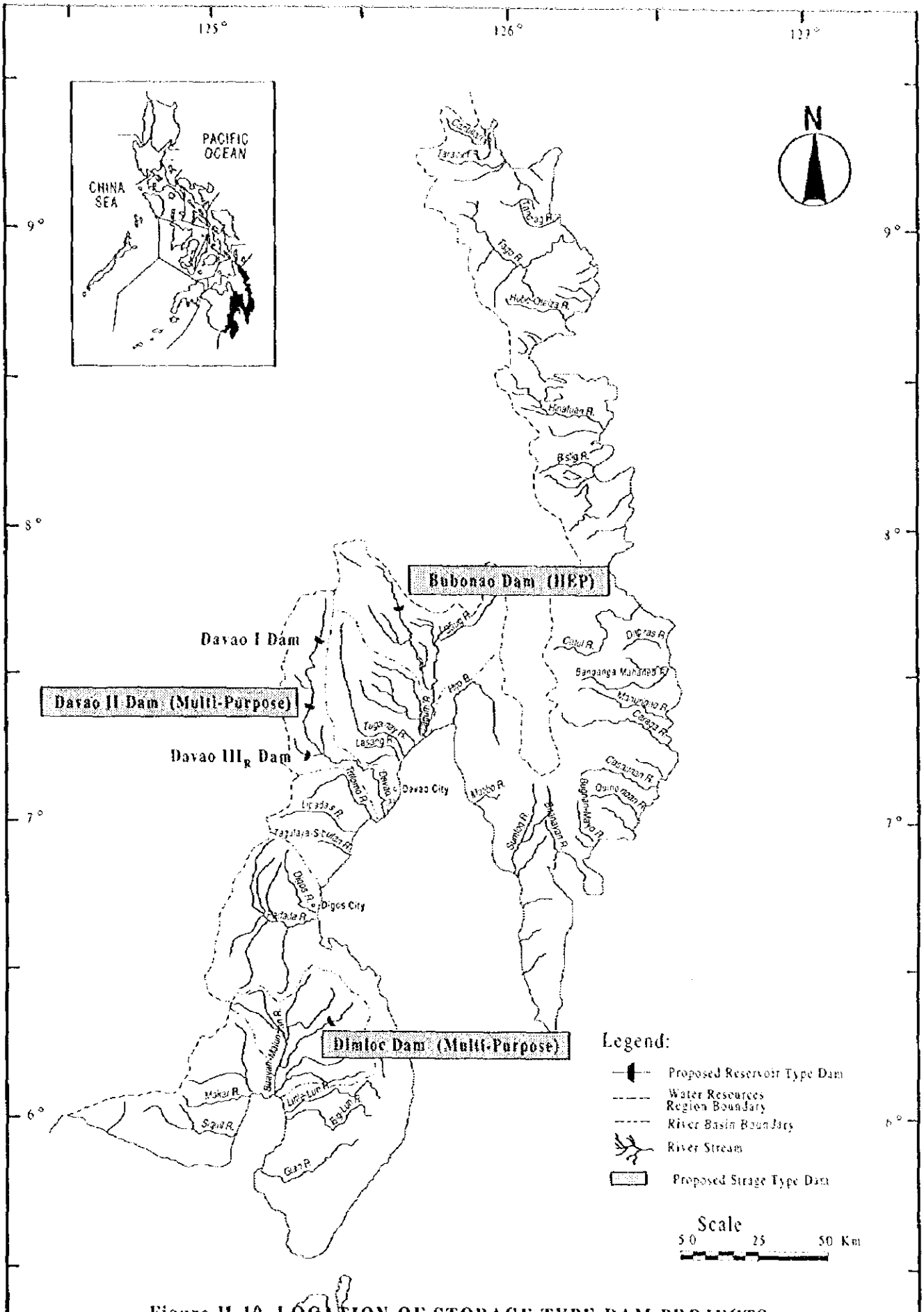


Figure H-10 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION XI

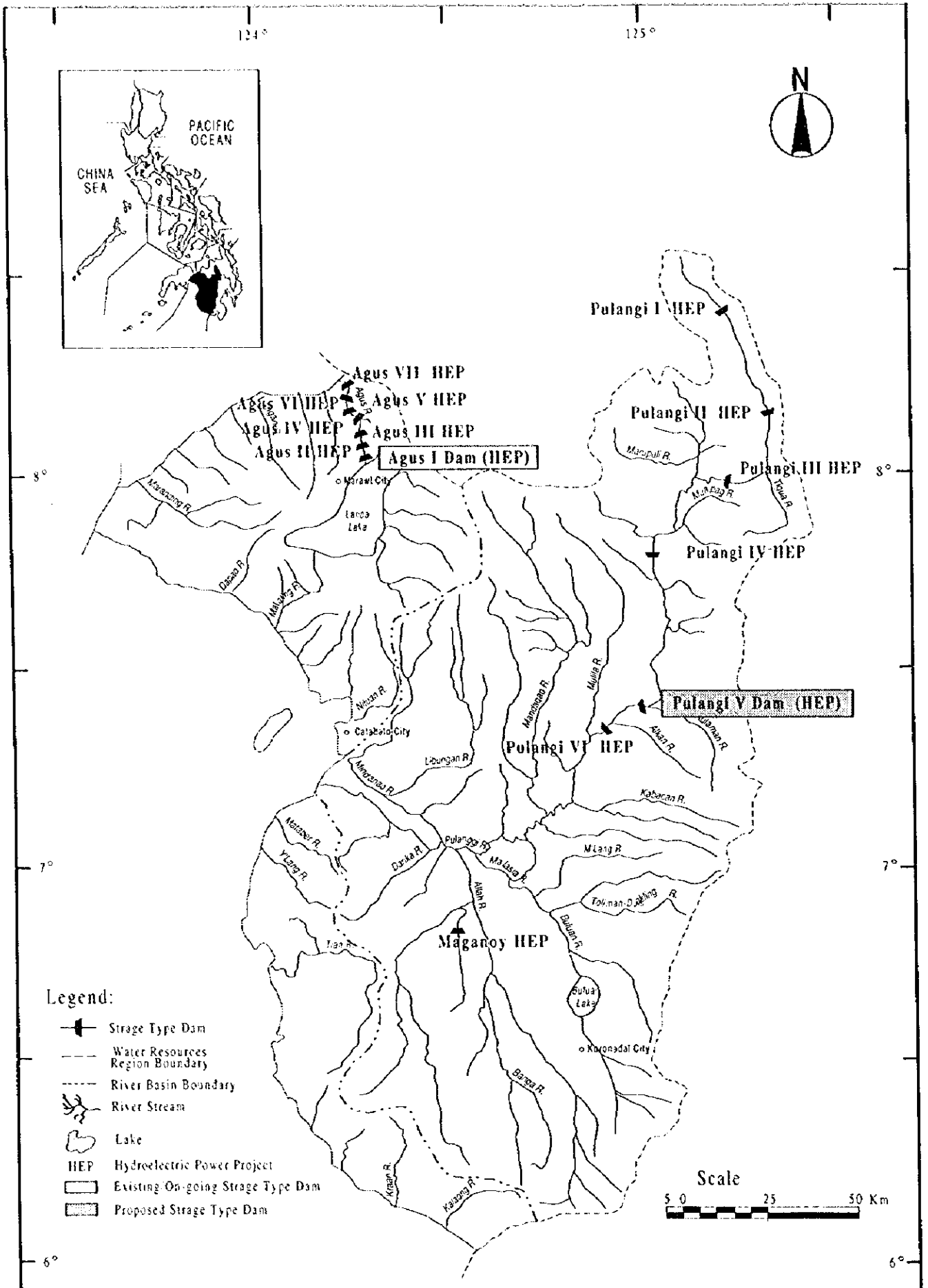


Figure H-11 LOCATION OF STORAGE TYPE DAM PROJECTS IN WATER RESOURCES REGION XII

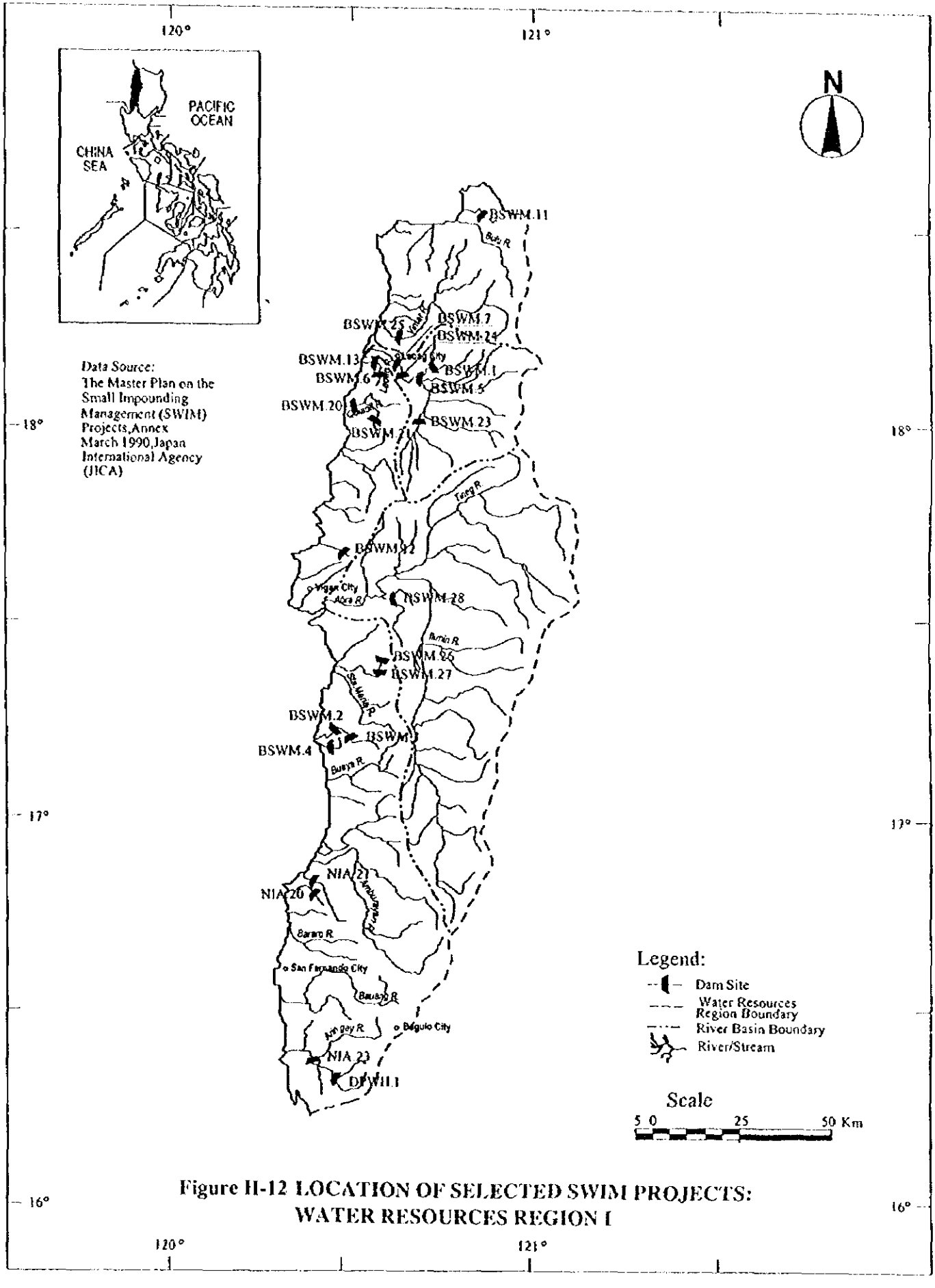


Figure H-12 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION I

