BASIC DESIGN STUDY REPORT
ON
PROJECT FOR ESTABLISHMENT
OF
CROCODILE FARMING INSTITUTE
IN
THE REPUBLIC OF THE PHILIPPINES

FEBRUARY 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

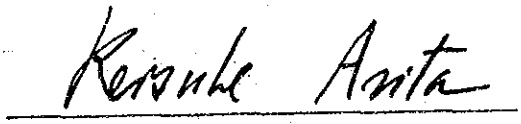
In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a Basic Design Study for the Project for the Establishment of Crocodile Farming Institute and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to the Philippines study teams headed by Mr. Hiroshi INOMATA, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from November 6th to 26th, 1983 and from October 29th to November 14th, 1984.

The teams had discussions with the officials concerned of the Government of the Philippines and conducted field surveys in Manila, Mindoro and Palawan. After the teams returned to Japan, further studies were made and the present Report has been prepared.

I hope that this Report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

February, 1985



Keisuke ARITA

President

Japan International Cooperation Agency

SUMMARY

SUMMARY

In the Philippines, there live two species of crocodiles, both of which originated in the country, however, their population has been decreasing rapidly due to excessive hunting, environmental destruction of their habitats, and so on. Since the 1970's, there has been emerging a movement for the conservation of wild fauna and flora. This being the situation, the Bureau of Forest Development (BFD) under the Ministry of Natural Resources (MNR), has established a Parks, Range and Wildlife Division that provides preservatory areas for rare animals and plants in various parts in the country and undertakes administration and management activities.

The introduction of crocodile farming will contribute to the conservation of wild crocodiles and a socio-economic upgrading of rural communities by expanding employment and stimulating relevant industries. The government has promoted a project to establish a crocodile farming institute whose purpose is the development and promotion of crocodile farming technology, and presented a request to the government of Japan for grant aid and technical cooperation to realize the project.

In response to this request, the government of Japan dispatched a study team (grant aid and technical cooperation) to the Philippines in November 1983 and a basic design study team (grant aid) in October 1984 to conduct field surveys and discussions with the Philippine authorities concerned. The functions and activities of the Institute, as understood by both governments, are as follows:

- research & study activities
  - ecological study of wild crocodiles; understanding the ecology & population dynamics of crocodiles ------ conservation of crocodiles, basic study
  - physiological study; basic physiology of crocodiles ---------- basic study
  - development of farming technology; various types of experimental farming & drawing up manuals of farming technology ------- applied study
  - nutrition study; research & development of effective feed -------- applied study
- experimental farming ------- presentation of specimens for research and study activities; presentation of data for evaluation of study results
- promotion activities
  - promotion
  - training and instruction (of those who are interested in crocodile farming)
  - seminars for farming technology promoters

The Project Site is in the Iwahig region --- the suburbs of Puerto Princesa City, Palawan Island, which used to be a habitat of crocodiles. The site area is approximately 10 hectares.

The Institute will contain the following facilities and equipment to make possible the above activities.

- buildings
  (R.C. or steel structures: 13 buildings, total floor area: 3,342m^2)
- rearing tanks, breeding and rearing pens
  (concrete block tanks: 1,294m^2, pens: 13,662.9m^2)
- Institute road, parking area
- deep well, water purification unit, sewage treatment system, storage tanks, water supply and drainage piping system
- power receiving and transformer system, standby generator system
- incinerator

- refrigerator and freezer for crocodile feed
- laboratory equipment and other relevant equipment for physical and chemical studies
- optical instruments and teaching equipment
- equipment for farming
- vehicles and a boat
- craft machines and tools

The construction period is planned to be about 14 months.

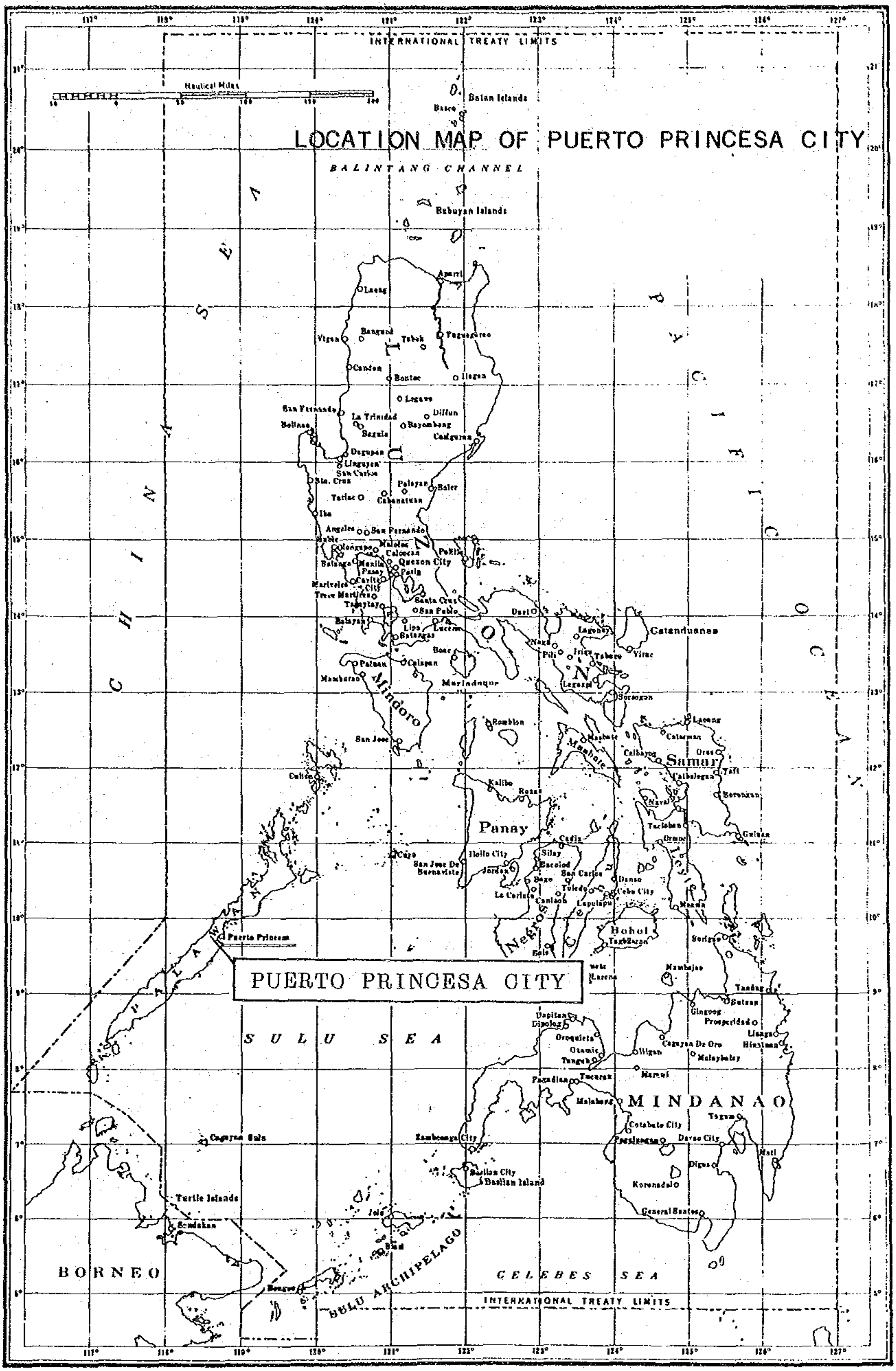
This Institute will be administered directly under the director of BFD with the support of other departments of BFD and Forest Research Institute (FORI) and Philippine Council for Agriculture and Resources Research and Development (PCARRD).

BFD has a plan to establish satellite stations of crocodile farming in such places as Mindoro, Mindanao, and Camotes islands. These stations will be operated by the promoters trained at this Institute.

For the effective implementation of the project, the following considerations shall be taken into account:

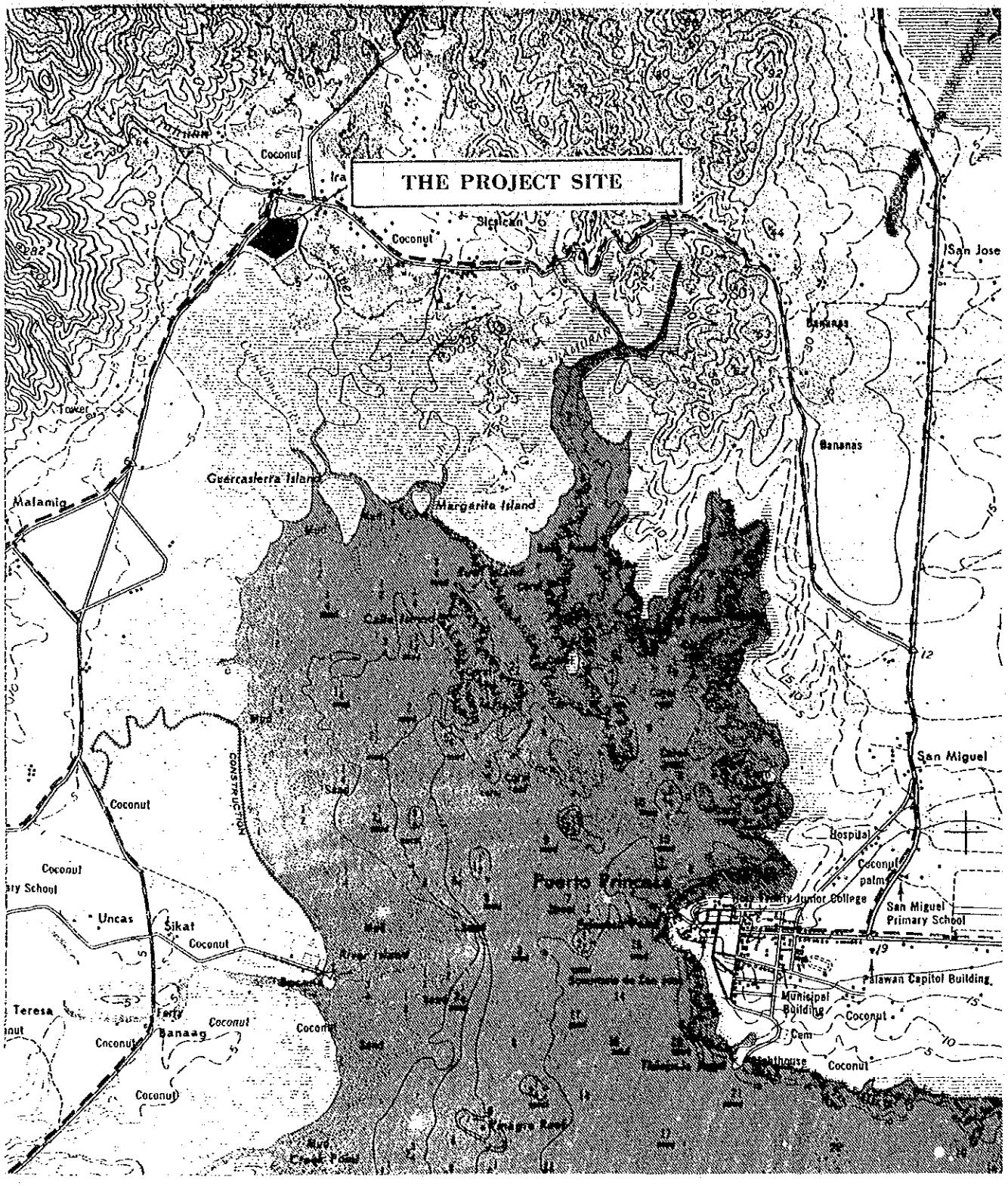
(1) to secure the funds necessary for the maintenance and running operation of the Institute, and

(2) to appoint promptly administration staff and researchers of the Institute who will undertake detailed planning of activities and management of the Institute. (In the planning of activities, emphasis shall be laid on promotion and training to disseminate farming technology to the public. Management planning to economize in electric power and to secure sufficient finance is also recommended.)


LOCATION MAP OF PUERTO PRINCESA CITY
INTERNATIONAL TREATY LIMITS
Nautical Miles
Batan Islands
Basco
BALINTANG CHANNEL
Babuyan Islands
Aparri
Laoag
Vigan
Bangued
Tabuk
Tuguegarao
Candon
Bontoc
Ilagan
Lagawe
San Fernando
La Trinidad
Diffun
Bolinao
Baguio
Bayombong
Cabarroguis
Dagupan
Lingayen
San Carlos
Sta. Cruz
Palayan
Baler
Tarlac
Cabanatuan
Iba
Angeles
San Fernando
Olongapo
Malolos
Caloocan
Quezon City
Balanga
Manila
Pasay
Pasig
Mariveles
Cavite City
Trece Martires
Santa Cruz
Tagaytay
San Pablo
Daet
Balayan
Lipa
Batangas
Lucena
Naga
Iriga
Tabaco
Virac
Catanduanes
Pili
Legaspi
Calapan
Boac
Palauan
Mamburao
Mindoro
Marinduque
Sorsogon
Romblon
Laoang
Masbate
Catarman
San Jose
Calbayog
Samar
Culion
Catbalogan
Taft
Borongan
Kalibo
Roxas
Panay
Tacloban
Guiuan
Ormoc
Cuyo
Cadiz
Silay
Iloilo City
Bacolod
San Jose De Buenavista
Jordan
San Carlos
Danao
Bago
Toledo
Cebu City
La Carlota
Canlaon
Lapulapu
Maasin
Bohol
Tagbilaran
Negros
Cebu
Leyte
Bais
Surigao
Puerto Princesa
PUERTO PRINCESA CITY
PALAWAN
Mambajao
Tandag
Butuan
Dapitan
Dipolog
Gingoog
Prosperidad
Oroquieta
Ozamis
Tangub
Iligan
Cagayan De Oro
Malaybalay
Lianga
Hinatuan
Marawi
SULU SEA
Pagadian
Tucuran
Malabang
MINDANAO
Tagum
Cotabato City
Davao City
Cagayan Sulu
Zamboanga City
Mati
Digos
Basilan City
Basilan Island
Koronadal
Turtle Islands
General Santos
Sandakan
Jolo
Siasi
BORNEO
CELEBES SEA
Bongao
SULU ARCHIPELAGO
SOUTH CHINA SEA
PACIFIC OCEAN
LUZON

LOCATION MAP OF THE PROJECT SITE

1 : 50,000



CONTENTS

CHAPTER 1. INTRODUCTION

CHAPTER 1 INTRODUCTION

There are two kinds of crocodiles (Crocodylus porosus and Crocodylus mindorensis) in the Philippines, however their population has been reduced due to unlimited hunting and destruction of the natural environment of their habitats. For the preservation of wild animals that are facing extinction, like crocodiles, Philippine Eagles, Pawikan, etc., the Parks, Range and Wildlife Division of the Bureau of Forest Development (BFD), the Ministry of Natural Resources (MNR) establishes conservation regulations and conducts field surveys and research activities in cooperation with other institutions. The government sets forth and endeavours to promote regional development policies such as the Kilusang Kabubayan at Kaunalaran Program (known as KKK Program).

Based on the new policies, the government of the Philippines made a request to the government of Japan of grant aid for facilities and laboratory equipment of the Crocodile Farming Institute for the purpose of conserving wild crocodiles, and technical cooperation for the establishment and development of farming technology.

In response to this request, the government of Japan dispatched a Phase I basic design study team (Grant Aid Team and Technical Cooperation Team) from November 6 to 26, 1983, and a Phase II study team (Grant Aid Team) from October 29 to November 14, 1984, through the Japan International Cooperation Agency (JICA).

