THE PANAY RIVER BASIN-WIDE FLOOD CONTROL STUDY

APPENDIX X

(POWER DEMAND AND SUPPLY)

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1. Introduction

The objective of the present study (the Panay River Basin-wide Flood Control Study) is to formulate an integrated water resources development plan for the Panay river basin placing a particular emphasis on flood control plan.

The study includes in its scope of works hydropower generation plan. This appendix describes the results of study on power demand and supply conditions and hydropower development plans in the study area. The study consists of four parts; i) investigation of power supply condition of Panay island, ii) power demand forecast in the supply area, iii) development plans of the power system, and finally iv) proposed hydropower development plans.

2. Power Supply in Panay Island

2.1 Organization

The electric power supply in the Panay Island is entrusted primarily to the National Power Corporation (NPC) which provides generation and transmission services, and to local power cooperatives which provide distribution services. There are six of such power cooperatives in the Panay Island, each responsible for distributing electric power to its exclusive supply area. They are,

	Name	Service Area
(a)	Panay Electric Company Inc. (PECO)	Iloilo City
(b)	Iloilo Electric Cooperative I (ILECO I)	Southern part of Iloilo province
(c)	Iloilo Electric Cooperative II (ILECO II)	Northern part of Iloilo province
(d)	Capiz Electric Cooperative (CAPELCO)	Capiz province
(e)	Aklan Electric Cooperative (AKELCO)	Aklan province
(f)	Antique Electric Cooperative (ANTECO)	Antique province

Figure X. 2-1 presents the electric service area of each cooperative.

Amongst the six, there are two important cooperatives in relation to this Study. The one is PECO, the Panay Electric Company, which is located at the Iloilo city, the principal town of the Iloilo Province. PECO has the largest supply capability amongst the cooperatives.

The other is CAPELCO, the Capiz Electric Cooperative, which assume the responsibility of supplying the electric power to the Capiz province, which covers an area nearly equal to the river basin of the Panay. The supply capability of CAPELCO is second only to that of PECO in the Panay Grid.

2.2 Generating Facilities

Figure X. 2-2 presents the existing power system in the Panay Island, including the existing, under construction (as of 1984) and proposed power systems.

The power generation for the Panay Island is owned by NPC and PECO. The facilities of NPC are four units of diesel generators at Dingle, Iloilo (called the Panay Diesel Power Plant I : PDPP I), two diesel generators at Panitan, Capiz (-ditto- : PDPP II), and four gas tubines at La Paz, Iloilo (called the Power Barge-2, PBP-2). The Power Barge Plant was newly commissioned in 1984, by rehabilitating the original units erected in the Cebu Island.

The total installed capacity of the NPC-owned facilities is 72,200 kW. The facilities owned by PECO totals at 19,750 kW in the installed capacity. The generating facilities of PECO are, however, outdated and inefficient. The total installed capacity of the Panay Grid comes to 91,950 kW and the total supply capability (station capacity) of the whole facilities is estimated to be 72,120 kW, as shown below.

Gerating Facilities in Panay Grid

Power Station		Station Capability (kW)	Installed (kW)
NPC:			
PDPP I	(NPC Dingle)	24,820	4 x 7,300
PBP-2	(NPC Power Barge)	27,200	4 x 8,000
PDPP II	(NPC Panitan)	7,600	2 x 5,500
PECO:			
Total capacity		12,500	19,750
TOTAL		72,120	91,950

Before the Power Barge Plant (PBP-2) came into operation, the supply capability had been only 44.9 MW in total against the demand of 44.5 MW.

Therefore the load shedding had often taken place at time of drop-off of some of the plants. To overcome this problem, the Power Barge was brought from Cebu Island and newly added to the system in July 1984.

Table X. 2-2 shows a detailed list of the existing generation facilities in the island. The location of the facilities is shown in Figure X. 2-2.

2.3 Transmission and Distribution Facilities

NPC is the implementing agency with full responsibility of setting up transmission grids (138 kV and above) in the Panay Island. It has the 138 kV main grid connecting the substations in Panitan and Sta. Barbara via PDPP II (Dingle). All the six power cooperatives are supplied from this main grid through the self-owned 69 kV spur lines. The power transmission lines in the Panay, thereby, form an interconnected Panay Grid of power supply. Fig. X. 2-3 shows the electricity supply system in the Panay Island in the form of a single line diagram.