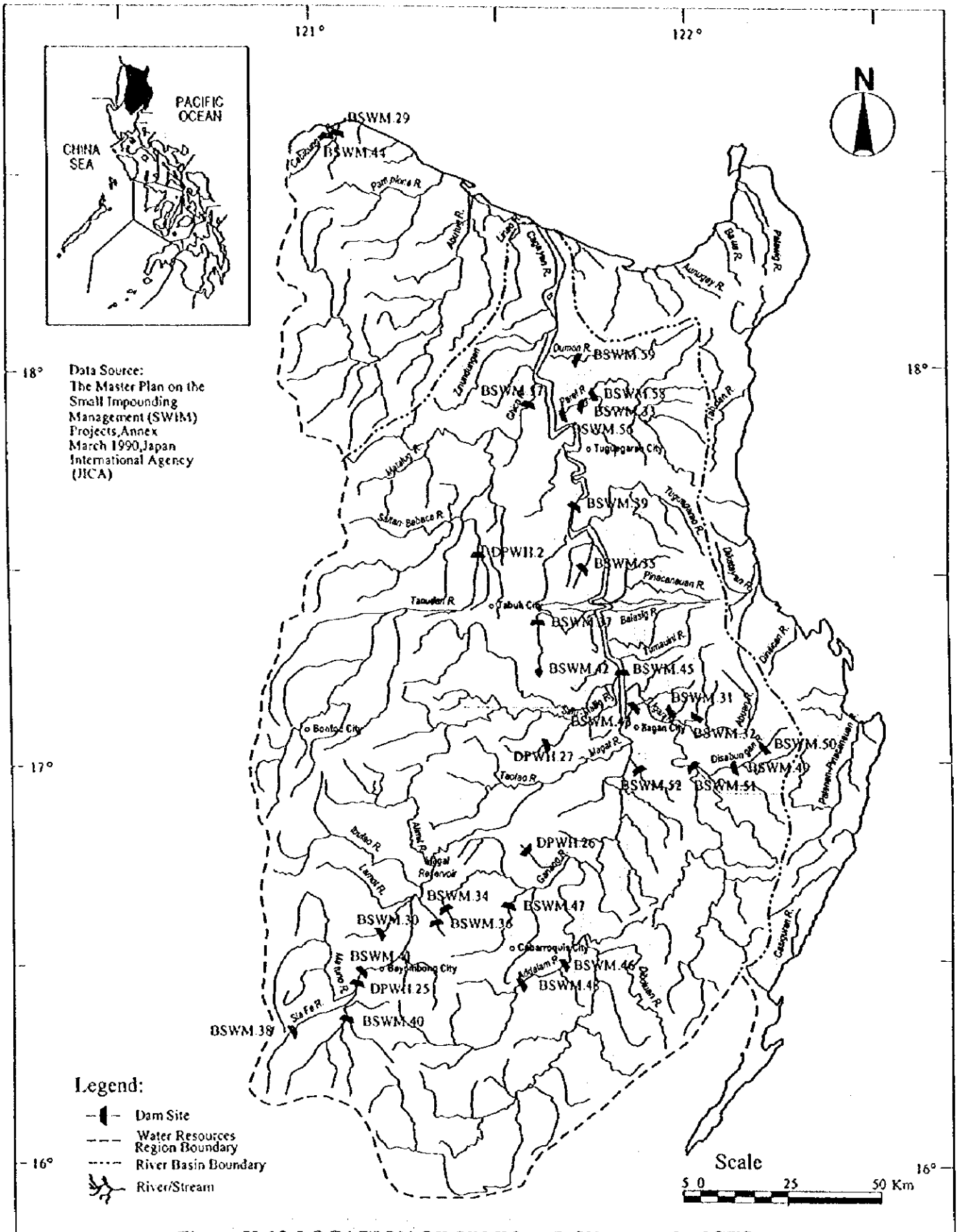


Figure II-13 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION II

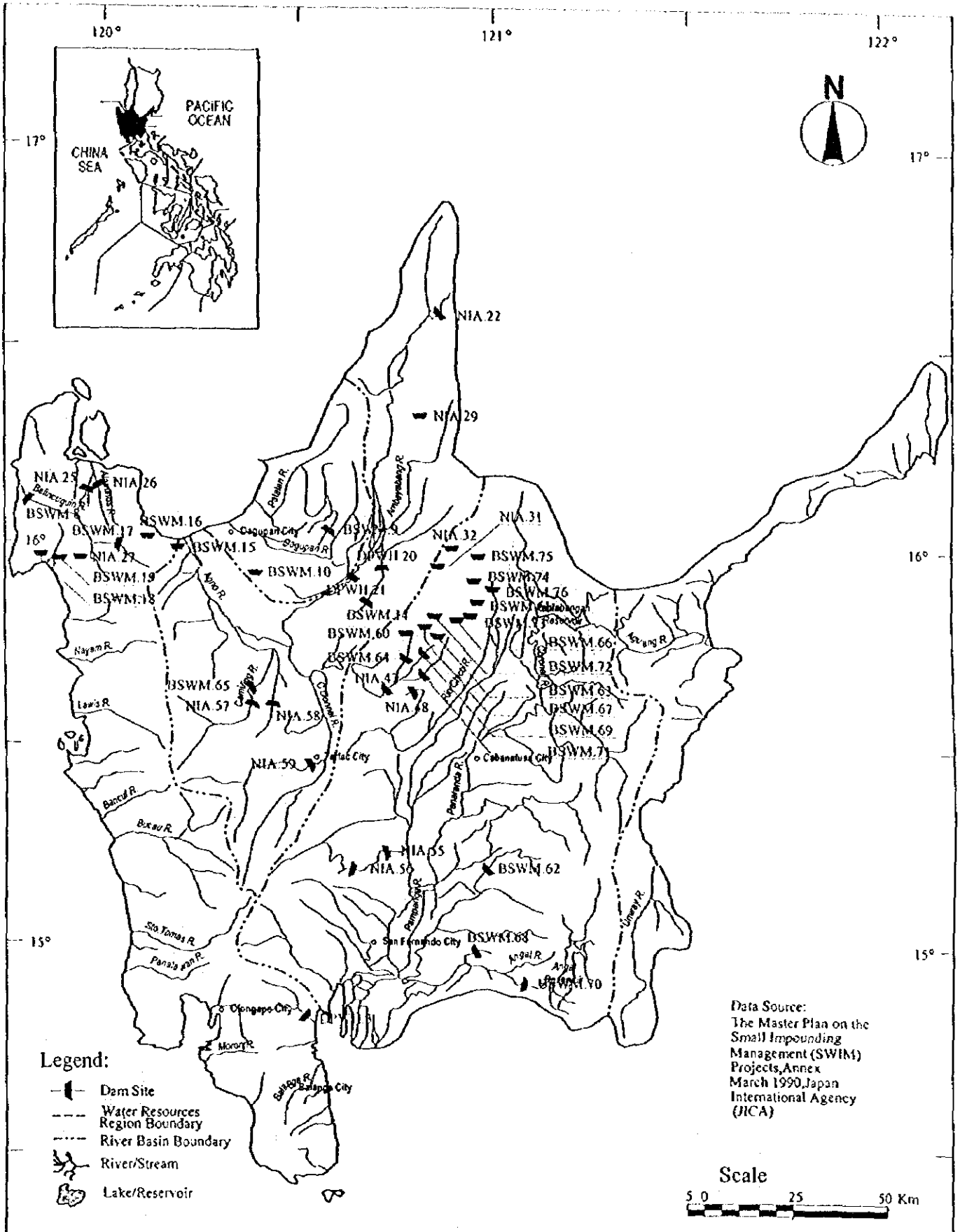


Figure H-14 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION III

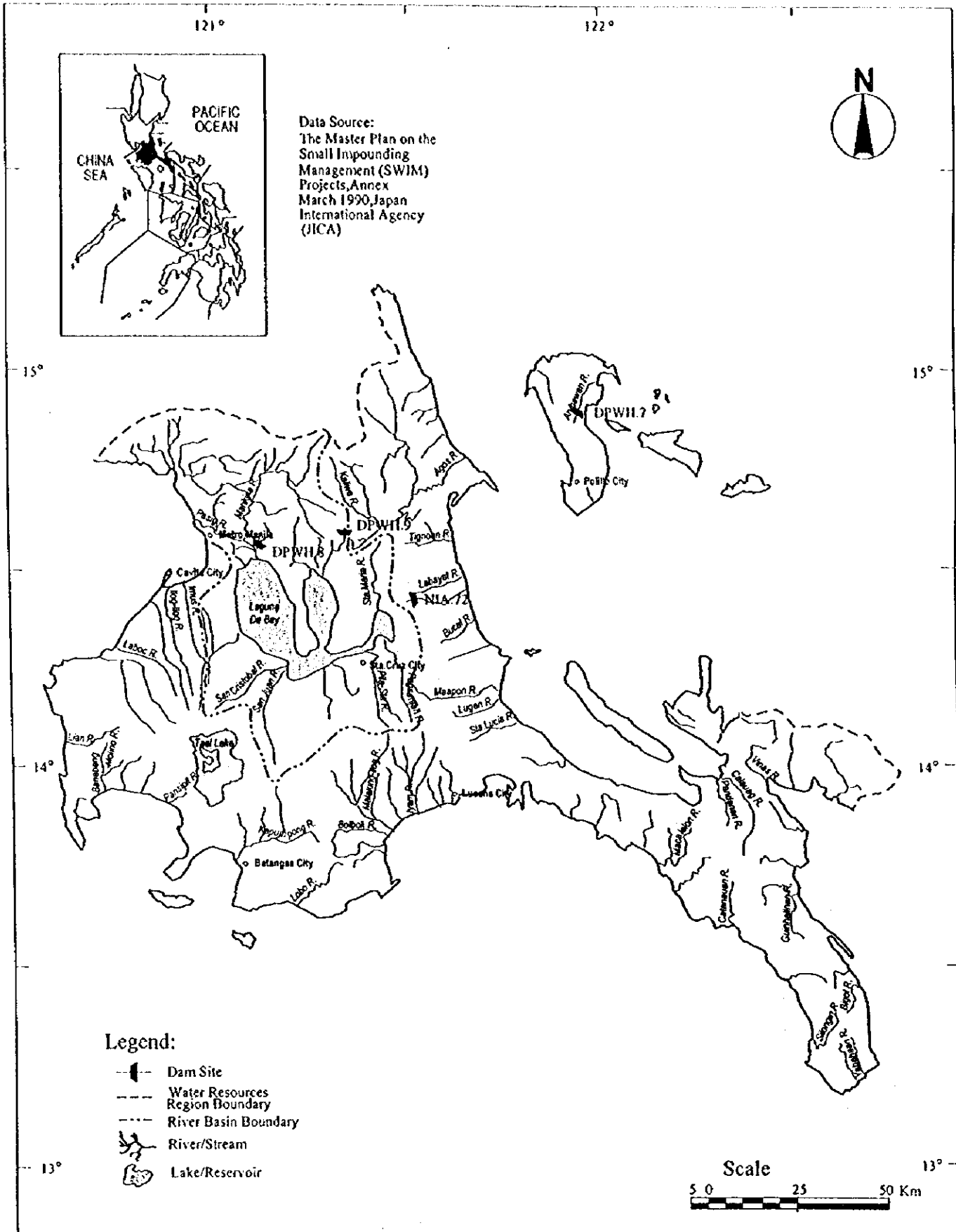


Figure H-15 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION IV (1/3)