In the Phase I study, the joint of Grant Aid Team and Technical Cooperation Team confirmed the background of the request for the grant aid and technical cooperation for the project by the government of the Philippines, and the objectives of the project. The study team conducted field surveys of the two proposed sites (Lake Naujan in Mindoro and the Iwahig region in Palawan) presented by the Philippine side from various aspects. Based on the results of the surveys, the government of the Philippines decided on the Iwahig region, Palawan, as the Project Site.

In the Phase II study, the study team discussed the objectives and functions of the Institute and its management concept and collected referential information.

Through these discussions, the basic design study team explained to the Philippine side the Japanese grant aid system and form of implementation and confirmed the responsibilities of both governments. The team carried out field studies on local construction, conditions at other similar facilities, codes and regulations on construction, procurement of crocodiles and crocodile feed, infrastructure, soil surveys of the Project Site, etc.

From January 31 to February 7, 1985, the government of Japan dispatched through JICA a final report draft mission to the Philippines to discuss and confirm the contents of the basic design study report.

The objectives of the project, its functions and nature, the Project Site, facility plan and equipment schedule were finalized in the minutes of discussions after a series of discussions between the basic design study team and the Philippine side.

CHAPTER 2. BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Land of the Philippines

(1) Geography

The Philippines is situated south-east of the continent of Asia, and is composed of about 7,100 islands extending 1,851 km from north to south and 1,107 km from east to west. The total coast line of these islands is about 34,600 km, the longest coast line in the world. These islands face the Pacific Ocean on the east, the South China Sea on the south, the Sulu Sea and the Sulawesi Sea on the south, and the Bashi Channel to the north.

The total area of the Philippines is about 300 thousand km^2, 93.5% of which is comprised of eleven main islands. These islands are classified into three large groups, the Luzon islands with 141,000 km^2, the Visayas islands with 57,000 km^2 and the Mindanao islands with 102,000 km^2.

(2) Administration Boundary

The Philippines is divided into 13 regions including the National Capital Region (NCR), and each region is divided into several administrative provinces. There are 73 provinces, as shown in Fig. 2.1. These are divided into 60 cities, 1,493 municipalities and 21 municipal districts. These are further divided into 40,207 barangays as the minimum administrative unit.

(3) Climate

The annual average temperature among the regions of the Philippines shows only the small range of 25-27°C, but the annual rainfall is quite different among the regions. In all these regions, April and May are the hottest, and January is the coolest. The land can be divided into the following four climatic zones as shown in Fig. 2.2:

N C R - METRO MANILA

REGION I - ILOCOS
1 ABRA
2 BENGUET
3 ILOCOS NORTE
4 ILOCOS SUR
5 LA UNION
6 MOUNTAIN PROVINCE
7 PANGASINAN

REGION II - CAGAYAN VALLEY
1 BATANES
2 CAGAYAN
3 IFUGAO
4 ISABELA
5 KALINGA-APAYAO
6 NEUVA VISCAYA
7 QUIRINO

REGION III - CENTRAL LUZON
1 BATAAN
2 BULACAN
3 NUEVA ECIJA
4 PAMPANGA
5 TARLAC
6 ZAMBALES

REGION IV - SOUTHERN TAGALOG
1 AURORA
2 BATANGAS
3 CAVITE
4 LAGUNA
5 MARINDUQUE
6 OCCIDENTAL MINDORO
7 ORIENTAL MINDORO
8 PALAWAN
9 QUEZON
10 RIZAL
11 ROMBLON

REGION V - BICOL
1 ALBAY
2 CAMARINES NORTE
3 CAMARINES SUR
4 CATANDUANES
5 MASBATE
6 SORSOGON

REGION VI - WESTERN VISAYAS
1 AKLAN
2 ANTIQUE
3 CAPIZ
4 ILOILO
5 NEGROS OCCIDENTAL

REGION VII - CENTRAL VISAYAS
1 BOHOL
2 CEBU
3 NEGROS ORIENTAL
4 SIQUIJOR

REGION VIII - EASTERN VISAYAS
1 EASTERN SAMAR
2 LEYTE
3 NORTHERN SAMAR
4 SAMAR
5 SOUTHERN LEYTE

REGION IX - WESTERN MINDANAO
1 BASILAN
2 SULU
3 TAWI-TAWI
4 ZAMBOANGA DEL NORTE
5 ZAMBOANGA DEL SUR

REGION X - NORTHERN MINDANAO
1 AGUSAN DEL NORTE
2 AGUSAN DEL SUR
3 BUKIDNON
4 CAMIGUIN
5 MISAMIS OCCIDENTAL
6 MISAMIS ORIENTAL
7 SURIGAO DEL NORTE

REGION XI - SOUTHERN MINDANAO
1 DAVAO
2 DAVAO DEL SUR
3 DAVAO ORIENTAL
4 SOUTH COTABATO
5 SURIGAO DEL SUR

REGION XII - CENTRAL MINDANAO
1 LANAO DEL NORTE
2 LANAO DEL SUR
3 MAGUINDANAO
4 NORTH COTABATO
5 SULTAN KUDARAT

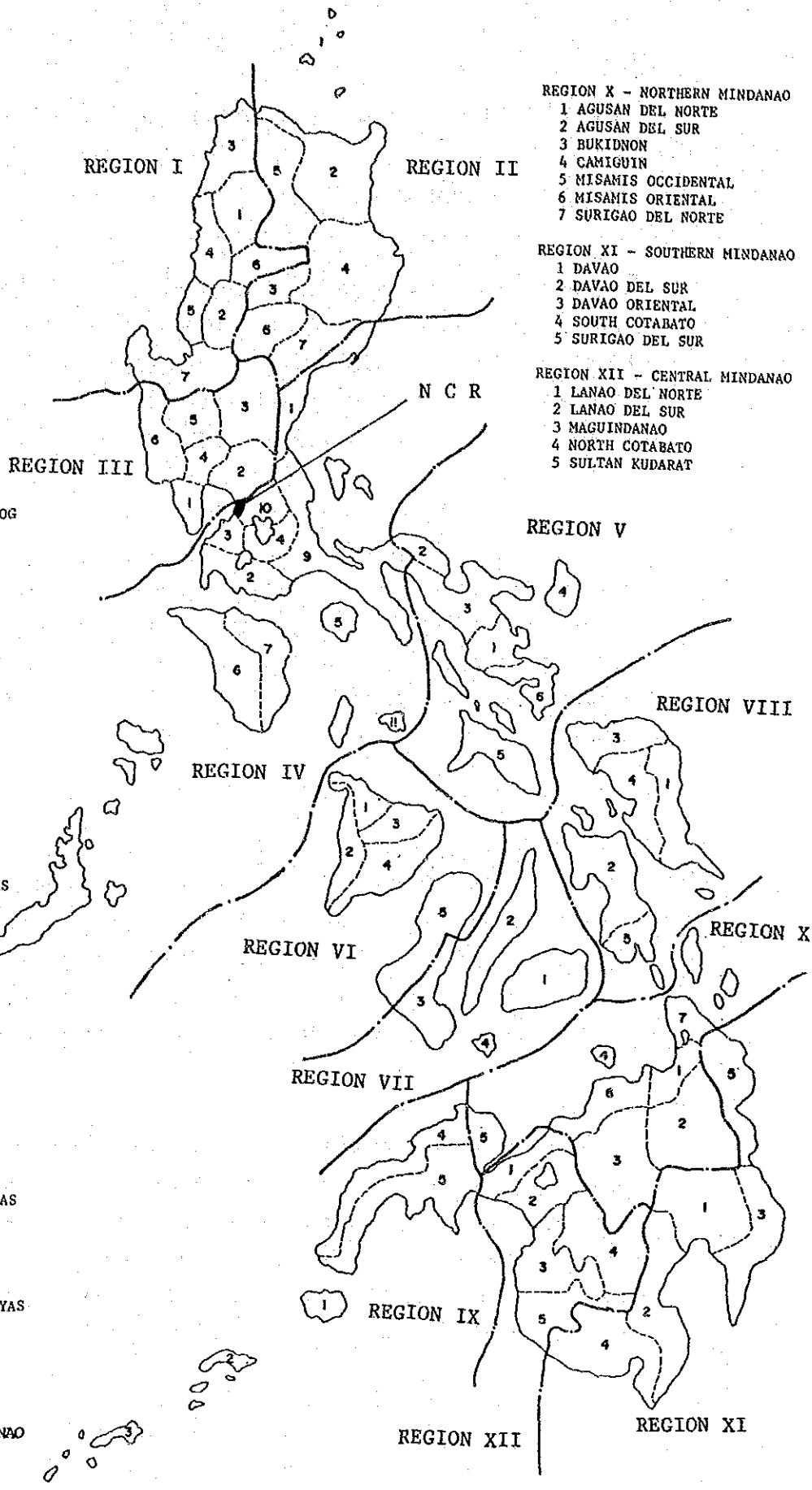


FIG. 2.1 LOCATION OF PROVINCES IN THE PHILIPPINES

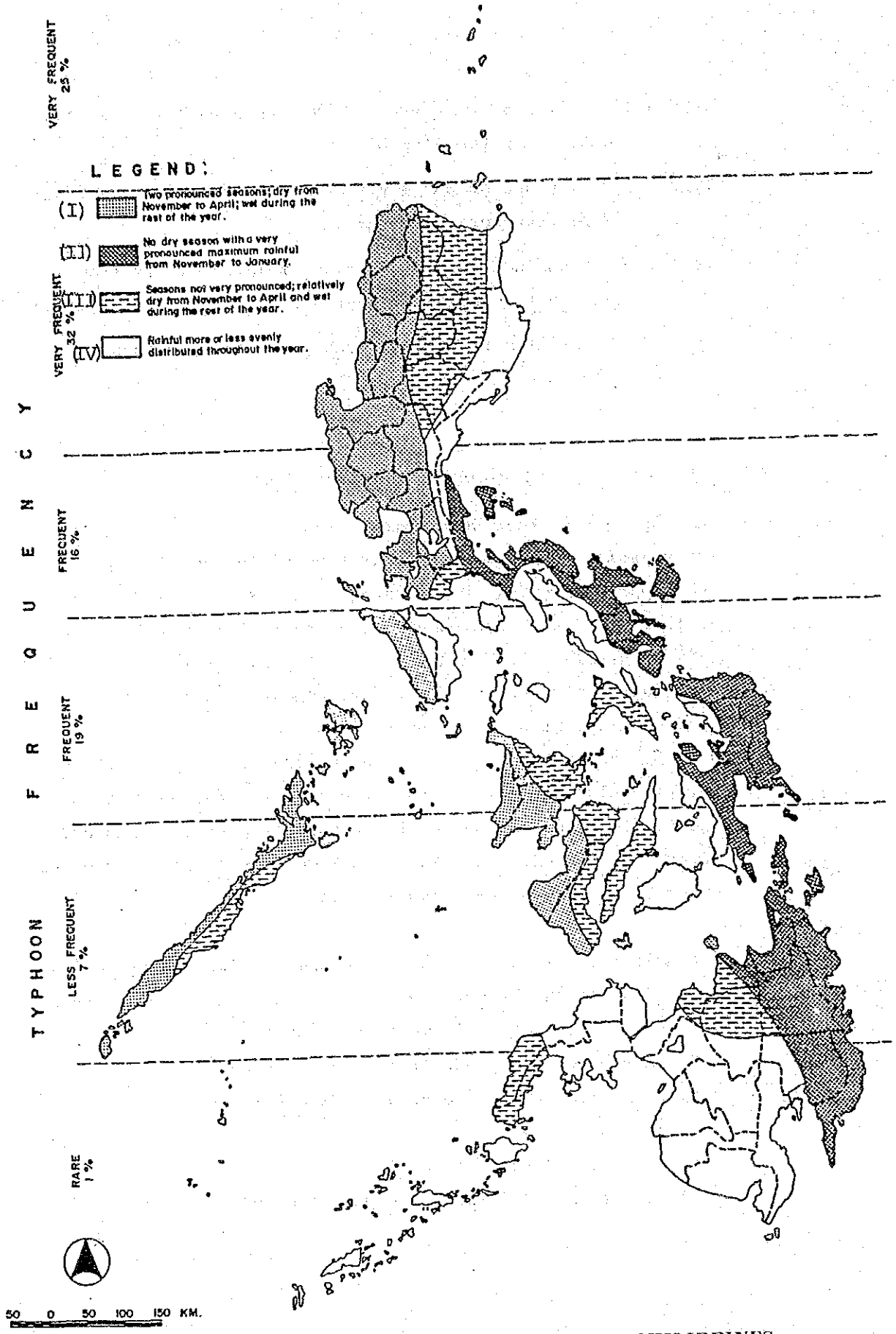


FIG. 2.2 CLIMATE MAP OF THE PHILIPPINES

Source: "MPWH Infrastructure Atlas, 1983," MPWH.
PAGASA and the Philippine Atlas, Vol. 1, 1975.

Type I : Two pronounced seasons; dry from November to April, wet during the rest of the year.

Type II : No dry season and a very pronounced maximum rainfall from November to January.

Type III: Seasons not very pronounced; relatively dry from November to April and wet during the rest of the year.

Type IV : Rainfall more or less evenly distributed throughout the year.

2-2 Socio-economic Conditions of the Philippines

(1) Philippine Five Year Development Plan

The on-going development plan in the Philippines is the "Philippine Five Year Development Plan (1983-87)". The aims of this Five Year Development Plan are as follows.

1) to attain a 6.5% annual economic growth rate
2) fair distribution of the development results
3) development of total human resources

However the economic growth rate in 1983 was only 1.39%, considerably below the aims of the plan. Therefore, the National Economic Development Authority (NEDA) reviewed the plan and revised it downward extremely. New socio-economic frameworks under the revision are shown in Table 2.1.

The priority policies of this development plan are as follows:

1) to bring the latent unemployment rate below 20% through enlargement of employment opportunity,
2) improvement of productivity in agro-industry,
3) to correct the regional differences in economic development,
4) decrease dependence on oil,
5) to attain a 2.2% annual population increase rate.

TABLE 2.1 SOCIO-ECONOMIC FRAMEWORK IN THE PHILIPPINES

	1983	1990	2000	Average Annual Growth Rate (%) 1983-1990	1990-2000
1. GDP (₱10^6 at 1972 price)	100,120	115,796	168,401	2.1	3.8
2. Population (10^3 persons)	52,055	61,481	75,224	2.4	2.0
3. Per capita GDP (₱ at 1972 price)	1,923	1,883	2,239	-0.3	1.7

Remarks: GDP of 1984 to 1987 are planned as the preliminary revision of the Five-Year Development Plan. Annual growth rates of GDP by major items of expenditure of 1986 to 1987 were applied for estimation of 1990 and 2000.

Source: 1) GDP: Preliminary Revised Five-Year Development Plan, August 1984, NEDA

2) Population: Population Projections of the Philippines and Its Regions, 1980-2030, NEDA

(2) KKK Program

The KKK (Kilusang Kabehayan at Kaunlaran) Program had been hammered out in 1981 following the establishment of the "Fourth Republic" and aimed at regional economic development. This program is to be one of the important policies of the "Philippine Five Year Development Plan".

The KKK Program aims at the growth and development of regional industries, correction of regional socio-economic differences, improvement of productivity and development of human resources through projects in agriculture, livestock, aquaculture and poultry farming at the barangay level.

(3) Population

The population of the Philippines was 48.1 million in 1980 according to the census and estimated to be 52.1 million in 1983 by NEDA. The population in 2000 is projected to be 75.2 million, an increase of 56% over that in 1980. The projected annual growth rate is 2.4% during 1980 - 1990 and 2.0% during 1990 - 2000. The projected population by regions and annual growth rate are shown in Table 2.2.