The distribution networks are owned by the power cooperatives. The supply areas of the cooperatives cover about 80 % of the Panay Island, with actual house connections accounting for 36 % of the potential users. Table X. 2-2 gives the present situation of electricity supply in the island.

NPC has a criterion to maintain the voltage and frequency within predetermined ranges as shown below.

- Voltage : 1 to 2 % (within transmission line)
- Frequency : 59 to 61 Hz
- Power factor: 90 to 99 % lagging

The power demand has been suppressed due mainly to shortage in power generating capability. NPC assumes that the demand would be as large as 48 MW against the current demand of 44.5 MW, if the system makes additional connections of waiting consumers, in which large power consumers will be rice mills, rice plants, the fishing port, etc. Moreover, it is also presumed that the Guimaras Island, which is located to the south-east of Iloilo City, has a potential electricity demand of 1.5 MW.

In 1983, total energy supply in the Capiz Province was 27,100 MWh, of which 6,324 MWh was generated by CAPELCO and 20,776 MWh was purchased from NPC. The energy sales amounted to 15,473 MWh with total power revenue of 20.7 million Pesos, of which average tariff was 1.34 Pesos per kWh. The number of customers was 26,621 and the peak load was 7.8 MW. Annual load factor at the supply end was 40 %.

Of the total energy produced, the plant use amounted to 652 MWh and the losses 10,975 MWh. This means that own consumption and distribution losses accounted for more than 40 percent. This may imply a possible existence of illegal use of power.

The connected consumers number 26,621 in total, of which residencial consumers accounts for 93 % and the rests are commercial (5 %), public use (2 %) and a negligibly small portion of industrial consumers. In terms of power revenue, 47 % came from residential, 18 % from commercial, 19 % from industrial and the remaining 16 % from public uses.

A typical load curve of the Capiz Grid is shown in Fig. X. 2-4.

Power supply situations, such as service hour, load factor and power factor measured as monthly averages, are shown by province in Table X. 2-3.

Table X. 2-4 presents the summary of interruption indices of the Panay Power Grid, from which faults in the system are classified by types as follows:

Electricity Supply Faults by Type

Reason of Fault	Interruption Frequency Ratio (times)	Percent (%)
Generation trouble	51.3	38
Load shedding	36.1	27
System trouble	26.5	20
Fault by customers	13.3	10
Line fault	6.5	5
Total	133.7	100

As seen above, the supply condition of electricity in the Panay Grid is unstable with frequent supply interruptions and load sheddings. The generation capability was insufficient, particularly before the Power Barge came into operation in 1984, and about 38 % of outages were attributable to generation troubles in 1983. Load sheddings due to insufficient supply capability accounted for 27 % of supply interruptions in the same year. The average duration of a supply interruption was 1.5 hours.

With the introduction of the Power Barge Plant in 1984, the supply condition was presumably improved to some extent. Even with this, there still is an ample room for further enhancement in supply capability in this area, that would bring about more dependable and efficient power generation in the Panay Grid.

2.4 Historical Power Demand

The present power demand in the Panay Island is as follows:

Area	Demand (MW)
Iloilo City	18
Capiz Province	8
Aklan Province	5
Antique Province	1.5
Iloilo Province (except Iloilo City)	12
Total	44.5 MW

Table X. 2-5 presents the historical data of power generation, purchase and consumption of each cooperative in the Panay Grid. Table X. 2-6 gives the records of power generation and sales and number of customers in the Capiz Province. According to Table X. 2-5, average growth rate of energy consumption during 1979 through 1983 was 5.5 % per year.

3. Power Demand Forecast

3.1 Panay Grid

NPC prepared power demand projections in 1984, including those for the Panay Grid, to establish a comprehensive development program of power facilities. Besides this, NPC Panay Grid local office worked out sales target projections in 1983. The latter presumed the growth rate of electricity demand to be about 10 % p.a., while the former presumed the growth rate slightly lower. This Study owed the demand projections mainly to the former on the ground of its more conservative propositions, though minor modification and extrapolation was made by correlation analysis. The demand projections of the above are shown in Table X. 3-1 and as illustrated in Figure X. 3-1.