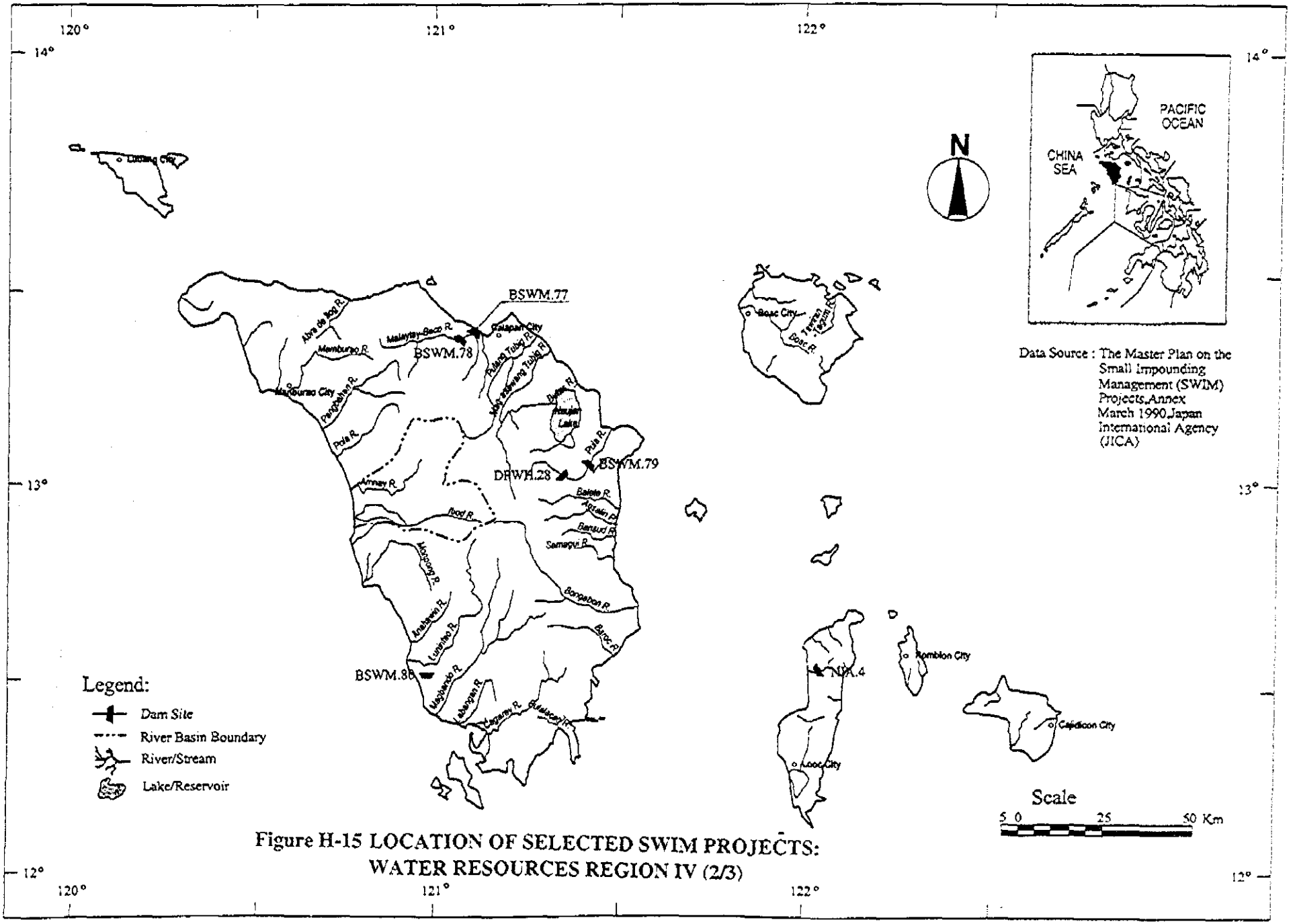


Figure H-15 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION IV (2/3)

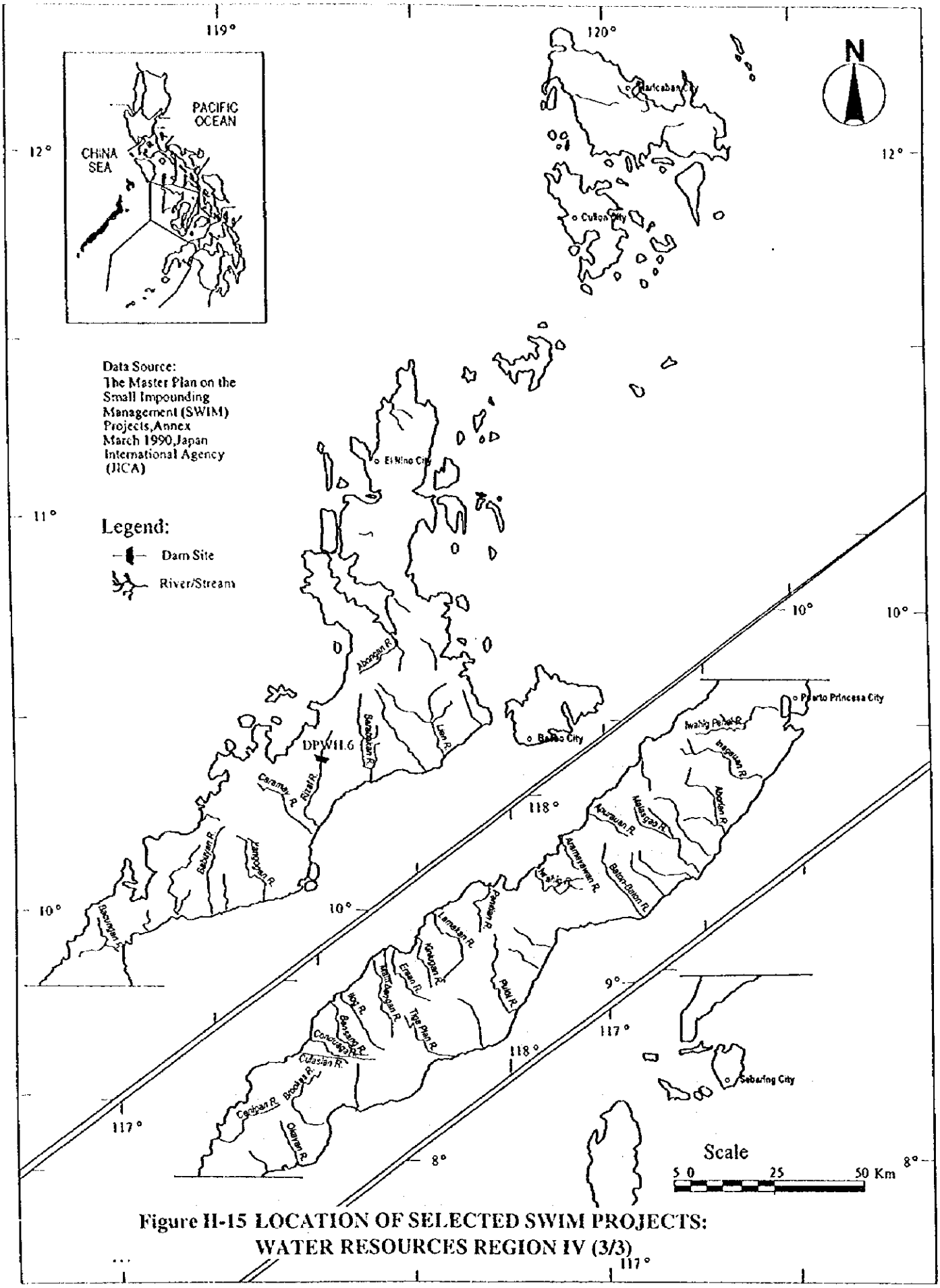


Figure II-15 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION IV (3/3)