TABLE 2.2 POPULATION BY REGIONS

REGION	Population (in thousand)				Average Annual Growth Rate (%)	
	1980 (Actual)	1983	1990	2000	1980-1990	1990-2000
NCR	5,926	6,540	7,974	9,895	2.9	2.2
I	3,541	3,754	4,292	5,073	1.9	1.7
II	2,215	2,399	2,845	3,514	2.5	2.1
III	4,803	5,196	6,142	7,529	2.4	2.1
IV	6,119	6,703	8,105	10,188	2.8	2.3
V	3,477	3,744	4,388	5,355	2.3	2.0
VI	4,526	4,866	5,672	6,800	2.2	1.8
VII	3,787	4,032	4,616	5,441	2.0	1.7
VIII	2,799	2,963	3,360	3,973	1.8	1.7
IX	2,528	2,734	3,195	3,874	2.3	1.9
X	2,759	3,012	3,616	4,540	2.6	2.3
XI	3,347	3,645	4,334	5,364	2.5	2.2
XII	2,271	2,467	2,942	3,675	2.5	2.2
TOTAL	48,098	52,055	61,481	75,224	2.4	2.0

Source: 1) Philippines 1980 Populations Land Area and Density, NCSO

2) Population Projections of the Philippines and Its Regions, 1980-2030, 1984, NEDA

(4) Economic Conditions

In 1983, the national revenue was 43.5 billion pesos against expenditure of 52.9 billion pesos, for an annual deficit of 9.4 billion pesos. The deficit tends to increase considering that the government is actively taking measures with various kinds of financial investment to improve recent economic conditions.

The GDP in 1983 amounted to 100.1 x 10^9 pesos at constant prices for 1972, showing an annual growth rate of only 1.1% during 1982 and 1983. The Revised Five Year Plan by NEDA shows a negative GDP growth from 1983 to 1984, but is plans to recover to a positive growth rate of 3.8% during 1986 and 1987, in the final year of the plan.

The share of GDP in 1982 by industrial origin is as follows:

Agriculture, fishery and forestry	25.5%
Mining and quarrying	2.0%
Manufacturing	24.8%
Construction	8.3%
Electricity	1.1%
Transportation, communication and storage	5.2%
Commerce	20.6%
Services	12.5%
T O T A L	100.0%

The projected GRDP in 2000 by region is shown in Table 2.3.

TABLE 2.3 GRDP BY REGIONS

REGION	GRDP (in Million Pesos at 1972 Prices) 1980 (Actual)	1983 (Actual)	1990	2000	Average Annual Growth Rate (%) 1980 -1983	1983 -1990	1990 -2000
NCR	29,294	32,537	35,736	48,146	3.6	1.3	3.0
I	3,433	3,821	4,576	6,978	3.6	2.6	4.3
II	2,620	2,747	3,335	5,186	1.6	2.8	4.5
III	7,802	9,036	10,470	15,224	5.0	2.1	3.8
IV	12,975	13,765	16,053	23,564	2.0	2.2	3.9
V	3,182	3,375	4,069	6,263	2.0	2.7	4.4
VI	7,636	8,172	9,657	14,445	2.3	2.4	4.1
VII	6,733	7,270	8,405	12,187	2.6	2.1	3.8
VIII	2,289	2,380	2,928	4,639	1.3	3.0	4.7
IX	3,102	3,324	4,034	6,269	2.3	2.8	4.5
X	4,378	4,427	5,338	8,218	0.4	2.7	4.4
XI	6,310	6,412	7,731	11,901	0.5	2.7	4.4
XII	2,952	2,854	3,463	5,381	-1.1	2.8	4.5
TOTAL	92,706	100,120	115,796	168,401	2.6	2.1	3.8

Remarks: Average annual growth rates by Region during 1983 to 1987, Five-Year Development Plan, May 1982, NEDA, were applied for 1990 and 2000

Source:
(1) The Regional Income Accounts CY 1980-82, Aug. 1983, NAS-NEDA

(2) GRDP by Region, by Industry 1983, 1984, NEDA

(3) Five-Year Development Plan 1983-1987, May 1982, NEDA

(5) Trade

The external trade balance of the Philippines in 1982 was US $5,010 million in exports and US $8,229 million in imports. This trade deficit is becoming "chronic" because of oil imports. The share of trade value with Japan is next to that of the USA and comes to about 20% as shown below.

(US $ x 10^6)

		1980	1981	1982
Export	Total	5,790	5,697	5,010
	(Japan)	(1,504)	(1,241)	(1,145)
Import	Total	8,295	8,481	8,229
	(Japan)	(1,651)	(1,594)	(1,645)

Since 1983, its external trade deficit has rapidly become worse and the import of raw materials was stopped for several months in 1984 due to the stoppage of bank service for foreign trade.

2-3 Background of the Establishment of Crocodile Farming Institute

In the Philippines there are two native crocodile species, the Mindoro crocodile (Crocodylus mindorensis) and the saltwater crocodile (Crocodylus porosus), both of which are now on the verge of extinction. The decimation of crocodiles is attributed to uncontrolled hunting, loss of habitat due to construction of dams, river diversions, water pollution, human disturbances, and so on.

The Washington Convention, on International Trade in Endangered Species of Wild Fauna and Flora (CITES), significantly calls for and encourages each concerned nation to initiate nationwide action programs aiming at the proper conservation and development of endangered wild fauna and flora.

This project is carried out by BFD under MNR in the Philippines. BFD administers a forest area occupying more than 1/3 area of the Philippines. BFD also manages big afforestration programs for the conservation and development of forest resources and other kinds of programs for environmental protection.

CHAPTER 3. OUTLINE OF THE PROJECT SITE

CHAPTER 3 OUTLINE OF THE PROJECT SITE

3-1 Selection of the Project Site

The government of the Philippines proposed two places for the Project Site; a hillside facing Lake Naujan in Mindoro Island, and the Iwahig region in Puerto Princesa City, Palawan Island. The government of Japan dispatched a joint team composed of Grant Aid Team and Technical Cooperation Team in November 1983, to conduct field surveys on the two proposed sites from various aspects and to hold discussions with the representatives of the Philippine government. At that time, the following 11 criteria were established for evaluation of the site:

1) existence of crocodiles in the area,
2) transportation accessibility,
3) adequacy of land area with component body of water,
4) presence of vegetative cover (trees, grasses, etc.),
5) relative distance from human settlements,
6) availableness of crocodile feed,
7) ease of construction,
8) suitable geographic features for constructing breeding pens, etc.,
9) security,
10) weather, and
11) infrastructure conditions like electricity, water, gas.

When two proposed sites were compared after the field surveys based on these criteria, Lake Naujan was found to have the advantage of the existence of Mindoro crocodiles, while the Iwahig region had the advantage of transport, land area, construction, geographic features and infrastructure. In the end, the Iwahig region in Puerto Princesa was decided as the Project Site.

3-2 Outline of the Project Site

(1) Palawan

Palawan province extends from northeast to southwest, with a length of 650 km from tip to tip. Palawan Island, the main island of the province, measures 425 km in length with a width of 40 km at the widest point. The entire land area of the province is 1,489,655 hectares, of which 7.45% or 111,010 hectares is cultivated (37.1% of this is coconut farms), and 38.6% or 574,725 hectares forest.

(2) Socio-economic Profile of Palawan

① Population

The number of inhabitants in Palawan was 412,000 in 1983, comprising 6.1% of the total population of Region IV. The majority of the population is concentrated in Puerto Princesa City, where the Project Site is located, and Brooke's Point in the south, the two having 16.4% and 12.5% of the population of the province respectively. Table 3.1 shows the population of Palawan by municipalities during 1980 and 1983 and the annual average population growth rate.

② Industry

Of the labor force by industry in Palawan, 60% are engaged in agriculture, forestry and fishery. This rate is higher than the average rate for the whole country. Of the agricultural products, cashews and honey are known as specialities. The ratio of cultivation of marine products, important for crocodile feed, is relatively low. Small and large scale ocean fishing constitutes the main part (Table 3.3). Most of the large scale fishing output is concentrated in the northern archipelago, while the small scale fishing with an output of several thousand tons takes place in the major fishing ports all over Palawan province (Table 3.4).

TABLE 3.1 POPULATION DISTRIBUTION OF PALAWAN BY MUNICIPALITIES

Municipality	Population (in thousands) (Actual population) 1980	1983	Average Annual Growth Rate (%) 1980 - 1983
ABORLAN	11.9	12.5	1.7
AGUTAYA	4.7	5.0	2.1
ARACELI (DUMARAN)	6.1	6.6	2.7
BALABAO	15.2	17.5	4.8
BATARASA	18.1	19.5	2.5
BROOKES POINT	46.7	51.6	3.4
BUSUANGA	10.4	12.1	5.2
CAGAYANCILLO	4.0	4.1	0.8
CORON	25.3	27.4	2.7
CUYO	14.8	15.5	1.6
DUMARAN	8.5	9.2	2.7
EL NIDO (BACUIT)	11.7	13.2	4.1
LINAPACAN	4.5	4.8	2.2
MAGSAYSAY	9.7	10.0	1.0
NARRA	30.3	32.9	2.8
PUERTO PRINCESA	60.7	67.8	3.8
QUEZON	33.3	36.7	3.3
ROXAS	25.1	27.6	3.2
SAN VICENTE	10.2	11.7	4.7
TAY TAY	23.2	26.1	4.0
KALAYAAN	0.3	0.4	10.1
PALAWAN TOTAL	374.7	412.2	3.3

TABLE 3.2 LABOR FORCE BY INDUSTRIES 1983 a/ (in: 1000s)

	Philippine Total	Palawan
Total sectors	2,362 (100.0)	153 (100.0)
Agriculture, fishing, forestry	1,049 (44.4)	92 (60.1)
Mining	11 (0.5)	b/(-)
Manufacture	291 (12.3)	14 (9.1)
Electricity, gas, water supply	12 (0.5)	b/(-)
Construction	103 (4.4)	5 (3.3)
Wholesale, retail	314 (13.3)	11 (7.2)
Freight, warehouses, transportation	137 (5.8)	6 (3.9)
Finance, insurance, service, real estate	38 (1.6)	1 (0.7)
Welfare	405 (17.1)	24 (15.7)
Others	2 (0.1)	b/(-)

a/ Average of 1/4 period and 3/4 period in 1983
b/ less than 1,000 persons

Source: National Census and Statistics Office

TABLE 3.3 FISH OUTPUT IN PALAWAN 1983 (in: M.T,%)

Ocean Fishing		Inland	Cultivation		
Large scale	Small scale	Fishing	Salt water	Fresh water	Total
21,695	49,852	-	722	3	72,322
(30.0)	(68.9)	(-)	(1.1)	(-)	(100.0)

Source: Fisheries Statistics of the Philippines, BFAR
(Preliminary data as of December 1984)

TABLE 3.4 OUTPUT OF OCEAN FISHING BY MUNICIPALITIES IN PALAWAN

(in: M.T)

Municipality	Large scale	Small scale	Total
Northern Palawan			
Liminanglong	3,628	N.A.	3,628
Icadambanua	7,799	N.A.	7,799
Tay Tay	4,848	91	4,939
Caran	3,575	9,161	12,736
San Vicente	637	N.A.	637
Linapacan	53	1,074	1,127
El Nido	-	6,614	6,614
Southern Palawan			
Quezon	305	1,353	1,658
Narra	783	3,345	4,128
Puerto Princesa	-	2,963	2,963
Aborlan	-	2,063	2,063
Dunarar	25	N.A.	25
Brooke's Point	5	1,491	1,496
Bataraja	37	3,330	3,367
Others	-	18,367	18,367
T O T A L	21,695	49,852	71,547

Source: Fisheries Statistics of the Philippines, BFAR
(Preliminary data as of December 1984)

(3) Puerto Princesa and the Project Site

Puerto Princesa, located at 9°44' N and 118°44° E, lies approximately 580 km south-southwest of Manila. It is in the center of Palawan Island and is the capital of the province.

The Project Site for the Institute is located in the Iwahig region at the foot of gently-sloping mountains, about 8 km northwest of central Puerto Princesa, across Puerto Princesa Bay. This ground is in a part of Iwahig Penal Colony, known as "the open prison", and lies in the north end of a 500-hectare area that the National Council for Integrated Area Development (NACIAD) owns as the project site of the Agricultural Center planned for the use of capital from the Asian Development Bank.

At present, jeepnies and buses under private management on an irregular schedule run as public transportation between the city and site area. Only a few scattered private houses and some concrete block plants lie around the site area.

3-3 Natural Conditions

(1) Topographic and Geological Features

Tall mountain ranges, having an average elevation of approximately 1,100 meters above sea level run through the entire central length bisecting the land into two areas --- the east and west coasts. The Project Site is located on the east coast at a place where the island is 15 km wide. It lies on a gently-sloping grass field, at the east side of Mt. Beaufort, which is 1,020 meters high.

Since the mountanious area is close to the sea, rivers are short and narrow, and many of them dry up in the dry season. One of these rivers is the Irawan River, on which the Project Site borders.

Strata around the Site consist of tertiary and quaternary layers, sediments from Mt. Beaufort, over olivine formed by orogenies in the Paleogene era. The top layer, about 15 m deep from the

surface, is alluvial and consists of sand with small gravels, clay and silt.

(2) Climate

The Philippines has four types of climate. Palawan is one which has a distinctive dry season from November to April and the rainy season from May to October. The climate of Palawan can be subdivided into two types:

Type I : Distinctive 6-month dry and 6-month rainy season; Extreme north and south portions, and the entire west coast

Type II : Short dry season from one to three months and no pronounced rainy period during the rest of the year; Rest of the province

Puerto Princesa is in the Type II area. The northern, southern and western portions of the province receive an annual rainfall of about 2,900 mm because these areas are sometimes struck by typhoons, while the eastern region from Puerto Princesa to Brooke's Point has only 1,670 mm.

The maximum monthly rainfall in Puerto Princesa was 844.5 mm, recorded in December 1975; however, this is an exceptional record. It is usually 450 mm or so. Maximum daily rainfall was also recorded in the same month: 269.3 mm.

Temperature in Puerto Princesa does not show a large fluctuation throughout a year, though slightly low from December to February and high in April and May.

Monthly average highest temp.	33.8°C	(April)	-	29.6°C	(Jan.)
Monthly average lowest temp.	25.5	(May)	-	21.7	(Feb.)
Highest temperature	35.7	(April)	-	33.4	(Jan.)
Lowest temperature	21.3	(May)	-	18.3	(Dec., Jan.)

Wind is comparatively weak because this region is where tropical dipressions originate which go north before developing into typhoons. There is a very high record of 48.8 m/sec. observed

in November 1968, but the next best record is only 17 m/sec. (from records from 1950 to 1975)

Though the Philippines belongs to the Circum-Pan-Pacific Earthquake Belt and suffer frequent earthquakes, no large earthquakes have been recorded near Palawan Island.

3-4 Infrastructure

(1) Electricity

In Puerto Princesa, electricity is served by either a 5,500 kw diesel generator, or a 3,650 kw one, while the maximum consumption load is approximately 2,400 kw. There is sufficient surplus capacity. An electric line of 13,200 V with a feeding capacity of over 2,000 kw is supplied along the national road running along the west side of the Project Site. However, power failures are observed about 60 to 70 hours a month on the average, and once a year, power is stopped more than 10 days for inspection and maintenance of the generators.

TABLE 3.5 ELECTRICITY CHARGES

(as of December 1984)

Equipment fee	20 ₱/kw (at the time of application only)
Consumption fee	3.88 ₱/kwh (77.6 ₱ less than 20 kwh)
Feeder laying cost	5,500 ₱ (up to the meter via pole trans.) (only when the customer prepares all the materials)

(2) Telephone

The Philippine Telephone Corporation (PILTEL) provided a capacity of about 400 lines in Puerto Princesa as of November 1984, and this is scheduled to be expanded 300 more lines in the near future, with direct access to all points in the country and in the world. However, the extension of telephone wiring around the Site has not been planned yet.