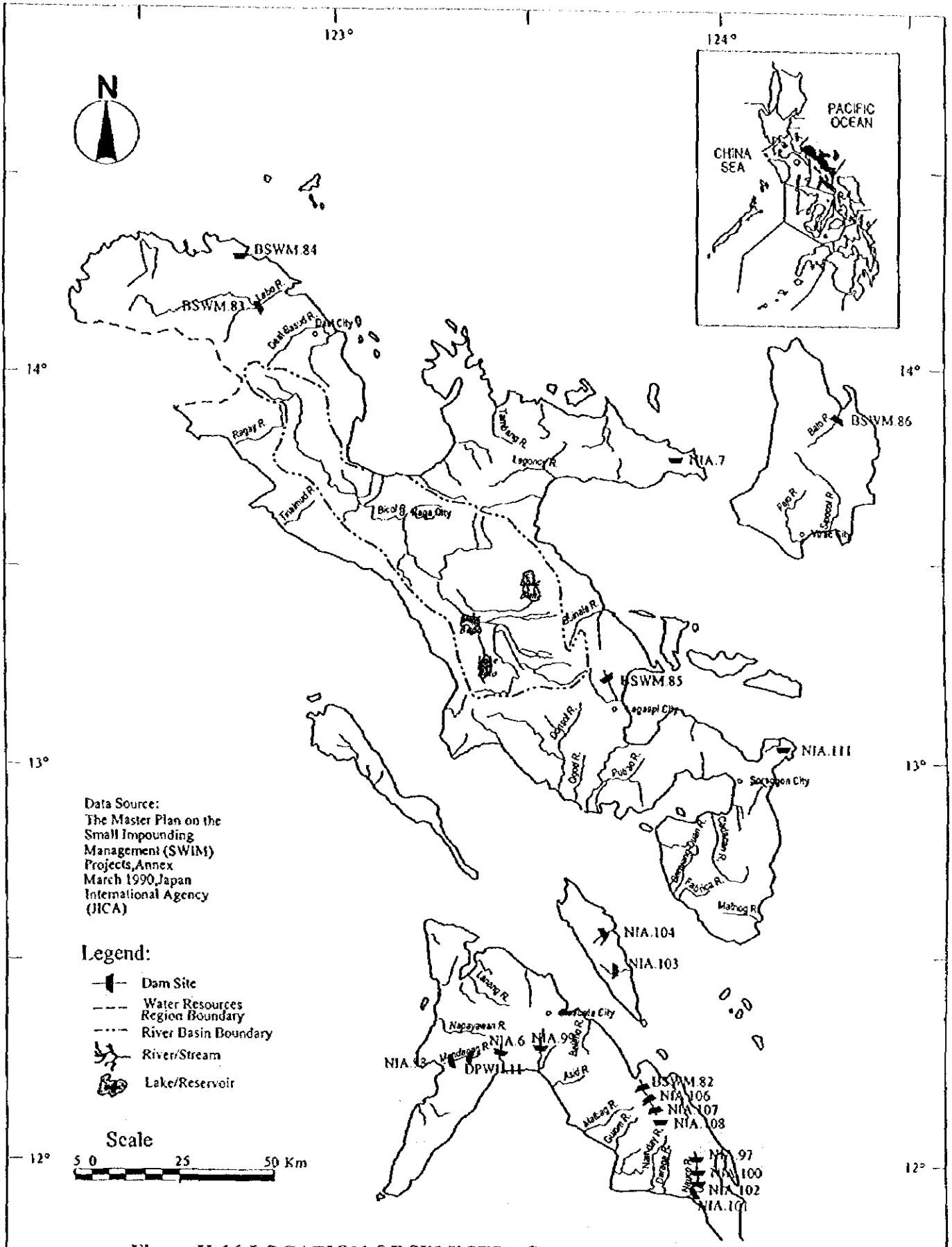


Figure H-16 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION V

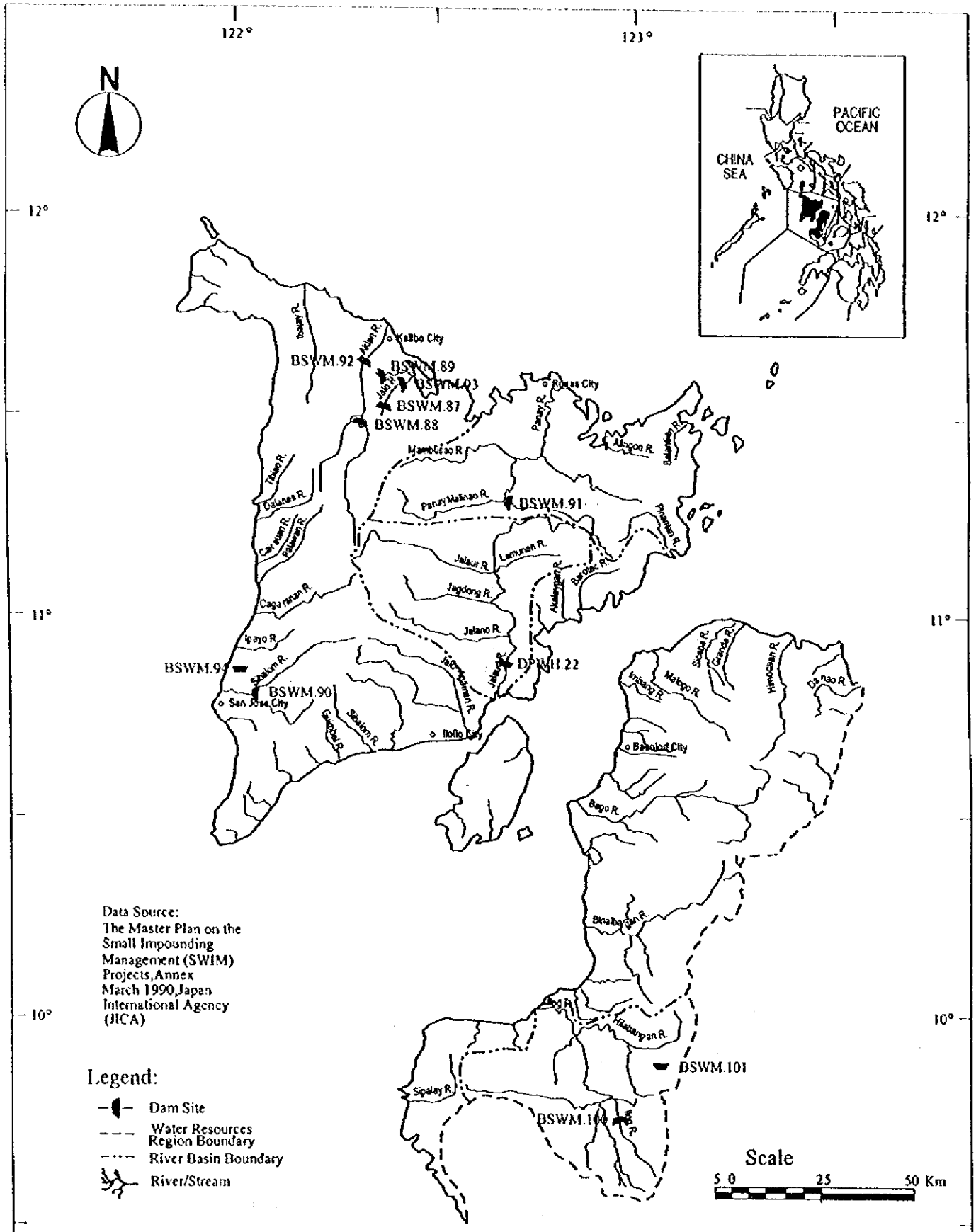


Figure H-17 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION VI

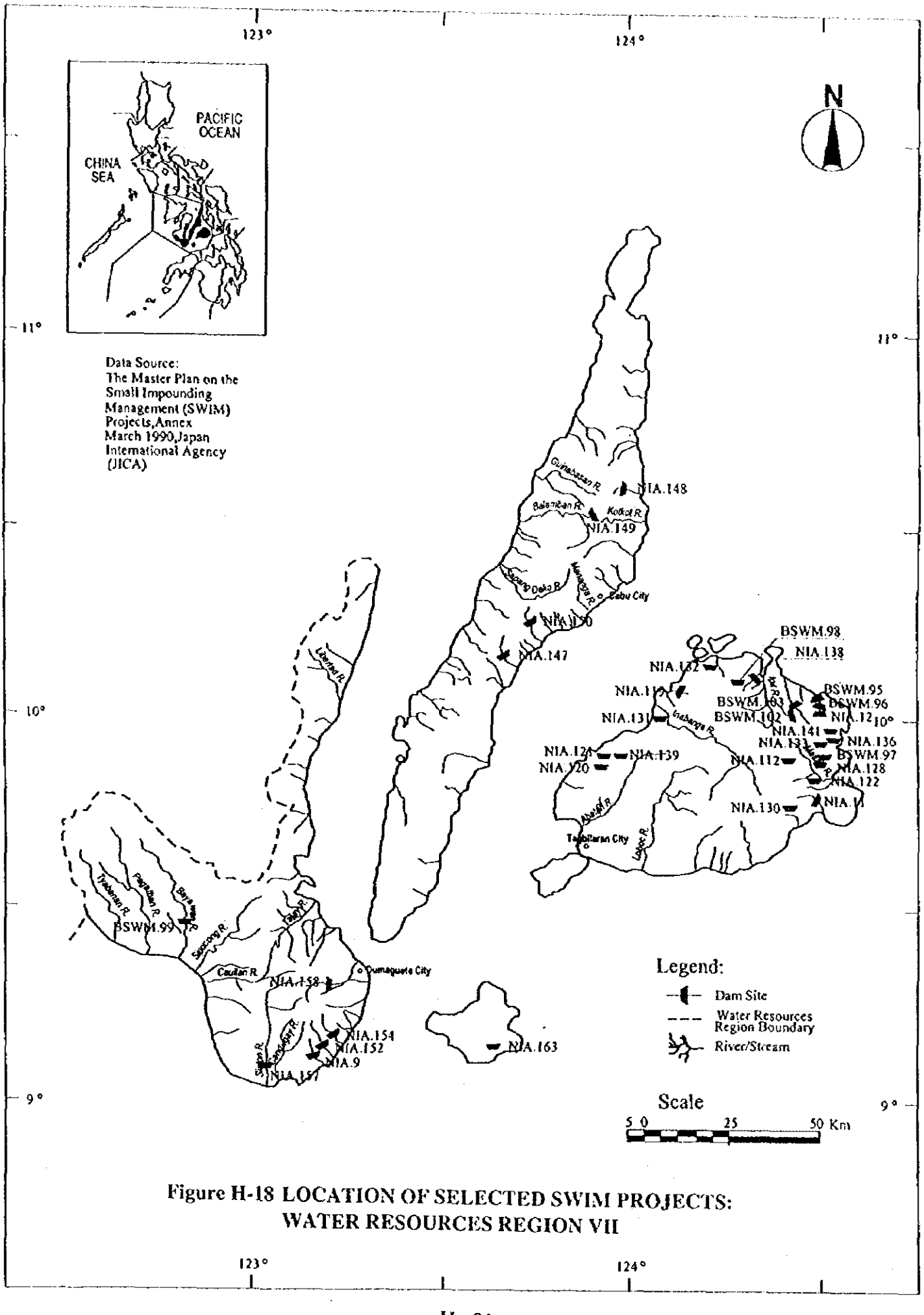


Figure H-18 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION VII

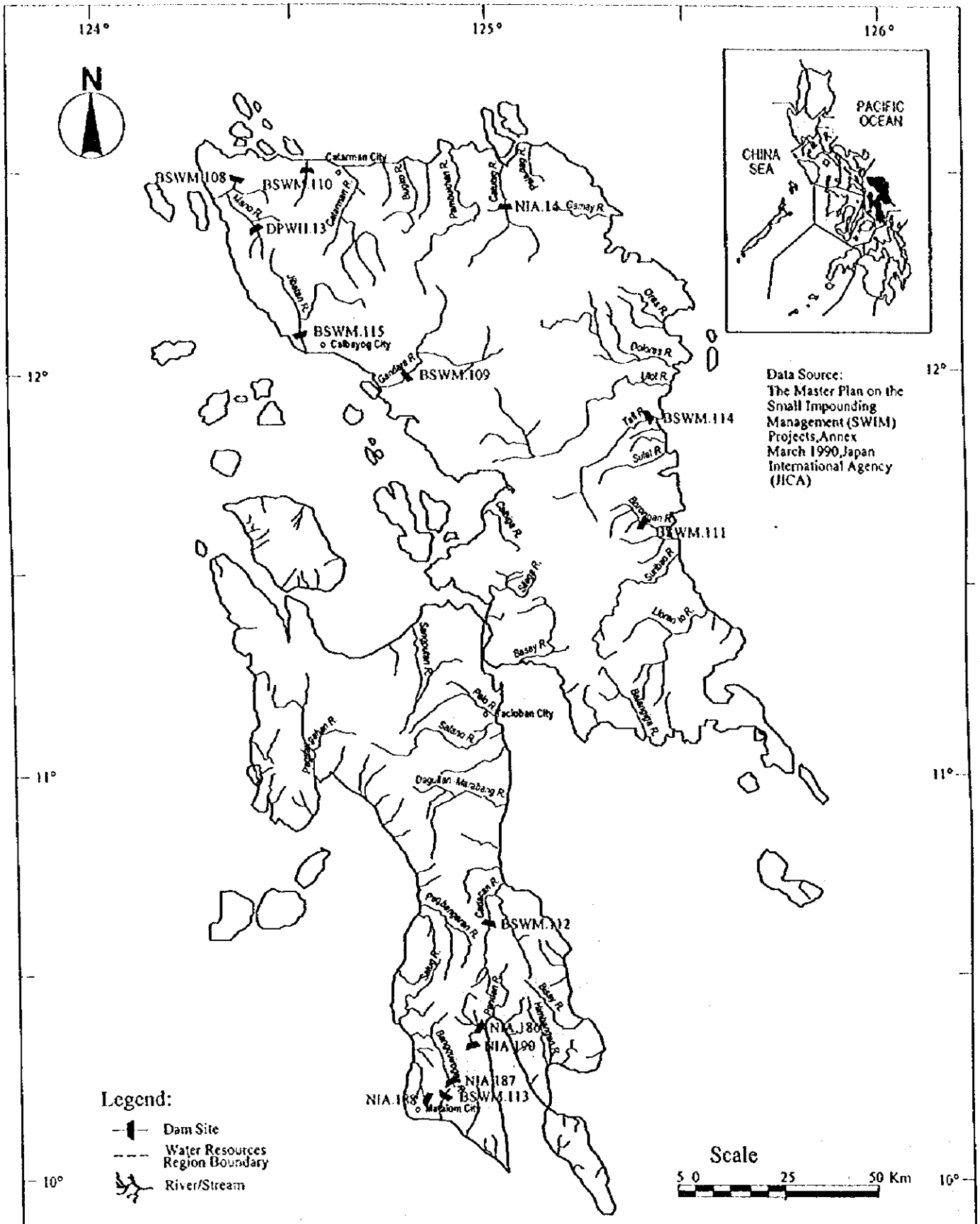


Figure H-19 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION VIII

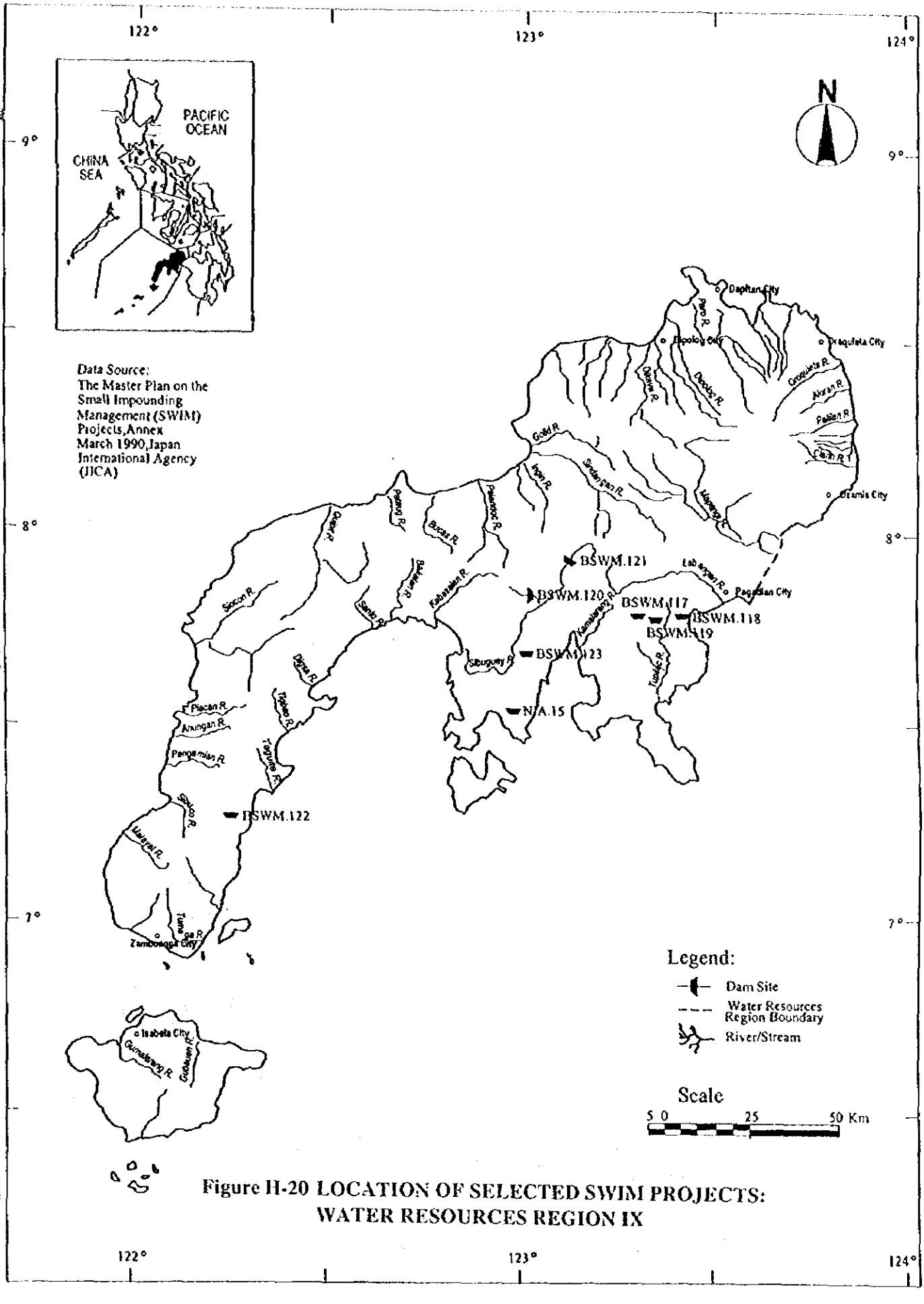


Figure H-20 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION IX

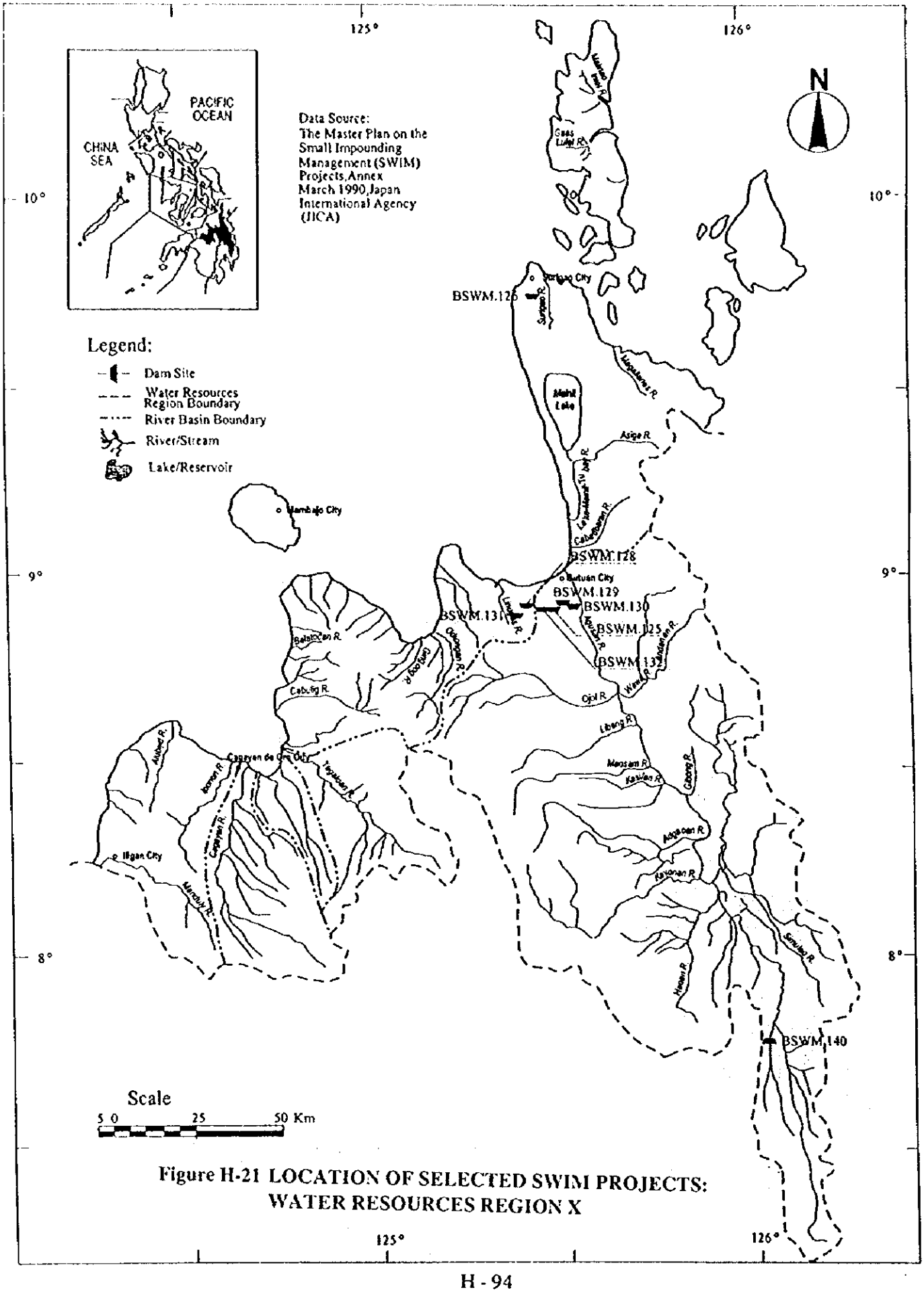


Figure H-21 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION X

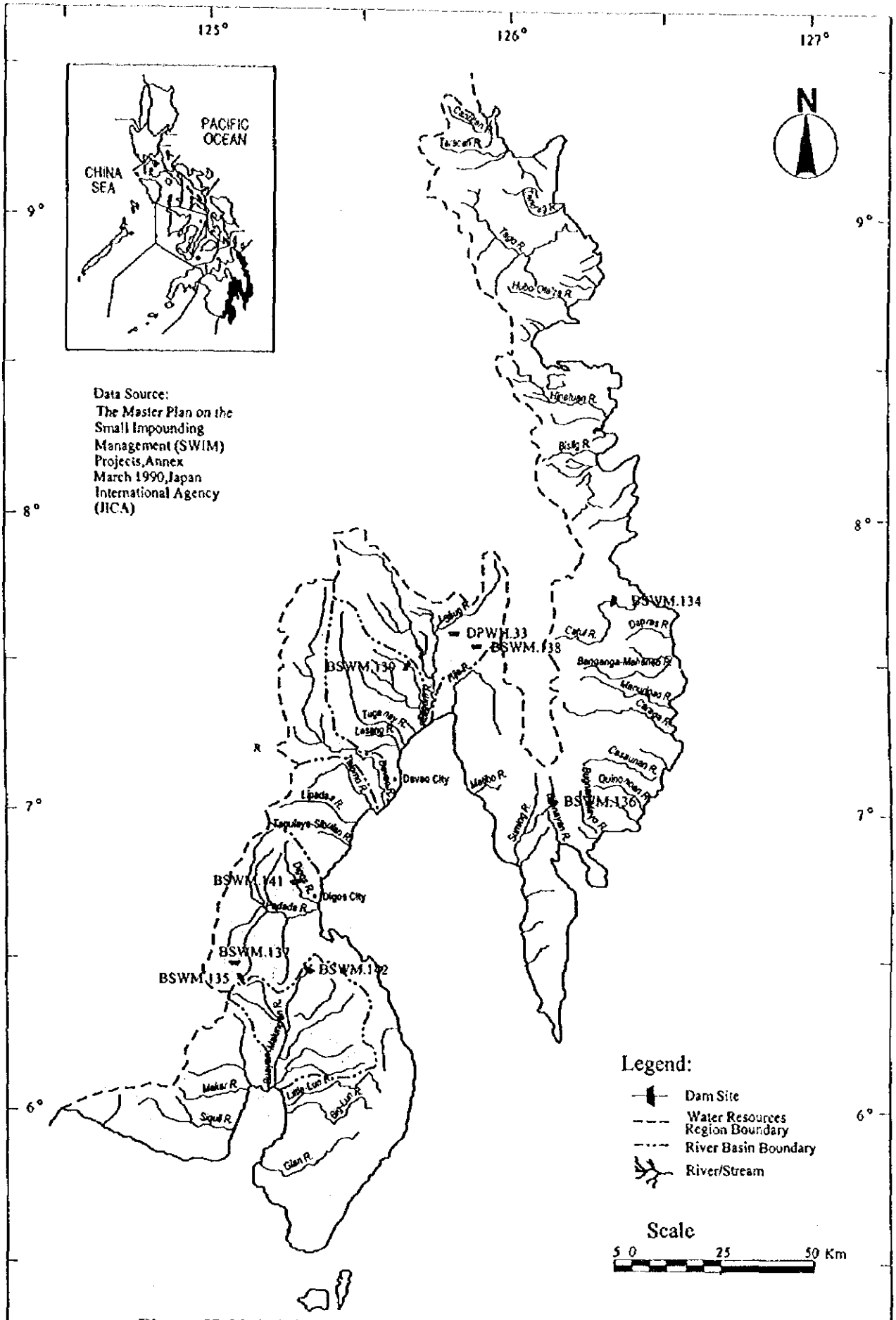


Figure H-22 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION XI

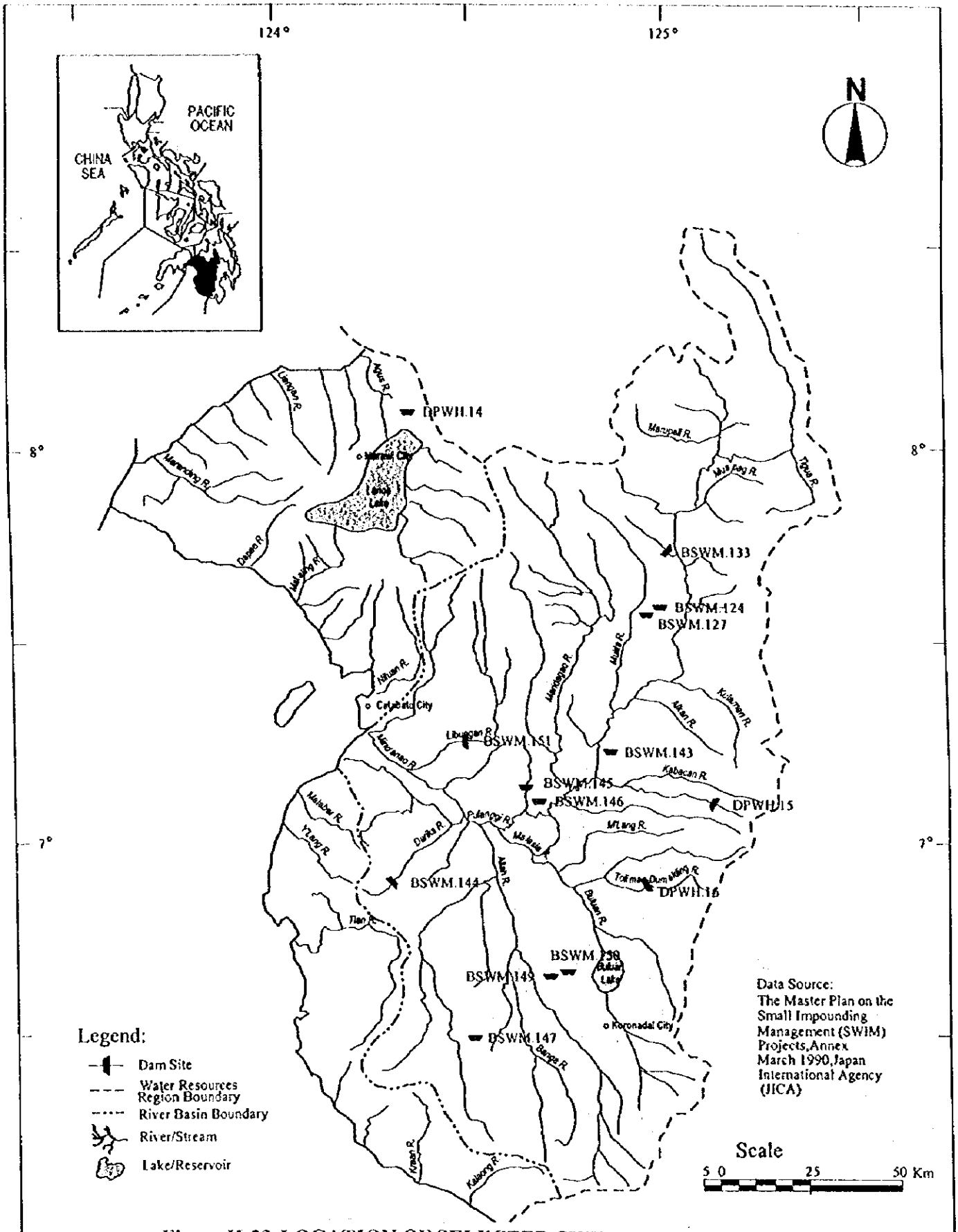
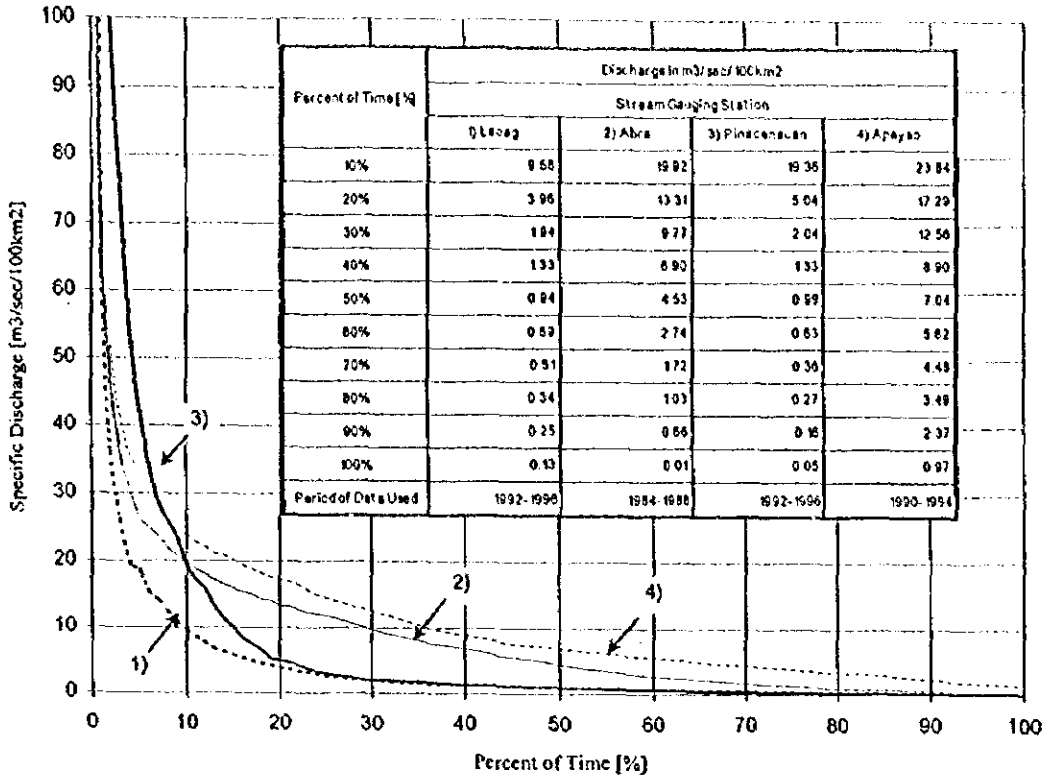
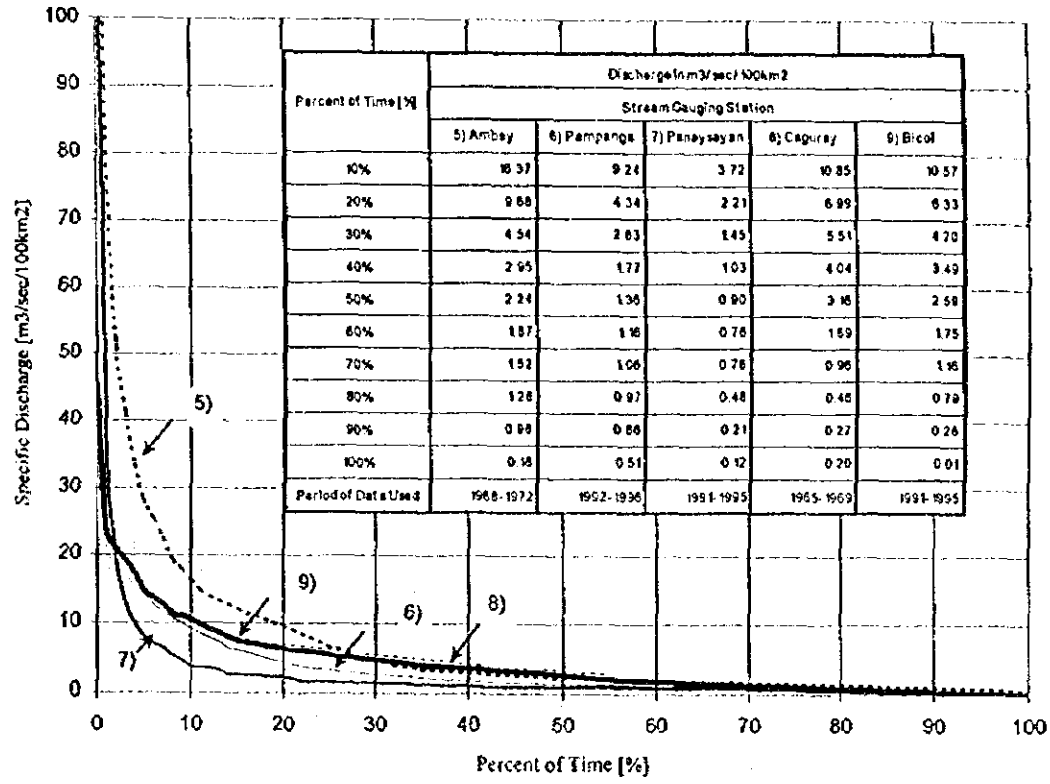


Figure H-23 LOCATION OF SELECTED SWIM PROJECTS: WATER RESOURCES REGION XII

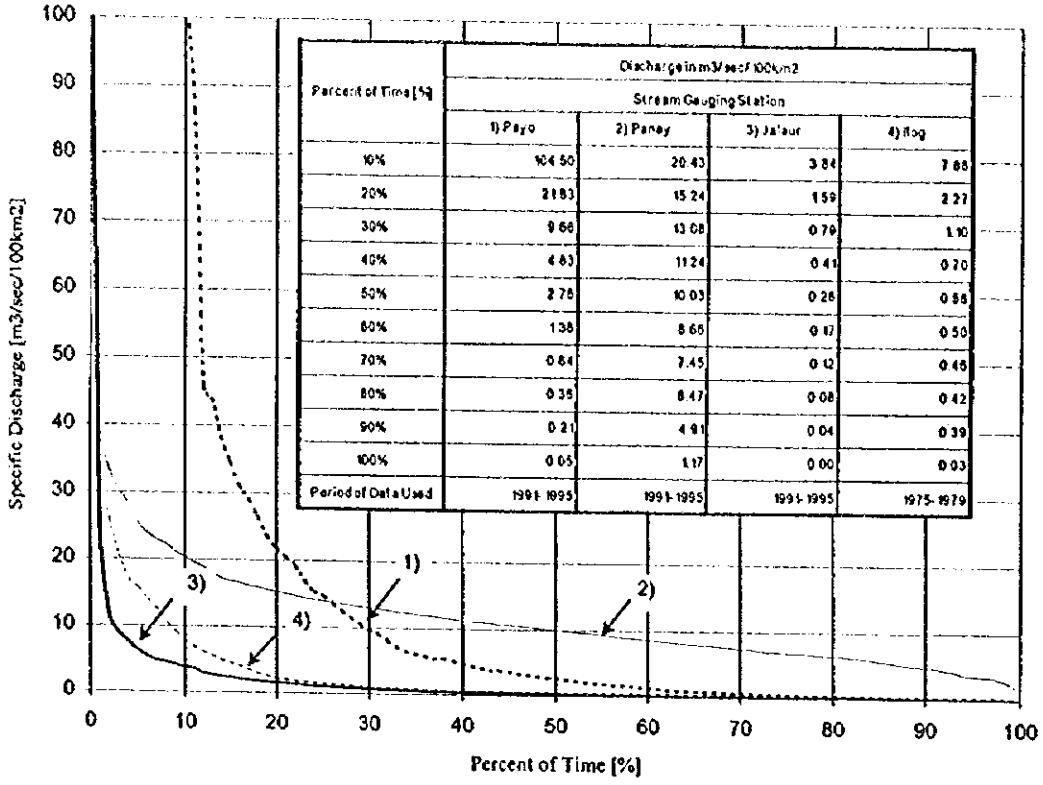


Percent of Time [%]	Discharge in m3/sec/100km2			
	Stream Gauging Station			
	1) Lasag	2) Abra	3) Pinacanauan	4) Apayao
10%	9.58	19.82	19.36	23.84
20%	3.96	13.31	5.04	17.29
30%	1.84	9.77	2.04	12.56
40%	1.33	6.90	1.33	8.90
50%	0.84	4.53	0.59	7.04
60%	0.53	2.74	0.53	5.62
70%	0.51	1.72	0.36	4.48