(3) Water

The survey found that a 4-inch steel water supply pipe runs from west to east across the Site, the source of which is spring-water in the mountains. A reliable supply of the required amount of water to the Institute by this pipe is considered difficult as it is utilized to supply water to barangays between the mountains and the city area.

There are four deep wells (minimum lift capacity of 300, 250, 200, 100 gallons/min) about 500 m north of the Project Site, starting operation in May 1984 for the supply of potable water to the city area. Water from these wells is delivered to a storage tank in Santa Monica and then distributed by pressure. They are said to have enough capacity to ensure potable water for the citizens of Puerto Princesa City for 50 years into the future. However, water supply to the Institute that will consume about 10,000 m^3 of water a month, while the total volume lift of 47,276 m^3 in October 1984 (No.1 - 3 wells; 8 to 9 hours/day operation) may greatly influence the municipal water supply program. It is considered difficult to ask the Philippine side for the extension of piping, which may be several hundred meters.

(4) Gas

No gas supply pipeline is provided even in the city area. LPG can be purchased in 11 kg or 50 kg cylinders, but no delivery service is provided.

TABLE 3.6 GAS CHARGES

(as of November 1984)

Capacity of cylinder	Gas fee	Cylinder fee	Regulator and hose
11 kg	175 ₱	250 ₱	175 ₱
50 kg	720 ₱	2,000 ₱	175 ₱

Oxygen and acetylene gas can be purchased at any time. Other special gas (for laboratory use) can be ordered in Puerto Princesa for delivery from Manila.

(5) Lodgings

Puerto Princesa City has one first-rate hotel with about 100 guest rooms, and three hotels with about 10 to 25 guest rooms. For the convenience of the long stay, some facilities can be added in the suites of these hotels. There are also houses for rent with 3 to 5 bedrooms, though not many. So lodgings are available for the Japanese engineers during the construction period and for the Japanese experts during the technical cooperation period. It is recommended to ask for a remodeling of the rooms beforehand.

3-5 Construction Conditions

Building styles in Puerto Princesa does not seem to be outstandingly different from other districts. Some of the public buildings are of wooden construction, but most of them are concrete. Most of the roofs, including private houses, use corrugated steel sheets with paint finish. Outside the city area, many of the private houses are built of wood with bamboo-woven walls and covered with a palm leaf roof.

As to construction materials, aggregates and timber are rather easily available, while other materials may be available in small quantities if one is not too selective about type. Materials are more expensive than in Manila except for aggregates and timber because they are shipped from outside the island. Concrete blocks to be used for the walls of the buildings and pens are available near the Project Site, though their quality is not satisfactory. Improvement in quality can be expected through instruction of production techniques.

There are several construction companies in Palawan, but there exists a great difference in scale and skill between these companies and those in Manila. Companies in Manila are extending their operations

widely in Palawan.

The number of construction engineers, skilled workers and machine operators in Palawan is small, nor are their skills trustworthy. Therefore, workers other than unskilled workers and assistants, will probably have to be transferred from Manila for such a large project as this. In this case, additional costs need to be met for their shipping fees, housing, transportation and extra wages for working in a remote area, which would not be necessary for construction around Manila.

Construction machinery and equipment will be transported from Manila. Though some construction machinery rental companies exist on the island, they do not have various types of machines nor is their maintenance sufficient.

As mentioned above, construction costs in Puerto Princesa are expected to be higher than those in and around Manila because of these factors (materials, labor, construction machinery).

CHAPTER 4. PROJECT

CHAPTER 4 PROJECT

4-1 Objectives of the Project

The project to establish a national crocodile farming institute has the following two long-term objectives:

1) to promote the preservation of the two crocodile species which inhabit the Philippines through efficient breeding and rearing in captivity,

2) to promote the socio-economic well-being of rural communities through the introduction and development of crocodile farming.

The objectives of the Institute were confirmed through discussions with the Philippine side as follows:

1) to formulate an effective and appropriate technology that will maximize the breeding capability of the selected crocodile species,
2) to determine the effectiveness of raising and breeding crocodiles under controlled conditions so that the wild population can be protected and preserved from extinction,
3) to develop an appropriate technology in effectively propagating the crocodile,
4) to determine constraints, especially diseases and feeding problems, that will affect the well-being of the stock,
5) to promote national awareness and appreciation of wildlife species found therein, and
6) to formulate a program which provides for the dissemination of the farming technology to a larger number of beneficiaries.

4-2 Policy of the Project

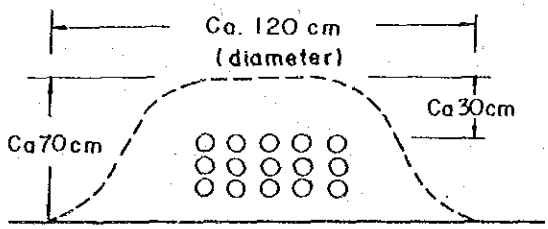
(1) Calculation of the Number of Crocodiles Farmed in the Institute

Number of crocodiles to be farmed in the Institute in the final stage is calculated based on general information on crocodile breeding.

① General information on crocodile breeding

a. Adult crocodiles

1) Age of maturation	: 10 - 15 years (C. porosus) 8 - 10 years (C. siamensis)
2) Size of maturation	: Total length of 200 - 300 cm
3) Reproductive longevity	: 10 - 20 years
4) Mating	: Once a year (i.e., December to March in Samutprakan Crocodile Farm)
5) Period from copulation to egg-laying	: 3 - 3.5 weeks (Alligator)
6) Nest building and egg-laying	: Nest building takes 1 - 2 days before egg-laying
7) Percentage of fertilization	: 70 - 80 %
8) Clutch size	: 30 - 70 eggs (C. porosus) 20 - 40 eggs (C. siamensis)



Remarks 1) Materials are dead grass and leaves accumulated in the water.

2) They lay eggs also in sand occasionally.

FIG. 4.1 NEST OF C. porosus IN PALAU

b. Development of eggs

1) Period for hatching	: 80 - 90 days
2) Temperature for hatching	: 28 - 34 °C
3) Humidity for hatching	: more than 90 %
4) Selection of fertilized eggs	: Blood vessels observed at 10 days after egg-laying.
5) Egg size	: 5x8 cm, ca. 110 g (C. porosus)
6) Transportation of fertilized eggs	: 50 - 75 days after egg-laying allowed for the transportation to incubator

c. Hatching and rearing of hatchlings

1) Hatching rate of fertilized eggs	: nearly 100 %
2) Size of hatchlings	: Total length of 25 - 30 cm ca. 70g (C. porosus)
3) Period for the closure of belly line space	: It is less than 0.5mm width on 10 days after hatching and completely closes in ca. 3 weeks after hatching.
4) Initial feeding	: 7 - 10 days after hatching
5) Survival rate up to 1 year old after hatching	: 80-90 % (in Samutprakan Crocodile Farm)

② Calculation of the number of crocodiles to be farmed

a. Proposition of the government of the Philippines

In the discussion of the Phase I study, the Philippine side proposed that a stock of 150 female and 50 male adult crocodiles would be maintained in the Institute in the final stage. The minutes of discussions in the Phase II study stated that "BFD should take the necessary measures to procure two hundred (200) crocodiles for the Institute at the initial stage". However, the Philippine side has not proposed any definite idea about the number of crocodiles by age levels including 3,500 hatchlings.

b. Assumptions for the calculation

The following assumptions were adopted for the calculation of the number of crocodiles, taking into account of the above proposition by the government.

1) Two hundred adult crocodiles, 150 females and 50 males, should be always kept for breeding in the final stage of the operation,

2) Baby crocodiles bred in the Institute should be supplied to private farms within 1 year except for the individuals used for the study in the Institute. One thousand 1-year-old crocodiles, approximately half the total baby crocodiles, will be kept in the Institute for the purpose of further study and rearing experiments.

3) Study of farming technology and the training of participants will be conducted basically using young crocodiles under 3 years old. Crocodiles over 3 years old will be sold except for the stocks for breeding or the study of maturation, egg-laying, etc.

Thirty crocodiles of each age level will be kept in the Institute considering the following conditions:

i) Natural mortality after 3 years of age seems to be negligible,

ii) Assuming that reproductive longevity extends to about 10 years, 10-20 crocodiles is enough for annual recruitment to the breeding stock,

iii) Ten crocodiles of each age level shall be kept for study.

c. Number of crocodiles to be farmed

The number of crocodiles to be farmed was calculated in the final stage of operation as shown in Table 4.1 based on general information on crocodile breeding (①) and the assumptions mentioned above. A total number of ca. 4500 crocodiles will be farmed continuously in the Institute. About half of the total will be comprised of baby crocodiles under 1 year old and more than 90% of crocodiles under 3 years old.

TABLE 4.1 NUMBER OF CROCODILES STOCKED IN THE INSTITUTE AT THE FINAL STAGE OF OPERATION

Age (years old)											
0	1	2	3	4	5	6	7	8	9	10~	Total
2,200	1,000	900	30	30	30	30	30	30	30	200	4,510

Remarks:

1) Assuming that 90 females out of a breeding stock of 200 (more than 10 years old : no. of female is 150) would lay eggs once a year and the mean clutch size to be 40 eggs, fertilization rate to be 70% and the hatching rate of fertilized eggs to be 100%, the number of hatchlings can be estimated with the following equation.

   90 females x 40 eggs x 70% x 100% = 2,520 hatchlings

   The average number of 0 year old crocodiles for nursery rearing should be 2,200, considering i) some eggs and hatchlings are necessary for experiments and ii) mortality in this period will be 10 to 20%.

2) Mortality from 1 to 2 years old was estimated to be 10% including natural mortality and experimental use.

(2) Growth and Calculation of Feed Amount

There is considerable information on growth and the feed for crocodile farming, but most of it has not been systematically reviewed and does not suggest a quantitative relation between growth and feed amount.

In this section, the amount of feed required for the Institute was calculated based on the data on growth and feed amount of C. porosus farmed in Papua New Guinea.

① Growth

The average growth of C. porosus estimated in Moitaka Crocodile Farm, Papua New Guinea is shown in Table 4.2, and based on these data growth curves expanded beyond 5 years of age are shown in Figs. 4.2 and 4.3.

TABLE 4.2 GROWTH OF FARMED CROCODILES, C. porosus IN PAPUA NEW GUINEA

Age	Total length (cm)	Belly width (cm)	Body weight (kg)
0	55	12	0.5
1	110	25	5
2	160	35	16
3	190	45	30
4	210	53	40

Source : Crocodile husbandry in Papua New Guinea, FAO, 1981

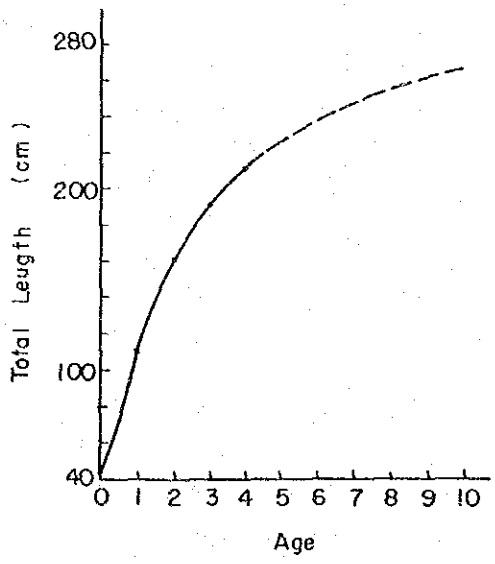


FIG. 4.2 RELATION BETWEEN AGE AND TOTAL LENGTH OF FARMED CROCODILE, C. porosus

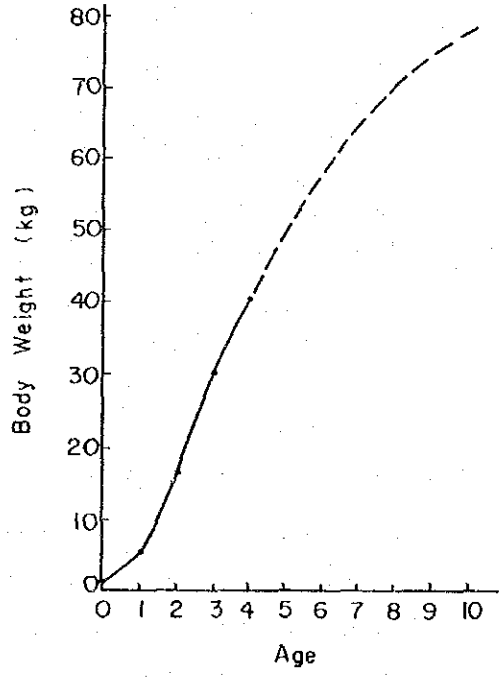


FIG. 4.3 RELATION BETWEEN AGE AND BODY WEIGHT OF FARMED CROCODILE, C. porosus

② Required amount of feed

Required amount of feed for crocodile farmed in the Institute was calculated by multiplying the mean body weight by the feed intake rate per day at each age level. The feed intake rate per day was estimated for each age from the data shown in Table 4.3.

The total amount of feed required in the Institute was estimated

to be ca. 600 kg per day or ca. 220 tons annually, as shown in Table 4.4.

TABLE 4.3 FEED INTAKE RATE FOR FARMED CROCODILES

Age	Size (cm)		Feed per day (g)	Feed per feeding day (g)	Feed intake rate (% Body weight)	
	Total length	Belly width			per week	per day
0	45- 60	(9-12)	25	35	35	5.0
1	60- 90	(12-20)	50	70	21	2.0
	90-120	(20-28)	100	140	15	2.1
2	120-140	(28-32)	160	225	13	1.9
	140-160	(32-36)	230	320	11	1.6
3	160-180	(36-46)	330	460	10	1.4

Source : Crocodile husbandry in Papua New Guinea, FAO, 1981

NOTE : Feeding days are five days a week.

TABLE 4.4 AMOUNT OF FEED REQUIRED FOR CROCODILES FARMED IN THE INSTITUTE

Age	A 1) No. of crocodiles	B 2) Mean body weight (kg)	C Feed intake rate (%BW/dy)	Required amount of feed		
				BxC day (g/dy-head)	AxBxC (kg/dy)	AxBxC x365 (ton/yr)
0	2200	0.5	5.0	25	55	20
1	1000	5	2.0	100	100	37
2	900	16	1.5	240	216	79
3	30	30	1.3	390	12	4
4	30	40	1.1	440	13	5
5	30	50	1.0	500	15	5
6	30	58	0.9	520	16	6
7	30	65	0.8	520	16	6
8	30	70	0.75	530	16	6
9	30	75	0.75	530	16	6
over 10	200	100 3)	0.6	600	120	44
Total	4510				595	218

Remarks: 1) refer to Table 4.1.
2) refer to Table 4.2 and Fig. 4.3
3) Mean body weight at over 10 years old was assumed to be 100 kg.

(3) Structure and Scale of Pens and Rearing Area per Crocodile

There are several kinds of rearing pens, i.e., concrete tanks for intensive farming, and rearing pens for extensive farming which are fenced with wire net and composed of open land, shrub and a pond, or very simple pens which are composed of a part of pond and land enclosed with wooden pickets. The breeding pens have a larger area and a deeper pond than the rearing pens. Every crocodile farming pen basically consists of a water area, a land area necessary for regulation of body temperature by sun-bathing and a shaded area for rest or shelter in consideration of the ecological habits of crocodiles.

Rearing pens in the Institute shall be multipurpose, useful in various rearing experiments to develop farming and breeding techniques, and the plans for these pens shall refer to other advanced facilities.

In this view, appropriate rearing pens and rearing density in the Institute are discussed based on the consolidated data of Samutprakan Crocodile Farm, Thailand, in which farming and breeding appear to be carried out commercially, as were investigated during the Phase I study.

① Samutprakan Crocodile Farm in Thailand

Major species reared in this farm are the freshwater crocodiles (C. siamensis) and partially saltwater crocodiles (C. porosus), and a hybrid between them is also found. A small number of foreign species such as gavials, caimans, etc. were reared for exhibition.

Pens are classified into the following 3 categories:

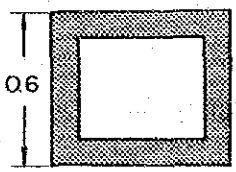
a. Nursery tank : for 0 year old
b. Rearing tank : for over 1 year old
c. Breeding pen : for breeding stock

The structure, scale and rearing density are described as follows:

a. Nursery tanks

Nursery tanks were set inside the wire netted house, which was closed to tourists. The roof of this house was made of corrugated asbestos cement sheet and care was taken for sunshine penetration by installing translucent plastic windows. Water is distributed to nursery tanks through a water purifier and ultraviolet ray sterilizer.

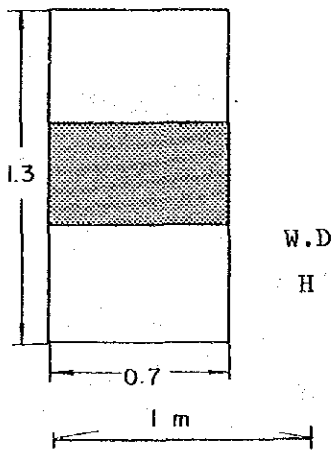
N-1



W.D.; 7 - 8 cm
H ; 50 cm

0-year-old crocodile
N = 10
d = 23.8 /m^2

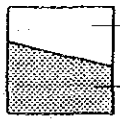
N-2



W.D.; 7 - 8 cm
H ; 50 cm

0-year-old crocodile
N = 15
d = 16.5 /m^2

Legends and remarks



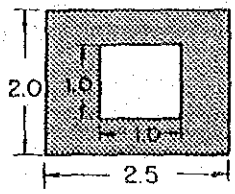
1) The unit measure of tanks and ponds is the meter (m) and the unit scale is indicated in every pen.

2) W.D.: Water Depth
H : Height of the wall of pen
N : Number of crocodiles
d : Rearing density
(No. of crocodiles/m^2)

b. Rearing tanks

The roofs of rearing tanks consist of square timbers which are arranged 10 cm apart for sunshine penetration.

R-1



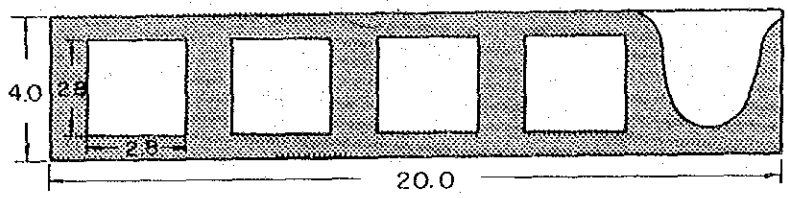
W.D.; 7 - 8 cm
H ; 100 cm

1-year-old crocodiles
N = 20
d = 4.0 /m^2

1 m

R-2

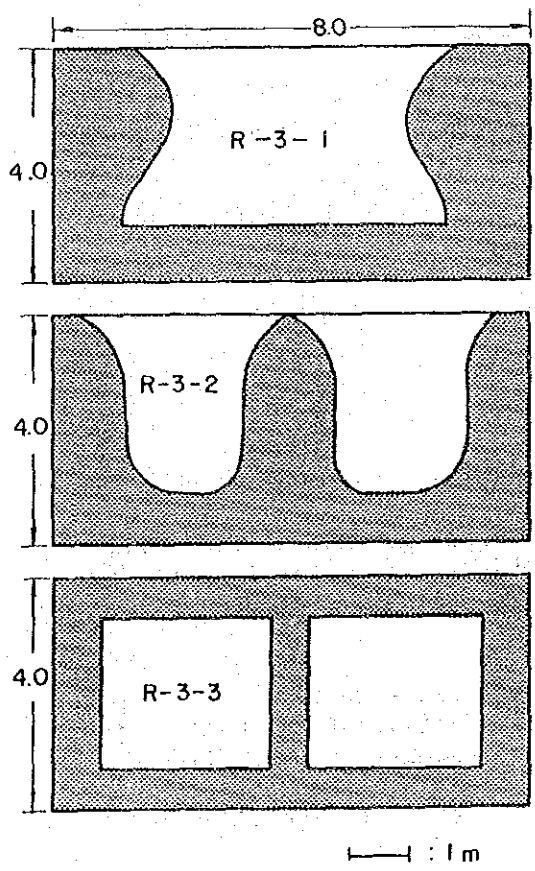
2-year-old crocodiles
N = 200 ~ 250
d = 2.5 ~ 3.1 /m^2



W.D.; 20 cm
H ; 130 cm

1 m

R-3

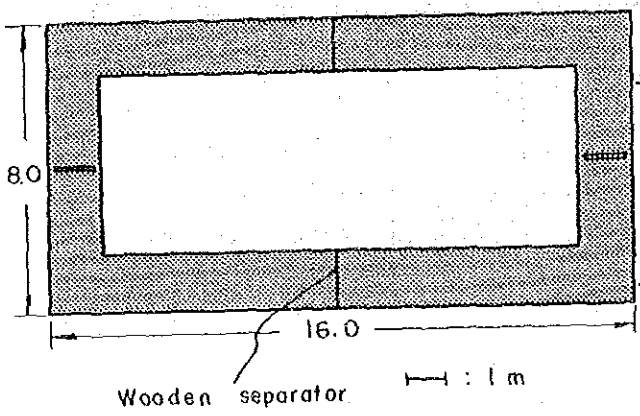


Case	N	d
2-year-old crocodiles	70	2.2
3-year-old ones	50-60	1.7-1.9
4-year-old ones	50-60	1.7-1.9
5-year-old ones	25-35	0.8-1.1

W.D.; 10 ~ 20 cm
H ; 150 cm

1 m

R-4



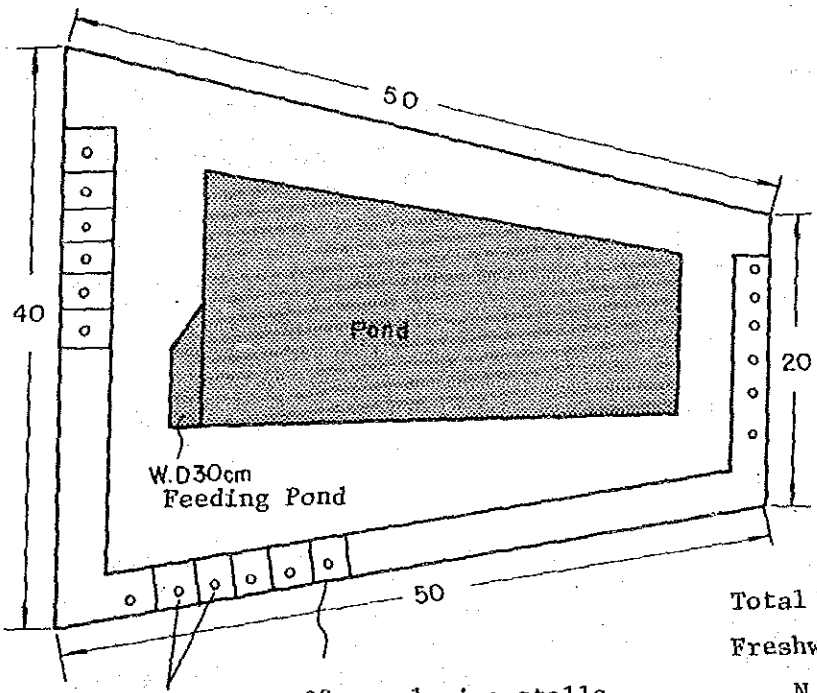
Case	N	d
2-year-old crocodiles	150	1.2
4-year-old ones	75	0.6
5-year-old ones	40	0.3

W.D.; 10 - 20 cm
H ; 150 cm

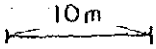
c. Breeding pens

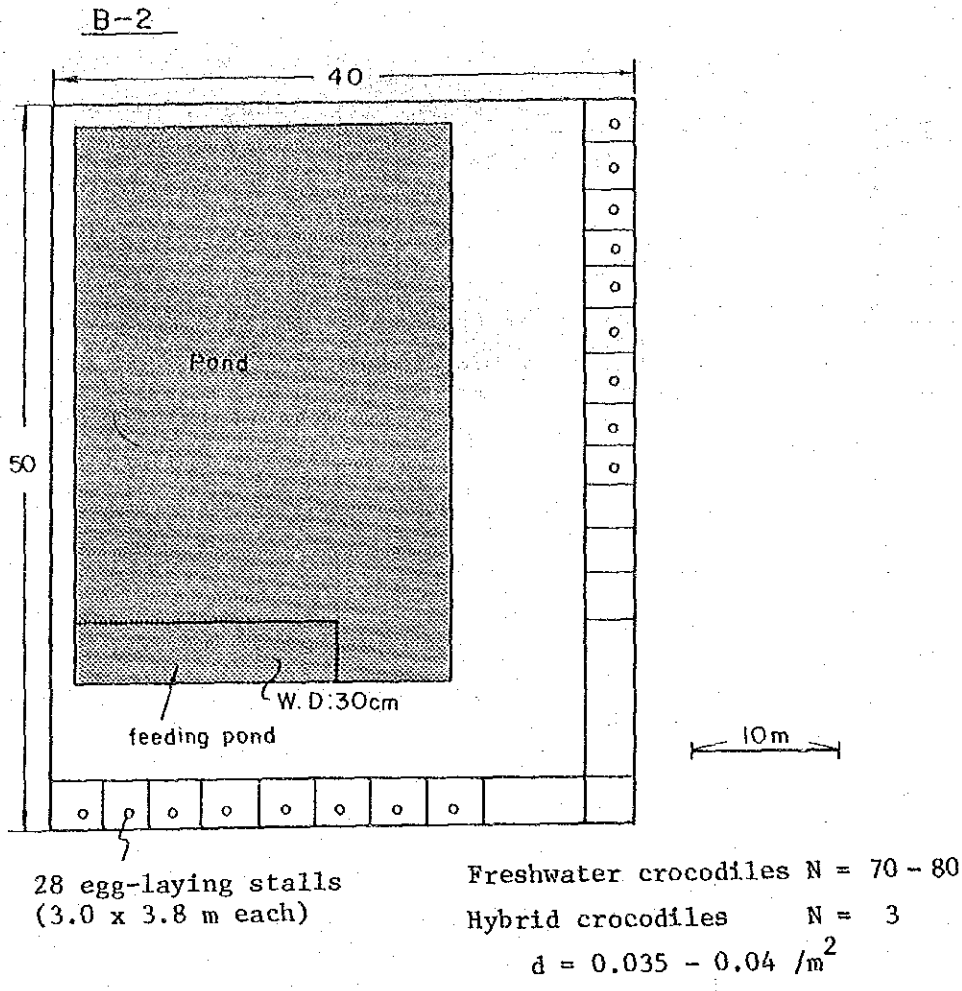
Breeding pens have no roof.

B-1



Total area: ca.1,500m^2
Freshwater crocodiles
N = 60
d = 0.04 /m^2





The rearing density in the above described pens is summarized in Table 4.5.

TABLE 4.5 REARING DENSITY IN SAMUTPRAKAN CROCODILE FARM

Pens	Age of crocodiles	Rearing density No. of crocodiles/m^2	Area occupied per individual (m^2/crocodile)
a. Nursery tanks	0	16.5 - 23.8	0.04 - 0.06
b. Rearing tanks	1	4	0.25
	2	1.2 - 3.1	0.3 - 0.8
	3	1.7 - 1.9	0.5 - 0.6
	4	0.6 - 1.9	0.5 - 1.7
	5	0.3 - 1.1	0.9 - 3.3
c. Breeding pens	adult	0.035 - 0.04	25.0 - 28.6

② Scale of rearing facilities

Samutprakan Crocodile Farm is operated on a commercial basis and the rearing density is so high that some crocodiles have deformed legs and some are injured in fights. Hence the scale of rearing facilities in the Institute shall be slightly larger than that in Samutprakan Crocodile Farm. The actual scale of the facilities shall be determined considering the activities of the Institute, land conditions at the Site, and related infrastructure, etc. in an integrated view (refer to Chapter 5 "BASIC PLANNING (3) Planning of Breeding and Rearing Pens and Tanks".)

4-3 Activities of the Institute

(1) Basic Policy on Activities

The Institute shall fulfill the main roles of basic biological studies of crocodile and development and dissemination of the farming technology in the Philippines as mentioned in Sec. 4-1. However, an integrated institute of this nature to study crocodile farming has never been established anywhere and the various data on rearing or breeding are insufficient. Thus it is rather difficult to refer to activities of existing facilities. Accordingly, the Institute is required to make some fundamental progress in studies such as on the basic biology, development of applied technology of crocodile farming and study of wild crocodile conservation policies or dissemination of the farming technology to the private sector by referring to the histories of development and dissemination of aquacultural or livestock breeding technology. The concept flow of these activities is shown in Fig. 4.4.

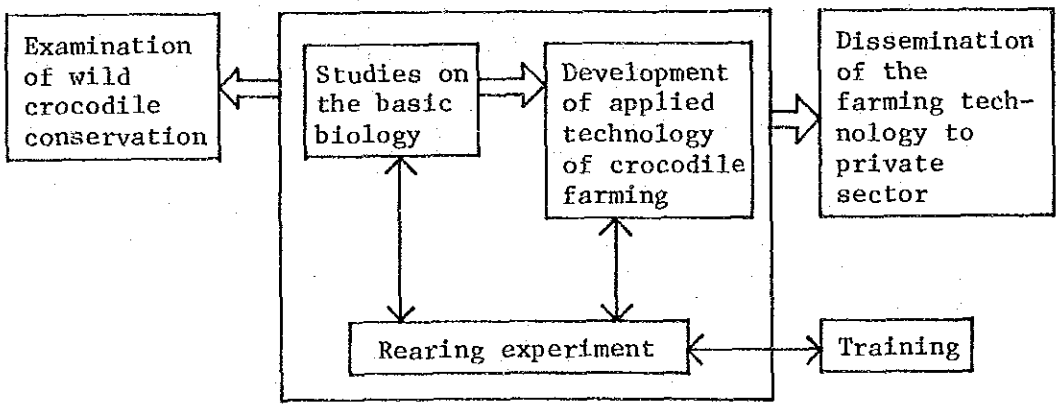


FIG. 4.4 FUNDAMENTAL RELATION OF THE ACTIVITIES IN THE INSTITUTE

(2) Structure of the Laboratories and Study Subjects

The studies to be carried out in the Institute can be considered as two major subject; one is the basic biologial study of crocodile and the other is the study of the development of farming technology. In this view, a minimum of four study groups seems to be required, i.e., in the former study, a 1st group for the ecology and population dynamics of wild crocodiles and a 2nd group for the basic physiology and pathology of crocodiles mainly in captivity, and in the latter study, a 1st group for the development of technology of rearing, breeding and stock production, and a 2nd group for the chemical/nutritional analysis of feed, something likely to become one of the most important problems in the management of a crocodile farm. It is expected that the ultimate objectives of the Institute will be achieved through repeated dissemination of data and information among these study groups. On the other hand, it would seem effective for each group to approach the study independently not only to acquire knowledge in general but also in the specialized areas which are necessary for the actual experiment.

Considering the above factors, it is appropriate that the Institute shall consist of the following four laboratories.

1) Resource Management and Ecology Lab. : Study of the ecology and population dynamics of the wild crocodile and the examination of conservation policy

2) Physiology and Pathology Lab. : Study of the basic physiology and pathology of the crocodile

3) Crocodile Farming Lab. : Study of the development of actual technology of rearing, breeding and stock production and the preparation of a technical manual

4) Nutritional Chemisty Lab. : Chemical study of feed for farming

The contents of these studies are explained as follows.