80%	0.34	1.03	0.27	3.49
90%	0.25	0.56	0.16	2.37
100%	0.13	0.01	0.05	0.97
Period of Data Used	1992-1996	1984-1988	1992-1996	1990-1994

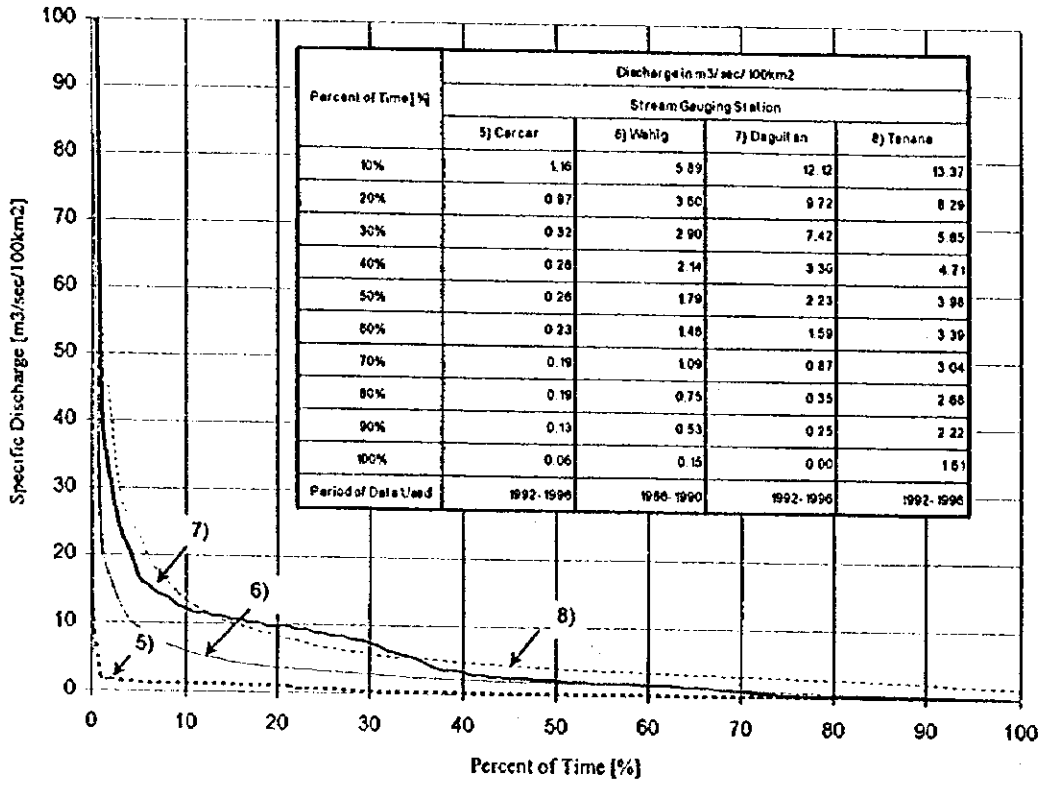


Percent of Time [%]	Discharge in m3/sec/100km2				
	Stream Gauging Station				
	5) Ambuy	6) Pampanga	7) Pinaysayan	8) Caguray	9) Bicol
10%	16.37	9.24	3.72	10.85	10.57
20%	9.68	4.34	2.21	6.99	6.33
30%	4.54	2.63	1.45	5.51	4.70
40%	2.95	1.77	1.03	4.04	3.49
50%	2.24	1.36	0.90	3.16	2.58
60%	1.87	1.16	0.78	1.59	1.75
70%	1.52	1.06	0.78	0.96	1.16
80%	1.28	0.97	0.48	0.48	0.79
90%	0.98	0.86	0.21	0.27	0.26
100%	0.18	0.51	0.12	0.20	0.01
Period of Data Used	1968-1972	1992-1996	1991-1995	1965-1969	1991-1995

Figure H-24 FLOW DURATION CURVE OF MAJOR RIVER BASIN IN LUZON ISLAND

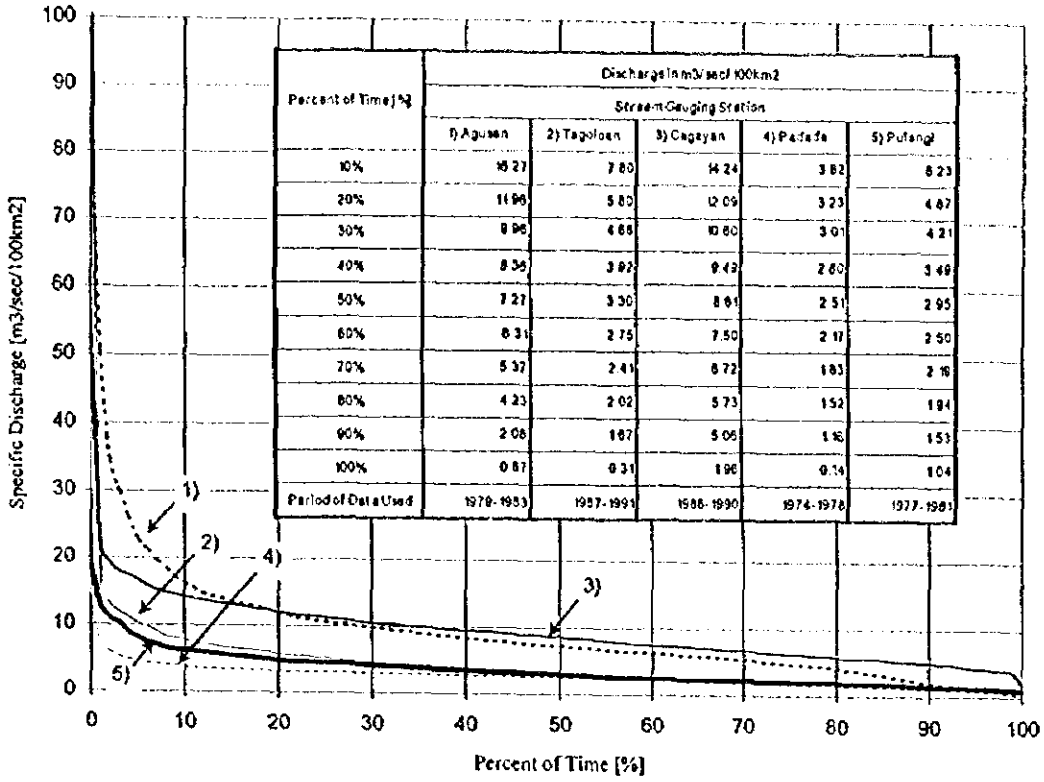


Percent of Time [%]	Discharge in m3/sec/100km2			
	Stream Gauging Station			
	1) Payo	2) Paney	3) Jalaur	4) Ilog
10%	104.50	20.43	3.84	7.88
20%	21.83	15.24	1.59	2.27
30%	9.66	13.08	0.79	1.10
40%	4.83	11.24	0.41	0.70
50%	2.78	10.03	0.26	0.56
60%	1.38	8.65	0.17	0.50
70%	0.84	7.45	0.12	0.46
80%	0.35	6.47	0.08	0.42
90%	0.21	4.91	0.04	0.39
100%	0.05	1.17	0.00	0.03
Period of Data Used	1991-1995	1991-1995	1991-1995	1975-1979



Percent of Time [%]	Discharge in m3/sec/100km2			
	Stream Gauging Station			
	5) Cercar	6) Wahig	7) Daguitan	8) Tanana
10%	1.16	5.89	12.12	13.37
20%	0.87	3.60	9.72	8.29
30%	0.32	2.90	7.42	5.85
40%	0.28	2.14	3.30	4.71
50%	0.26	1.79	2.23	3.98
60%	0.23	1.46	1.59	3.39
70%	0.19	1.09	0.87	3.04
80%	0.19	0.75	0.35	2.68
90%	0.13	0.53	0.25	2.22
100%	0.06	0.15	0.00	1.61
Period of Data Used	1992-1996	1986-1990	1992-1996	1992-1996

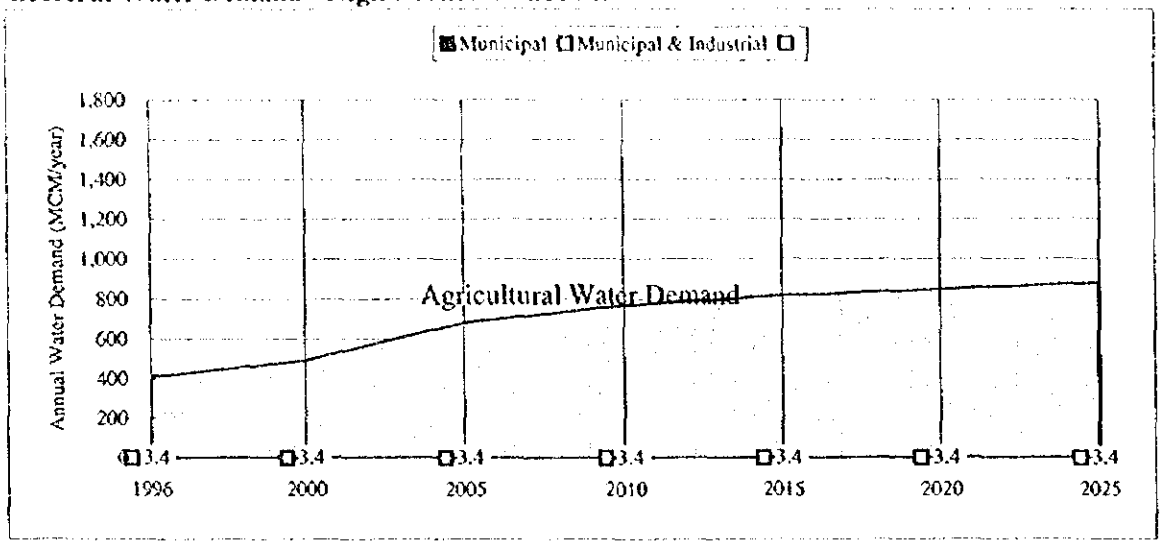
Figure H-25 FLOW DURATION CURVE OF MAJOR RIVER BASIN IN VISAYAS ISLAND



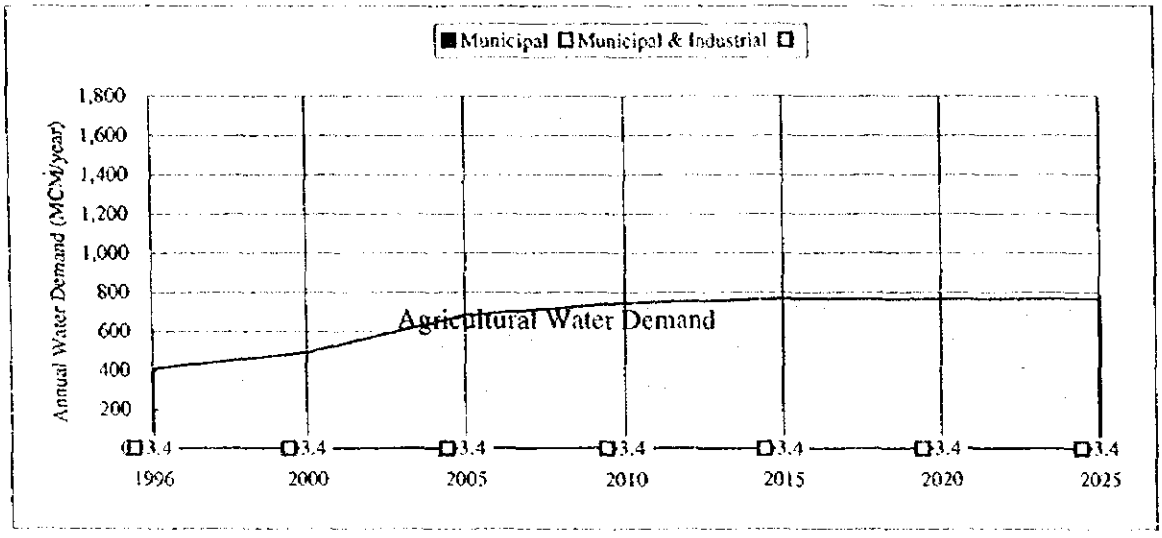
Percent of Time [%]	Discharge in m3/sec/100km2				
	Stream Gauging Station				
	1) Agusan	2) Tagoloan	3) Cagayan	4) Padada	5) Pulangi
10%	16.27	7.80	14.24	3.82	8.23
20%	11.96	5.80	12.09	3.23	4.67
30%	8.96	4.66	10.60	3.01	4.21
40%	8.36	3.92	9.43	2.60	3.49
50%	7.27	3.30	8.61	2.51	2.95
60%	6.31	2.75	7.50	2.17	2.50
70%	5.37	2.41	6.72	1.83	2.16
80%	4.23	2.02	5.73	1.52	1.84
90%	2.08	1.67	5.05	1.16	1.53
100%	0.67	0.31	1.96	0.14	1.04
Period of Data Used	1979-1983	1987-1991	1988-1990	1974-1978	1977-1981