① Resource Management and Ecology Laboratory

a. Population dynamics and ecology of wild crocodiles

The objective of this section is to obtain a basic knowledge of the distribution, behavior and life history of wild crocodiles, necessary to protect them and to imporve farming technology.

1) Identification of species

To identify species of crocodiles in the Philippines and clarify their taxonomical characteristics.

2) Relation between distribution of crocodiles and environmental characteristics of their habitats.

To learn the optimum environmental conditions for crocodiles through the investigation of such factors as climates, water quality, nature of soil, fauna and flora of their habitats and their egg-laying grounds.

3) Life history

To learn the life history of wild crocodiles through observation and existing data on the season of mating/egg-laying, maturation age, life span and other characteristics.

4) Feeding habits

To give information for improvement of rearing technology of crocodiles through investigation of feeding habits and feed intake by growing stage, season, maturing stage, etc.

5) Behavior

To learn optimum conditions of rearing/breeding through observation of behavior such as mating, egg-laying, strife, predators, etc.

6) Population dynamics of crocodiles

To estimate the stock abundance of crocodiles from life history data or mark and recapture surveys, and to study population dynamics of crocodiles by the analysis of relationships among growth, maturation, clutch size,

mortality and other characteristics.

b. Conservation of wild crocodiles

To make an original plan of the conservation policies (releasing of crocodile stock, standards for sanctuaries) based on the above described data and information.

② Physiology and Pathology Laboratory

a. Basic physiology of crocodiles

To study such basic functions as digestive mechanism, internal secretion, circulatory system, etc. and apply as basis of maturing control, improvement of feed, pathological examination and other studies.

b. Prevention and treatment of disease

1) Symptoms

To study clinical method by surgery observation, epidemiological tests, etc.

2) Cause of disease

To study pathogenic organisms, infection routes and the effect of environmental stress.

3) Treatment and prevention

To study methods of treatment and prevention by dosage tests (antibiotic substances, anesthetics and other medicines), sterilization experiments, etc.

③ Crocodile Farming Laboratory

a. Breeding technology

1) Maturation factors

To observe the maturing process and investigate the effects of feeding rate, growth, rearing density, hormones and other factors on maturation.
(Finally to study artificial control of maturing)

2) Optimum conditions for mating

To study appropriate conditions for mating (selection of matured crocodiles, sex ratio, environmental conditions, etc.) and improve fertility.

3) Optimum conditions for egg-laying, development of eggs and hatching

To identify optimum ranges of such factors as temperature, humidity, nature of soil, light intensity and others by the investigation of egg-laying grounds and artificial hatching experiments.

4) Control of sex ratio

To investigate whether sex ratio can be controlled by environmental conditions on egg development like other reptiles.

b. Rearing technology

1) Optimum environmental conditions

To identify appropriate rearing density and structure of pens for growth, prevention of disease and mutual injuring of crocodiles.

2) Feeding efficiency

To establish appropriate feed and feeding methods by the investigation of the effects of feeding (amount and frequency of feeding, etc.) on the growth and health of crocodiles, and of feed preference or feed conversion ratios.

3) Rearing management

To study methods of periodical measurement, diagnosis, individual identification of crocodiles, safety programs and other items.

4) Breeding studies

To learn superior characters (i.e., growth rate, clutch size, etc.) and study methods of preservation of these characters (selection and cross breeding).

5) Dissemination of farming technology

To develop a suitable management system of farming and prepare a technical manual for crocodile farming.

④ Nutritional Chemistry Laboratory

1) Essential nutrients for crocodiles

To investigate nutritional elements of feed necessary for growth and maturation by the analysis of digestive enzymes, rearing experiments with various feeds, etc.

2) Digestion and absorption rate of feed

To identify digesting/absorption rate by analysis of excrement, etc.

3) Selection of feed

To select appropriate feed for farming crocodiles by the measurement of the nutritional elements of feed.

4) Development of compound feed

To study compound feed for farming crocodiles through improving the existing compound feeds for other animals, or processing by selecting and mixing ingredients which are mainly available in the Philippines.

4-4 Component of the Institute

The Institute is composed of the following facilities and equipment.

(1) Facilities

1) Buildings (Administration and Training Bldg., Hatchling House, Dormitory, etc.; 13 bldgs. in total)
2) Rearing and breeding pens
3) Rearing tanks
4) Institute road and parking area
5) Wells
6) Water purification and sewage treatment facilities
7) Water supply and drainage system

8) Water tank and pond
9) Waste disposal facilities
10) Power receiving substation and standby generator
11) Fence and security facilities
12) Freezer and cold storage for feed

(2) Equipment

1) Equipment for physical and chemical studies
2) Optical equipment and electrical appliances
3) Laboratory instruments
4) Farming instruments
5) Vehicles
6) Boat
7) Laboratory furniture
8) Tools for maintenance of equipment
9) Others

4-5 Future Plans

The Institute will, in the future, serve as a breeding stock production center as well as a main center for crocodile farming study in the Philippines. Once breeding stocks are matured and the cycles of egg-laying and nursery care can be firmly established, the Institute will be able to start its functions in supplying stock to peripheral farmers and in teaching and disseminating the farming technology.

The government of the Philippines plans to establish satellite stations in many areas to introduce crocodile farming technology into rural communities and to make it as a major industry. In this plan, promoters who have mastered the necessary farming techniques in a long-term training program in the Institute will be assigned to each of the satellite stations, and activity of farming industry will be propagated to surrounding communities through the station as a regional center.

The recommended sites for the satellite stations are places where wild crocodiles have already been confirmed to inhabit such as Naujan Lake in Mindoro and Zamboanga in Mindanao.

CHAPTER 5. BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5-1 Basic Design Policy

The following are the basic policies for drawing up the basic design of the project.

1) Minimize the local cost especially the running costs borne by the Philippine side,

2) Keep harmony with the environment around the Project Site,

3) Investigate the related local regulations and conform the facilities to them,

4) Consider precautions against generating air, water, noise and other forms of pollution,

5) In design, function will take precedence over all,

6) Design buildings with due care for local nature, climate, the construction situation and other conditions,

7) Use local construction materials as much as possible after examining their durability, maintenance and other conditions,

8) The Institute should be capable of providing study opportunities (e.g. publication of studies) and of serving relevant data to scholars or researchers who are interested in crocodile farming, and

9) As to the equipment to be granted, types and quantity will be decided to match the actual activities of the Institute, based on a through examination on the request from the Philippine side as well as the discussions with the Japanese side concerning technical cooperation. Equipment causing a minimum of trouble and easily maintained will be selected considering the possibility of equipment maintenance service in the Philippines.

5-2 Site Plan

(1) Site

The Project Site lies on a plain southeast of the mountains running through Palawan, about 2 km from Puerto Princesa Bay. It is located in the east end of a grass field, spread between a forest on the mountain side and mangroves on the bay side. A part of the Site includes the woods adjoining the mangroves. The Project Site, which used to be a ranch for goats and cattle, is located in the north end of a ground for the Agricultural Center Project of approximately 500 hectares. Ten hectares of that will be transferred from NACIAD to MNR as the Project Site. Since this Site faces the national road stretching southward from Puerto Princesa to Brooke's Point, no access road need be constructed, however, there are 4 goat houses which need to be replaced. The east end of the Site is a woods of approximately 2 hectares, where some large trees grow to one meter in diameter. It is recommended that these woods be left as they are considering the conservation of present environment and the difficulty of felling trees and excavation of their roots.

(2) Topography and Environment of the Site

The Project Site has an irregular pentagon shape of approximately 10 hectares. An open ditch about 1.0 m wide runs dividing the Site into the north and south portions, which leads rain water falling on the west side of the national road to the Irawan River. As this area spreads at the foot of the mountains, it has a gentle downward slope from west to east. In addition, the Site has a gradient toward the said open ditch. The elevation of the Site is approximately 37 m at the north end, and approximately 33 m around the downstream area of the ditch (center of the east boundary). The buildings and pens will be designed to utilize this gradient as much as possible, however, grading work may be required since the gradient of the ground is not even. Grading work is planned so that least amount of earth is needed from elsewhere.

The north side of the Site faces the bank of the Irawan River,

where the river turns about 140 degrees. The north side does not seem to be heavily eroded by the river flow according to the Phase II site survey, but revetment work is considered necessary for some ten years hence.

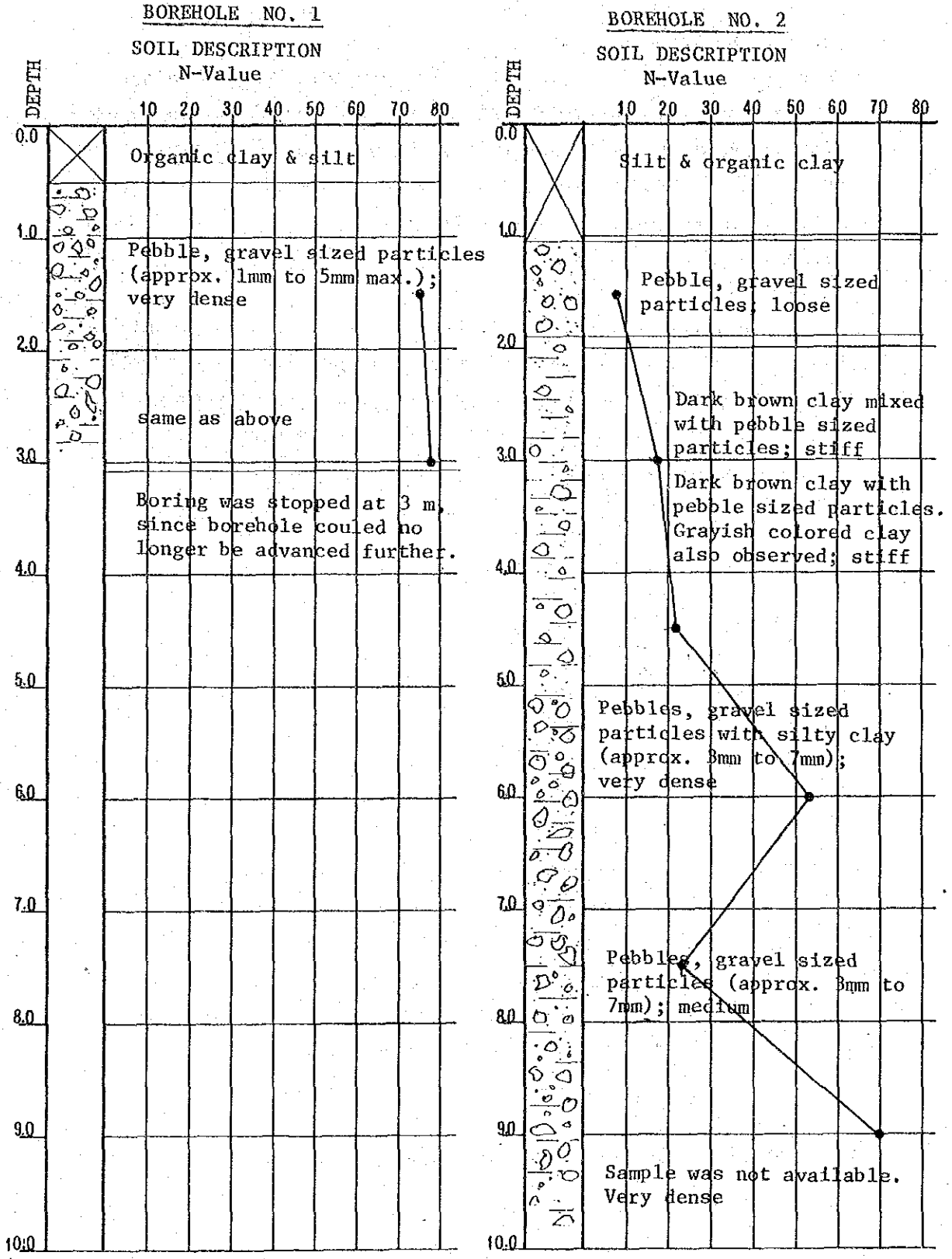
(3) Service and Treatment Facilities

No service except for electricity are provided to the Project Site because it is approximately 13 km from the city area, approximately 4 km from the Iwahig Penal Colony and only a few private houses lie scattered around it. A deep well will be dug in the Project Site because of difficulties of introducing water supply piping, as is stated in sec. 3-4 Infrastructure.

Both rain water and sewage will be discharged into the Iwahig River. Sewage will be treated before discharging. The BOD of the sewage is targeted at less than 60 ppm. As the garbage collection service is not expected of the city government due to the long distance from the city area, an incinerator will be installed.

(4) Soil Conditions

The results of borings and penetrations tests are shown below.



5-3 Basic Planning

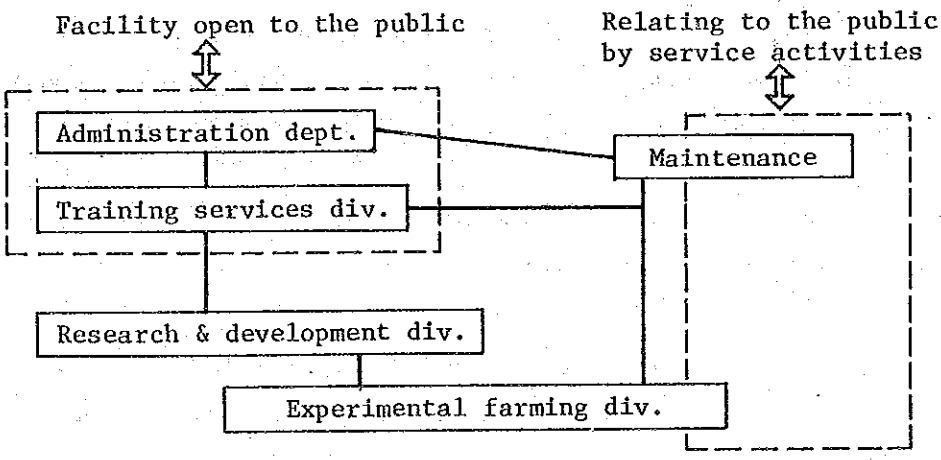
(1) Arrangement of Buildings

① Functional categories

Each division of this Institute may be separated into the following groups according to their functions:

- Administration department and Maintenance
- Training services division, in charge of training and dissemination of crocodile farming technique
- Research and development division
- Experimental farming division

The following chart shows the inter-relationship of each division and their relationship to the public.



② Characteristics of major buildings and facilities

a. Administration and Training Building

Administration work, conference and seminars are major activities. This is the sole building open to the public in this Institute.

b. Laboratory Building

This building is for research and laboratory work. It will also accommodate a library. This building has close relationship with the training services division.

c. Maintenance Building and Garage

Base for the staff of the maintenance work and experimental farming work.

d. Feed House

This building will accommodate cold storage and feed preparation room. Care shall be taken about sanitary conditions and the traffic approach for feed delivery.

e. Machine House

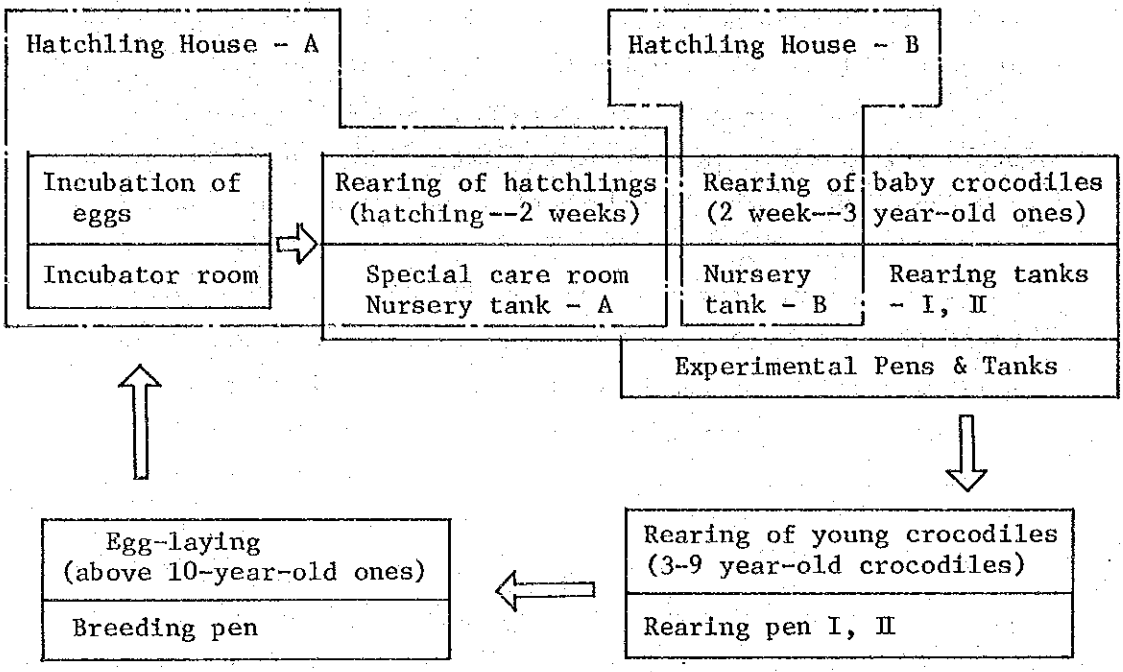
This building will accommodate energy and utility supply facilities such as a generator, water supply equipment, etc.

f. Crocodile Breeding and Rearing Facilities

Breeding and rearing will be carried out in a cyclic process. Facilities appropriate to each stage of growth of crocodiles as well as those for experimental purpose need to be provided.

The following flow chart shows the life cycle of crocodiles and facilities of each stage.

In addition to the ordinary rearing facilities, isolation tanks for sick and/or injured crocodiles, and a disinfection pen for newly arrived crocodiles will be considered.



③ Arrangement of buildings

The woods existing in the northeast of the Site is to be left as it is not only to preserve the existing scenery and environment but to avoid unnecessary expense for grading work. This area is to be utilized as a natural observation pen for the crocodiles.

The ditch running from west to east through the center of the Site cannot be removed because it now serves for rain water drainage from a part of west side of the national road. This ditch will also be used for water drainage from the Site.

Since this ditch will divide the Site into north and south portions, major facilities are to be concentrated at the northwest in the Site considering management and work efficiency. An entrance approach will also be provided in this area. As the facilities requiring electricity and potable water will be concentrated there, the supply facility will be installed seeking optimum conditions of energy efficiency.

Specifically, the Administration and Training Building, which is open to the public, will be arranged near the entrance, with the Feed House, Maintenance Building, Garage, Machine House, etc., which relate to the outside with service activities, on the east side of the Administration and Training Building.

These buildings, however, will be located to be a certain distance from each other because some of them may be source of noise and odor. As the Laboratory Building has close relations with the Training Services Division, it will be located on the south side, facing to the Administration and Training Building.

Crocodiles are sensitive to noise. The rearing and breeding pens will be located to be a certain distance from the national road and the noise-generating facilities. As is mentioned in sec. 2 -f, the rearing and breeding of crocodiles is a cyclic process, so the pens will be arranged in accordance with this cycle. Work efficiency should be taken into consideration to arrange the hatchling houses which need concentrated care-taking, near the Laboratory Buildings and rooms for caretakers.

④ Flow line planning

The flow line planning from the outside will be limited around the entrance by gathering those facilities relating to the outside directly through the use of vehicles at the northwest portion in the Site.

Vehicles within the Institute grounds will be needed for feed delivery, transportation of wastes, transfer of crocodiles, maintenance work, etc., but the roads are planned to be single lane becuase it is advisable to limit the use of vehicles. Major buildings and facilities will be connected by a loop road for vehicles about 3.5 m wide, and approximately 1.8 m wide pedestrian roads will be arranged for the facilities inside the loop.

(2) Building Planning

① Building in the Institute

a. Administration and Training Building

This building consists of the Administration Department, the official liaison section of the Institute that administers all the divisions, and the Training Services Division that accepts trainees from the outside. These are accommodated in the same building as both of them serve the public. The entrance hall and the lounge are arranged as a buffer space to separate the functions of these divisions.

A cafeteria will be provided for the institute staff, researchers and trainees, because this Institute is distant from the city area.

b. Laboratory Building

This building consists of laboratories, researchers' rooms and the library. The researchers' work is composed of laboratory work and desk work, and it is desirable to arrange laboratory space and research space adjacent to each other in a biological research center like this Institute. The laboratories need to be spacious in order to install work tables, sinks and large laboratory equipment, while the researchers rooms, for desk work, need not be very spacious.

Based on these considerations, a central corridor system, shifted to one side, will be introduced to the plan. Some laboratories will be provided with doors directly open to the outside for connection to the outdoor rearing and breeding pens.

c. Maintenance Building and Garage

This building consists of the rooms for maintenance and caretakers. A garage will be attached to this building to be used also as a work room extension.

d. Feed House

This building consists of cold storage for crocodile feed and a feed preparation room. Noise is expected from machines for freezers and refrigerators for feed storage, while smell is expected from the feed preparation room. Due care shall be taken as to sanitary conditions and ventilation.

e. Hatchling House - A, B

These are for concentrated control of hatchling crocodiles. An incubation room and special care rooms after hatching will be attached to the Hatchling House - A to keep good work efficiency and to decrease the mortality of crocodiles during this period. FRP nursery tanks will be installed in both houses.

A translucent roofing material will be used to introduce natural lighting.

f. Machine House

This building will accommodate the generator room and machine room for the water purification and supply system.

g. Gate House

h. Observation House - I

This is an observation base for the Natural Observation Pen.

i. Observation House - II

This is a control and observation base mainly for egg-laying stalls during the egg-laying and incubation period in the breeding pens.

j. Japaneese Experts' House

k. Dormitory

1. Incinerator House

② Description of the Buildings

Floor area of each building

Buildings	Structure	Area	Total Area
a) Administration and Training Building	Reinforced concrete	630.0	630.0
b) Laboratory Building	ditto	630.0	630.0
c) Maintenance Building and Garage	ditto Steel structure	252.0 126.0	378.0
d) Feed House	Steel structure	168.0	168.0
e)-1 Hatchling House A	Reinforced conc.	420.0	420.0
-2 Hatchling House B	Steel structure	627.0	627.0
f) Machine House	Reinforced conc.	119.0	119.0
g) Gate House	ditto	16.0	16.0
h) Observation House I	ditto	12.0	12.0
i) Observation House II	ditto	12.0	12.0
j) Japanese Experts' House	ditto	112.0	112.0
k) Dormitory for promoters under training	ditto	108.0	108.0
l) Incinerator House	Steel structure	110.0	110.0
T O T A L	Reinforced concrete	2,311.0	3,342.0
	Steel structure	1,031.0	

The following tables indicate names, purposes and activities, personnel and floor area of the rooms in each building.

a. ADMINISTRATION AND TRAINING BUILDING

ADMINISTRATION PORTION	237	(m^2)
TRAINING CENTER PORTION	201	
COMMON SPACE	192	
T O T A L A R E A	630	

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
ADMINISTRATION			
Director's Office	official services, meeting w/ institute staff & visitors, important meetings (executive meetings, etc.)	director (asst. director, manager, Japanese experts)	42
Assistant Director's Office	official services, meeting w/ institute staff & visitors	asst. director	21
Secretary's Office	secretarial work for director & asst. director, waiting room for those to meet director or asst. director	secretary 1	21
Japanese Team Leader's Office	official services by Japanese team leader, meetings w/ Japanese staff or Philippine officials concerned	Japanese experts team leader 1	21
Manager's Room	official services, frequent discussion w/ division chiefs	manager 1	15
Administration Office	general services of administration, finance & training, etc., installing telecom. unit	financial staff 1 clerks 2	42
First Aid Room	first aid for injured persons		15
Cafeteria	lunch & refreshments for the institute staff, researchers and trainees		42
Kitchen	cooking for cafeteria	cook & helper 2	15

(cont.)

Heat Exchanger Rm	hot water supply equipment installed			3
		(SUB-TOTAL)		237
TRAINING				
Trainer's Office	programming & preparation of training curriculum, schedule, text, publicity planning	trainer asst. trainer	1 1	30
Trainees' Room	study & rest room for promoters under training	trainees	6	30
Exhibition Room	exhibition of crocodile specimens, explanation, maps & other materials	visitors		63
Lecture Room	lecture to trainees, presentation by researchers lectures or speeches to visitors (students & various institutions)	space to accommodate max. 20 audience		42
Storage I				15
Storage II				21
		(SUB-TOTAL)		201
COMMON SPACE				
Entrance Hall & Lounge	buffer space between administration & training portions, guests waiting			84
Toilet (Gents' & Ladies')				30
Corridor				78
		(SUB-TOTAL)		192
		T O T A L		630

b. LABORATORY BUILDING (630 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Researchers' Room	desk work (data analysis, consideration & personal data keeping), desks for asst. researchers also provided	researchers 4 asst. researchers 4	90
Farming Lab.	study of breeding/rearing technology	researchers Japanese experts	63
Resource Management & Ecology Lab.	study of population dynamics and conservation of wild crocodiles	ditto	42
Nutritional Chemistry Lab.	study of essential nutrients for crocodiles, feed selection & development of compound feed	ditto	63
Physiology & Pathology Lab. (inc. Clean Rm area)	study of basic physiology of crodociles, and prevention & treatment of diseases	ditto	84
Treatment Room	diagnosis & treatment of sick & injured crocodiles	ditto	42
Japanese Experts' Room	desk work (data analysis, consideration & personal data keeping)	Japanese experts 2 - 3	30
Conference Rm cum Library	exchange of information or discussion by researchers, library use	researchers Japanese experts	30
Storage 1 - 5	storage of lab. utensils, equipment & spare parts		43.5
Dark Room			7.5
Toilet (Gents' & Ladies')	w/ shower booth		24
Heat Exchanger Room	hot water supply equipment installed		6

(cont.)

Corridor			105
		T O T A L	630

c. MAINTENANCE BUILDING & GARAGE (378 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Garage	shed for granted vehicles & repair or carpentry work		126
Work Room	maintenance, inspection & repair of equipment in Institute, making devices specially designed for Institute use	electrician 1 mechanic 1	42
Engineers' Room	drawing and data adjustment	safety/maintenance eng'r, technicians	16.5
Chief's Room	recording control data on feed, data on crocodile growth & assigning work to caretakers, electrician, mechanic & utility men	chief caretaker	16.5
Caretakers' Room	report making	caretakers 2 or 3	16.5
Workers' Rest Room	waiting, meals & rest area for caretakers, utility men, guards, drivers, etc.	drivers 3 caretakers 11 technicians 2 utility men 4 guards 2 (6) Total 22 (26)	33
Change Rm (Men's & Women's) Shower Rm	changing clothes for caretakers, technicians & utility men	ditto	33.5
Storage 1	simple spare parts for vehicles, materials & equipment for maintenance or inspection		21

(cont.)

Storage 2	tools for cleaning buildings, pens and tanks	10.5
Storage 3	standby FRP nursery tanks, etc.	10.5
Toilet (Gents' & Ladies')		16.5
Hot Water Service		4
Corridor		31.5
	T O T A L	378

d. FEED HOUSE (168 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Feed Preparation Room	loading & unloading of feed, feed assorting for crocodiles in each stage, processing of feed for hatchlings	caretaker	63
Blast Freezer Anteroom Cold storage	rapid freezing, storage & thawing of feed		82.5
Machine Room	installing machines attached to the above freezer and refrigerator		22.5
		T O T A L	168

e-1 HATCHLING HOUSE - A (420 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Hatchling Special Care Rm	special rearing for about 2 weeks after hatching, experimental rearing under controlled environment	researchers caretakers	252
Wet Lab.	dissection & treatment of crocodiles, prepartion of shipping of hatchlings & other work that cannot be done in Lab. Bldg.	ditto	54
Incubator Room	artificial hatching to maximize hathing rate	ditto	36
Machine Rm	water sterilization unit		18
Corridor			60
		T O T A L	420

e-2 HATCHLING HOUSE - B (627 m^2)

	protection of 2-week to 1-year-old crocodiles from insects & rodents	caretaker	627

f. MACHINE HOUSE (119 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Generator Room	equipment to supply power to each facility in Institute & a generator for emergency use		49
Machine Rm for Water Supply System	installing pumps, water purification & sterilization equipment		70
		T O T A L	119

g. GATE HOUSE (16 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Guards' Office	guards on watch, monitors for alarm system	guards 2	8
Rest Room	equipped w/ a bed for naps		5
Toilet			3
		T O T A L	16

h. OBSERVATION HOUSE - I (12 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Observation Room	preparation of observations & records of Natural Observation Pen	researcher	9
Toilet			3
		T O T A L	12

i. OBSERVATION HOUSE - II (12 m^2)

ROOM NAME	PURPOSE & ACTIVITIES	PERSONNEL	AREA (m^2)
Observation Room	observation & records of egg-laying stalls in Breeding Pens	researcher	9
Toilet			3
		T O T A L	12

j. JAPANESE EXPERTS' HOUSE (112 m^2)

	lodging for Japanese experts during night work (observation during egg-laying season, etc.)	Japanese experts maximum 2	112

k. DORMITORY FOR PROMOTERS UNDER TRAINING (108 m^2)

	lodging for long term trainees	trainees 6	118

l. INCINERATOR HOUSE (110 m^2)

	housing a incinerator	110

③ Construction materials

In principle, weather-proofing materials will be used for construction because of the hot and humid weather condition, and as the Site is near the seashore. Major structures will be of reinforced concrete construction. Although it is desired to use local lumber, structural steel will be used instead, to avoid termite damage. Care shall be given especially to coating on steel materials.

a. Structural materials

Reinforced concrete and concrete blocks
- Administration & Training Bldg.
- Laboratory Bldg.
- Maintenance Bldg.
- Hatchling House - A
- Machine House
- Gate House
- Observation House - I, II
- Japanese Experts' House
- Dormitory for Promoters under Training

Structural steel
- Feed House
- Garage
- Hatchling House - B
- Incinerator House

Roof trusses will be of steel structure in principle.

b. Exterior finish

Roofs : prepainted steel sheet (folded sheet)

Exterior walls : epoxy type spray paint on concrete base

Doors and windows : steel and aluminium

Walls, floors and pools of breeding/rearing pens and tanks : mortar with trowel finish

c. Interior finish

Floors

Common rooms : vinyl asbestos tile

Laboratories, entrance hall : cast-in-situ terrazzo

Hatchling houses and others : mortar with steel trowel finish

Walls : paint finish on mortar base

Ceilings

Exhibition room, lecture room : rock wool acoustic board

Common rooms, laboratories : decorative plaster board

NOTE: No ceilings will be installed in Hatchling House - B and the hatchling special care room in order to introduce natural lighting. A provision will be made to place a canvas curtain horizontally to protect temperature drops by night and to control lighting by day.

Doors and windows : wood (including frames)

④ Structural design

a. Frame and foundation design

Structural materials and framing systems will be selected according to the purpose and size of the building. The buildings occupied by people or accommodating equipment that generate noise will have steel roof trusses on reinforced concrete columns and beams, except that the small buildings like Gate House, etc. will have a wooden roof truss on concrete block construction. The Feed House, Garage, Hatchling House - B and Incinerator House will be of steel structure.