Figure H-26 FLOW DURATION CURVE OF MAJOR RIVER BASIN IN MINDANAO ISLAND

Sectoral Water Demand - High Economic Growth



Sectoral Water Demand - Low Economoic Growth



Comparison of 10-day Runoff and Water Demand in 2025-High Economic Growth

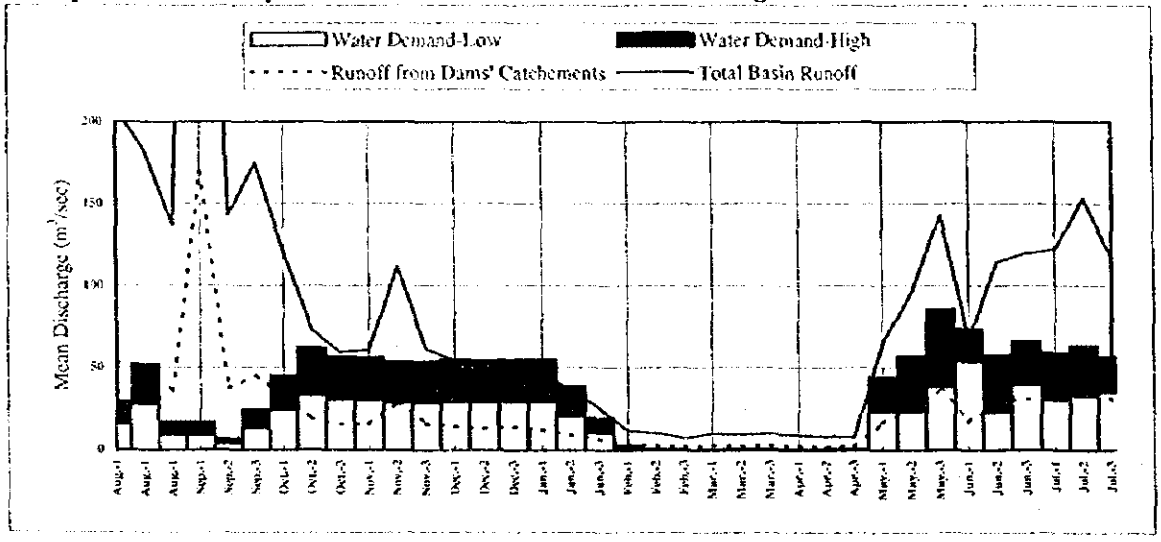
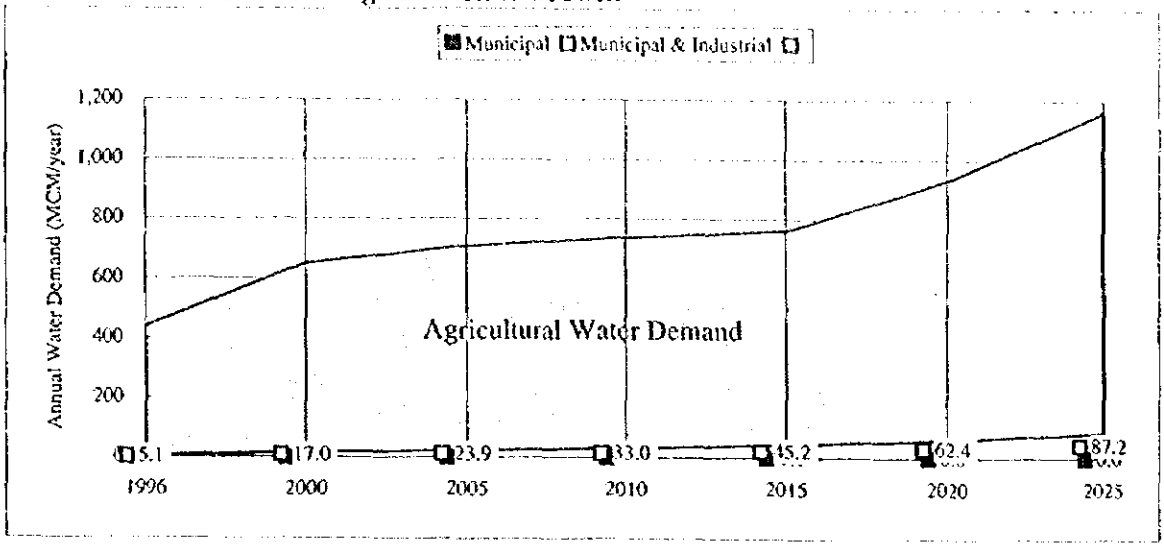
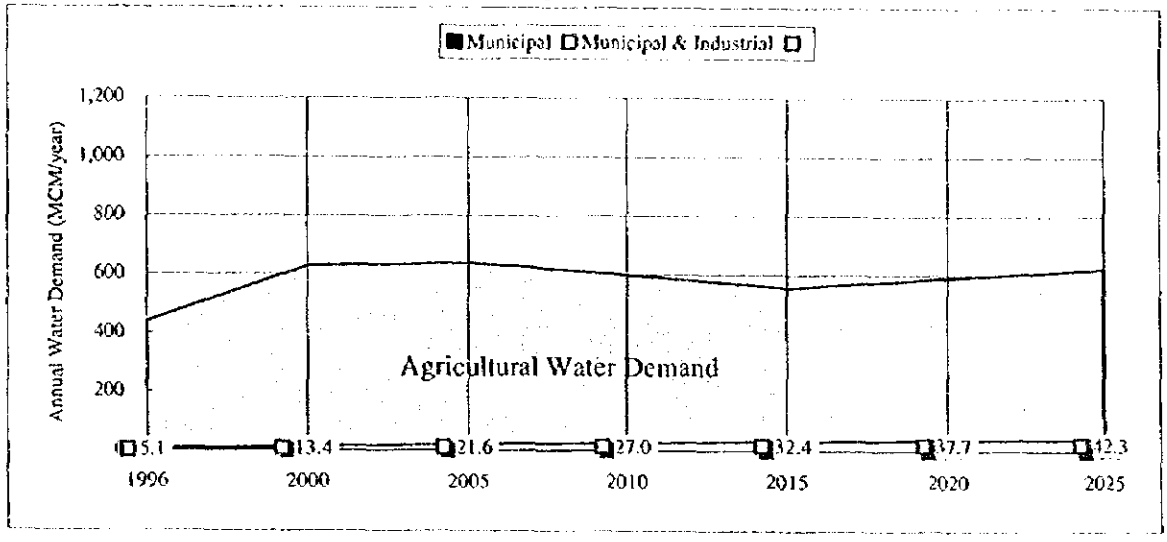


Figure H-27 WATER BALANCE FOR LAOAG RIVER BASIN

Sectoral Water Demand - High Economic Growth



Sectoral Water Demand - Low Economoic Growth



Comparison of 10-day Runoff and Water Demand in 2025-High Economic Growth

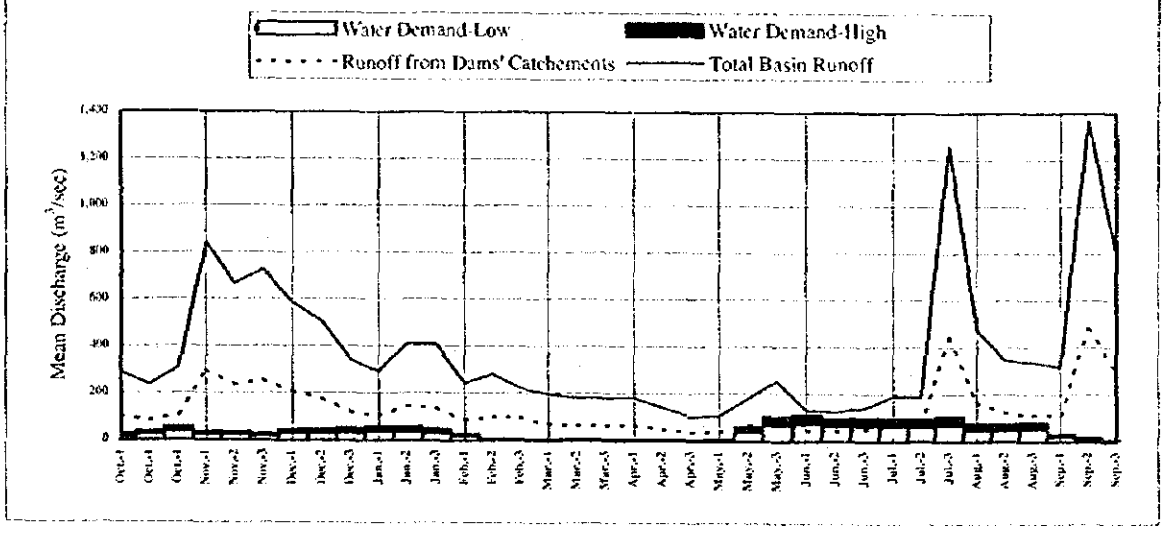
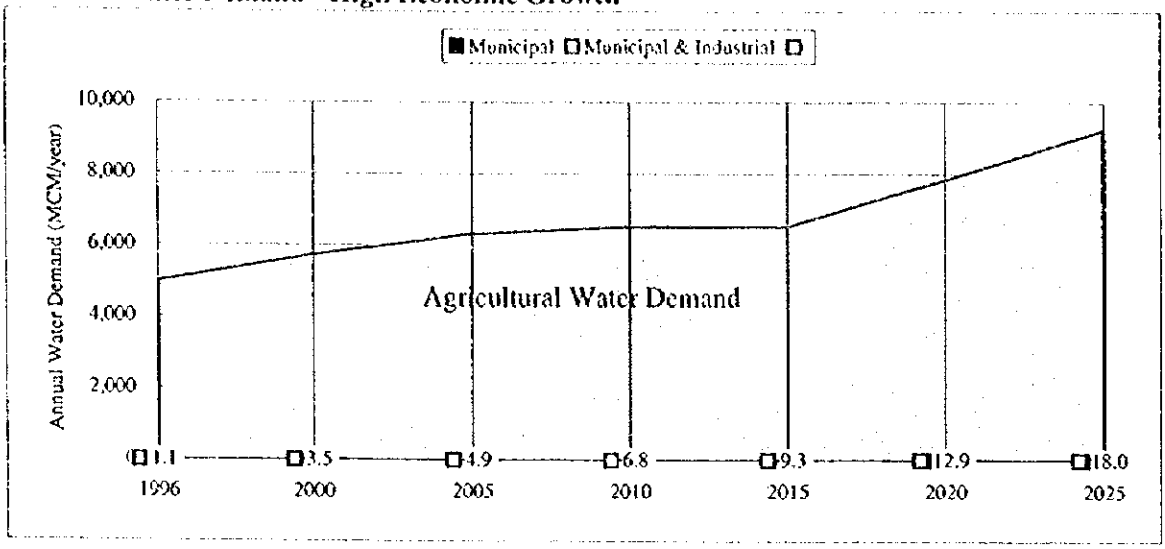
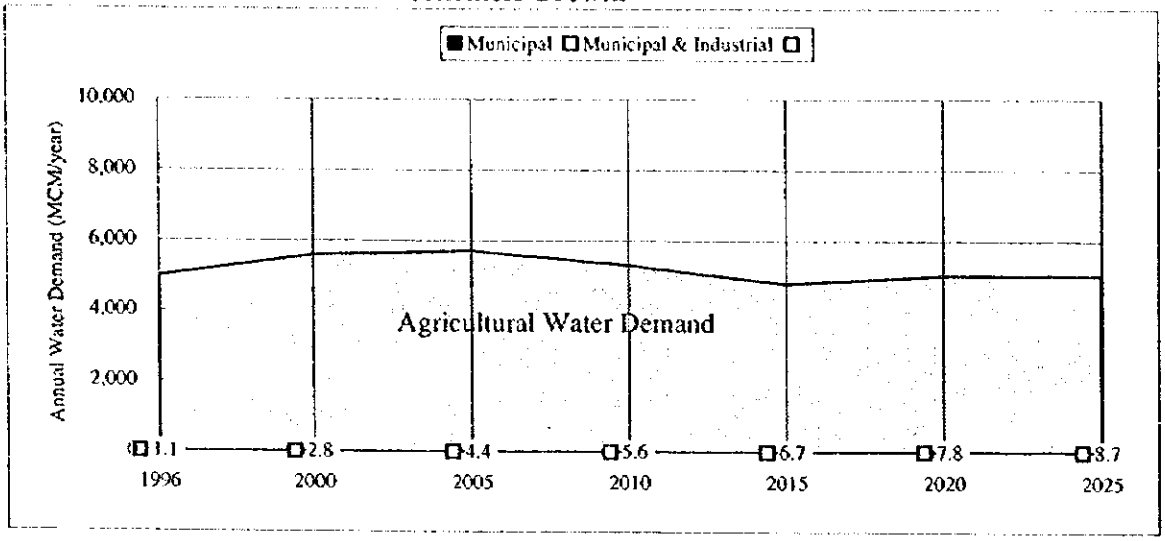


Figure H-28 WATER BALANCE FOR ABULOG RIVER BASIN

Sectoral Water Demand - High Economic Growth



Sectoral Water Demand - Low Economoic Growth



Comparison of 10-day Runoff and Water Demand in 2025-High Economic Growth

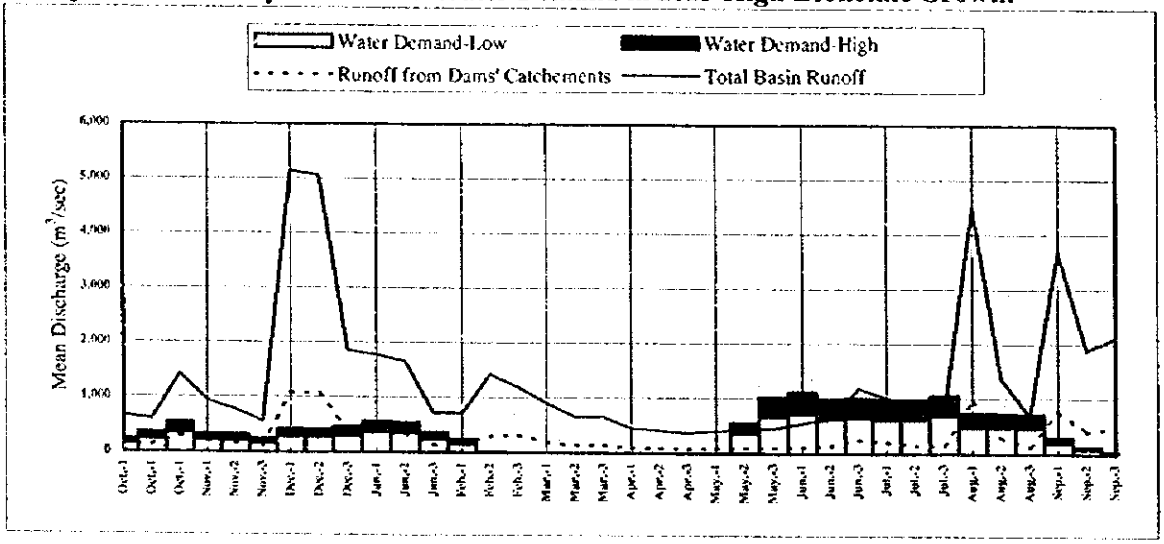


Figure H-29 WATER BALANCE FOR CAGAYAN RIVER BASIN