Though the elevation of the Site is not uniform, a solid bedrock lies at several decimeters under the natural ground surface. As this bedrock is expected to clear the allowable soil bearing capacity of 12.2 ton/m^2 isolated footings will be constructed on this layer. The foundation depth will depend on the locations, but will not be less than 75 cm under the ground level.

b. Design standards

Where applicable, the present regulations of the Philippines will be applied, and U.S. standards will be referred to otherwise. Codes and standards to be applied are:

National Structural Code of the Philippines (NSCP)

Uniform Building Code (UBC)

ACI Code

c. External forces and loads

i) Dead load

Dead load will include the weights of all the structural materials, finishing materials, mechanical equipment, etc.

ii) Live load

Only live load on the roofs will be considered in this Project. Load specified in NSCP will be applied.

	Distribution load		
	Loaded area (m^2)		
	0 - 18.6	18.7 - 55.8	55.8 or more
Roof gradient 1/3.3 or more	98 kg/m^2	78.1 kg/m^2	59 kg/m^2

iii) Earthquake force

The base shear assumed to act on the structure and distribution of earthquake force to each element will be calculated in accordance with NSCP. Base shear V will be calculated by:

$$V = ZIKCSW$$

where

Z : numerical coefficient depending upon the zone (See Fig. 5.1) Zone 1, therefore Z = 3/16

I : occupancy importance factor (See Table 5.1)

I = 1.0

K : horizontal force factor (See Table 5.2)

K = 1.0 or .8

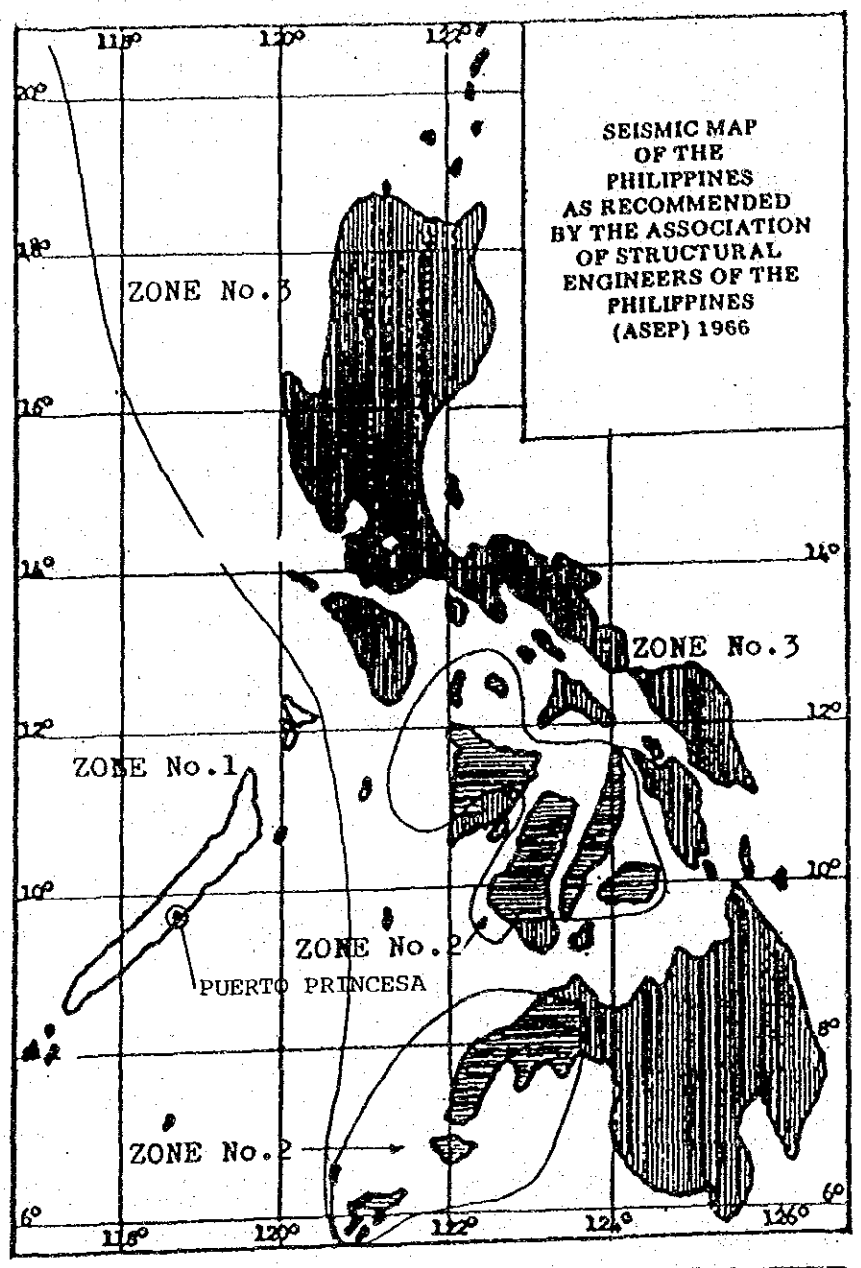
C : coefficent determined by natural frequency of the structure; must be .12 or less

$$C = \frac{1}{15\sqrt{T}} \qquad \therefore T = \frac{0.05hn}{\sqrt{D}}$$

S : numerical coefficient for site-structure resonance

S = 1.5 (as per UBC 2312 (d))

W : total load for calculation of earthquake force



	ZONE No. 1	ZONE No. 2	ZONE No. 3
Z	3/16	3/8	3/4

FIG. 5.1 SEISMIC MAP OF THE PHILIPPINES

TABLE 5.1 VALUES FOR OCCUPANCY IMPORTANCE FACTOR

TYPE OF OCCUPANCY	I
Essential Facilities[1]	1.5
Any building where the primary occupancy is for assembly use for more than 300 persons (in one room)	1.25
All others	1.0

[1]See Section 2312 (k) for definition and additional requirements for essential facilities.

TABLE 5.2 HORIZONTAL FORCE FACTOR "K" FOR BUILDINGS OR OTHER STRUCTURES

TYPE OR ARRANGEMENT OF RESISTING ELEMENTS	VALUE[1] OF K
1. All building framing systems except as hereinafter classified	1.00
2. Buildings with a box system as specified in Section 2312 (b)	1.33
3. Buildings with a dual bracing system consisting of a ductile moment resisting space frame and shear walls or braced frames using the following design criteria: a. The frames and shear walls shall resist the total lateral force in accordance with their relative rigidities considering the interaction of the shear walls and frames b. The shear walls acting independently of the ductile moment resisting portions of the space frame shall resist the total required lateral forces c. The ductile moment resisting space frame shall have the capacity to resist not less than 25 percent of the required lateral force	0.80
4. Buildings with a ductile moment resisting space frame designed in accordance with the following criteria: The ductile moment resisting space frame shall have the capacity to resist the total required lateral force	0.67
5. Elevated tanks plus fill contents, on four or more cross-braced legs and not supported by a building.	2.5[4]
6. Structures other than buildings and other than those set forth in Table No. 23-J	2.00

[1]Where wind load as specified in Section 2311 would produce higher stresses, this load shall be used in lieu of the loads resulting from earthquake forces.

[2]See Figure Nos. 1, 2 and 3 this chapter and definition of "Z" as specified in Section 2312 (c).

[3]The minimum value of "*KC*" shall be 0.12 and the maximum value of "*KC*" need not exceed 0.25.

[4]The tower shall be designed for an accidental torsion of five percent as specified in Section 2312 (e) 5. Elevated tanks which are supported by buildings or do not conform to type or arrangement of supporting elements as described above shall be designed in accordance with Section 2312 (g) using "C_p" = .2.

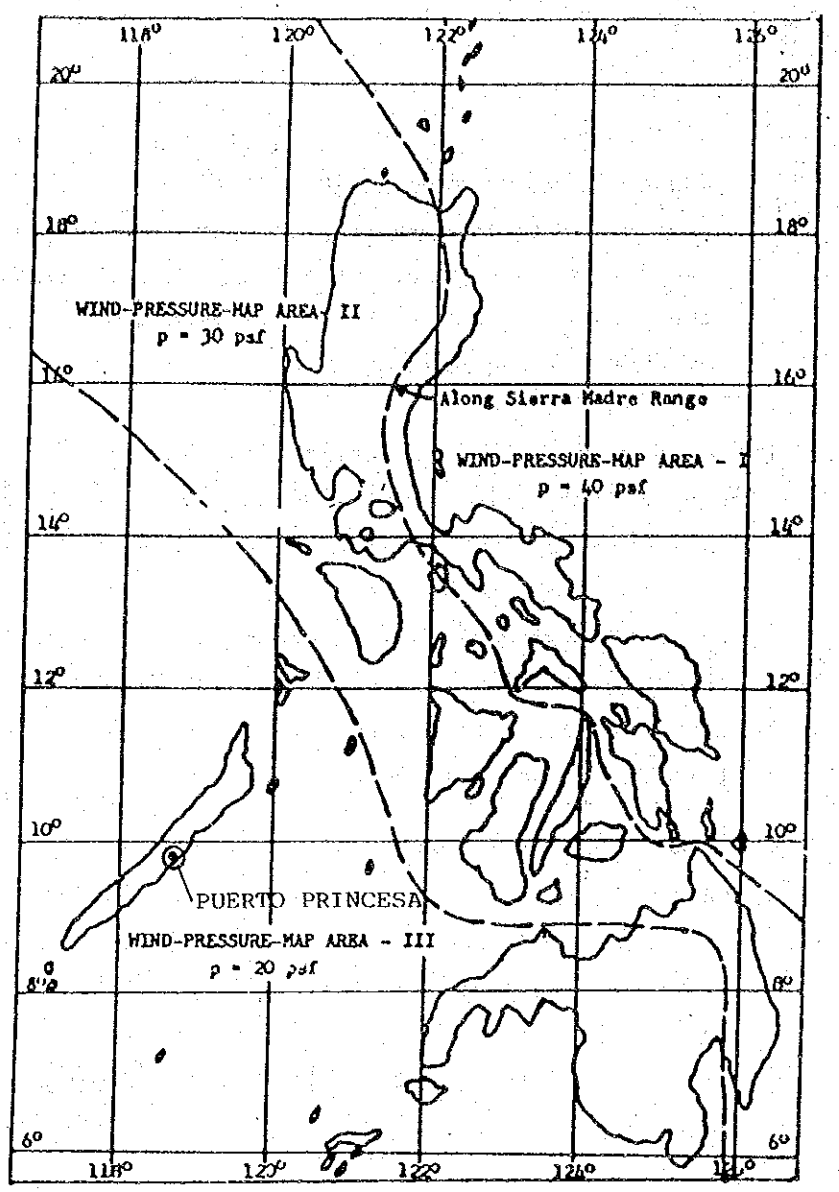


FIG. 5.2 WIND-PRESSURE-MAP AREAS OF THE PHILIPPINES

TABLE 5.3
BASIC WIND PRESSURES FOR DIFFERENT HEIGHTS ZONES
ABOVE GROUND FOLLOWING UNIFORM BUILDING CODE
HEIGHT ZONES AND PRESSURE VARIATIONS
(AUTHOR'S RECOMMENDATION)

HEIGHT ZONE IN FEET	WIND-PRESSURE-MAP AREA		
	AREA - I	AREA - II	AREA - III
Less than 30	30 psf	20 psf	10 psf
30 to 50	40 psf	30 psf	20 psf
50 to 100	50 psf	35 psf	25 psf
100 to 500	60 psf	40 psf	30 psf
500 to 1200	70 psf	45 psf	35 psf
over 1200	80 psf	50 psf	40 psf

Refer to Fig. 5.2.

iv) Wind force

Puerto Princesa belongs in Area III (Fig. 5.2), the weakest wind pressure area, therefore, the basic wind pressure in the column of Area III in Table 5.3 will be applied. For the pressure coefficients, recommended values prescribed by NSCP will be applied.

(3) Planning of Breeding and Rearing Pens and Tanks

Studies of crocodile farming technology are very rare anywhere in the world, and no confirmed figures have been established yet as to appropriate pen size and rearing density. But these are known to be two important elements that affect the growth of crocodiles. Therefore, the appropriate size of a pen and crocodile rearing density need to be established through the activities of the Institute.

Policy of Designing Pens

1) Calculate the expected number of crocodile in each stage in 10 years out of 200 parent crocodiles, and construct various types of pens having sufficient capacities to rear all of these crocodiles to be left in the Institute with a rearing density similar to that applied in Samutprakan Crocodile Farm.

2) Prepare several other pens for experimental purposes, such as to change the rearing density, or shape of pond, etc.

3) Prepare pens for disinfection of newly arrived crocodiles, and for isolation of sick or injured crocodiles.

4) Prepare a natural observation pen for the comparative study of wild crocodiles and captive crocodiles.

5) Protect the staff working in the pens and prevent the crocodiles from escaping.

6) Consider re-utilization of relatively clean water in the pens.

7) Warm water to proper temperature for the crocodiles before supplying to the pens for exchange.

8) Use various kinds of construction materials for the rearing ponds for 3 to 6-year-old crocodiles and 7- to 9-year-old ones for the purpose of comparative study.

wall: concrete --- bottom: concrete
wall: concrete --- bottom: earth
wall: log --- bottom: earth

NOTE: The reason that Samutprakan Crocodile Farm succeeds in farming crocodiles in a high density is that their crocodiles are hatching and growing in captivity from hatchlings and they are accustomed to living in a high density. It is not considered possible to farm captured wild crocodiles directly in such a high density because of strong territorial instincts of crocodiles.

The crocodiles to be farmed in the Institute at the initial stage will probably be wild ones captured in the country. At first, they can be farmed in a low density by using the whole area of tanks and pens in the Institute efficiently because the number of crocodiles at the initial stage are not large. When the number increases, these crocodiles must be those hatched and grown in the Institute. That is, they must be accustomed to living in a high density.

TABLE 5.4 STRUCTURE AND REARING DENSITY OF TANKS AND PENS

Type of Pens & Tanks	Construction of Pens & Tanks (W x L)	Environment	Capacity	Breeding Density
hatching~ 2 weeks	Portable FRP tank 650 x 900	Temperature controlled room, sunlight through the roof	1,440	20 P/m²
2 weeks ~ body length 60 cm	Portable FRP tank 900 x 1300	Inside the building surrounded by translucent resin roof & metal and nylon mesh wall	2,352	14 P/m²
body length 60 ~ 105 cm	Concrete block tank, 20 cm deep water and concrete deck	Half of the tank area to be covered with roof	1,080	3 P/m²
105 ~ 150 cm	Concrete block tank, 30 cm deep water and concrete deck	Half of the tank area to be covered with roof	1,008	1.4 P/m²
3 ~ 6 years	Mesh on top of concrete block wall 80 cm deep pond and feeding area,	Planting of evergreen trees	30 x 4 = 120	0.1 P/m²
7 ~ 9 years	Mesh on top of concrete block wall 50~150 cm deep pond and feeding area, egg laying stall, supplementary pen	Planting of evergreen trees	30 x 3 = 90	0.06P/m²
Parent crocodiles	Mesh on top of concrete block wall 50~200 cm deep pond and feeding area, egg laying stall	Planting of evergreen trees	200	max. 0.03P/m²
Experimental pen	Mesh on top of concrete block wall	Planting of evergreen trees	---	not specified
Experimental tank	Concrete block tank, 20~30 cm deep water and concrete deck, movable partition	Half of the tank area to be covered with roof	---	not specified
Disinfection pen	Same as experimental pen	Planting of evergreen trees	---	not specified
Isolation tank for sick crocodiles	Concrete block tank, 20~50 cm deep water and concrete deck	Half of the tank area to be covered with roof	---	not specified
Observation pen	Mesh fence, earth pond	Trees, plants	---	not specified
Feed culture pond	Concrete or mesh fence			