3.2 Negros Grid

NPC has a plan of interconnecting the Panay Grid with the Negros Grid by 1989. This will enable integration of power demands in the two islands. The demand forecast of the Negros Grid was made by NPC in 1983 as part of the review of the feasibility study of the interconnection project. The results of the forecast are presented in Table X. 3-2.

4. Power Development Plan

4.1 Generation Plan

NPC has decided to implement submarine cable interconnecting between the Panay and Negros Islands which is scheduled to be in operation in 1989. The Guimaras island, located on the midway of the submarin cable lines, will also be interconnected with the Panay-Negros Power Grid. NPC's power facilities installation plans before and after the interconnection of the Panay and Negros Grids are as summarized in Table X. 4-1.

The NPC's program in Table X. 4-1 shows a favorable balance of the demand and supply until the year 1995. However, the estimated peak demand growth in the Panay Island of 6.3 % per year is on a conservative side and there may be a possibility that the demand will increase more sharply. In addition, the additional units at Palimpinon Geothermal Plant (No.4, 5 and 6 units) are assumed to be commissioned, in 1989-1990, although some delay may be likely. Therefore hydropower project planned in the present study can be implemented before the extension of Palimpinon geothermal plant, provided that the hydropower project is economically more advantageous.

In addition to the NPC's development plans, the following mini-hydro plants are under investigation and planning

Mini-hydro Plants under Planning in Panay Island

Province	Municipality	Site	Capacity (kW)	Status
Iloilo	Igbaras	Nadsadjan	3,600	Feasibility Study (F/S) completed
Antique	Tibiao	Tibiao	800	F/S completed, equipment were manufactured
	Barbara	Dalaren	2,880	- do -
	Tibiao	Villasiga	30,000	F/S completed
Aklan	Madalag	Timbaban	33,000	F/S completed

4.2 Transmission Plan

Several transmission schemes in the Panay Island are under consideration in line with the long-term power development program as shown in Figure X. 2-2. It is also envisaged that the interconnection of the Panay and Negros systems will be implemented by means of submarine cable for commissioning in 1989. The financing for this project will be provided by a loan from ADB.

In the Guimaras Island, a 138 kV substation will be installed and an overhead line will be constructed along the island in connection with the submarin cable project.

5. Proposed Hydropower Development

5.1 Power Development Plan in Panay System

5.1.1 System Output Capacity

The present and its extension of installed capacity and station capability of the Panay system is as illustrated in Figure X. 5-1.

The station capability will drop if one of main generating units is out of service for overhaul. The system dependable output is defined as the total actual output capacity excluding units under overhaul, and is shown in Figure X. 5-1.

The dependable output will increase from 41 MW to 75 MW in 1989 just before the interconnection with the Negros system, by adding 6 MW of diesel unit (extension of Dingle) and 28 MW at the Power Barge (Power Barge B).

5.1.2 Load and Supply Balance before Interconnection

Figure X. 5-1 illustrates the peak load projected by NPC and the actual output capacity of the plants.

In the Figure X. 5-1, it is seen that load-shedding is liable to occur until 1983. During this period, there will be supply shortage because old diesel units will presumably need to be frequently overhauled. This situation will not be improved until the commissioning of power Barge-2.

In addition to the above, NPC intends to develop the expansion of the Dingle diesel plant and another unit at the Power Barge to meet the increasing demands.

It is liable that the PECO's old diesel units will be retired in view of their high operating cost and low reliability. In this case, the dependable output will drop to 62.5 MW, and the shortage of power will occur around 1990. Therefore NPC contemplates to proceed with interconnection with the Negros system to receive surplus power from geothermal plants in Negros.

5.1.3 Load and Supply Balance after Interconnection

The load in Panay Island will grow from 60 MW to 100 MW between 1989 and 2000. On the supply side, however, the Power Barge is scheduled to withdraw from the system in 1989 and the PECO's diesel plant will be retired in the same year.

A review of power supply and demand balance in the Negros system revealed that there would a surplus power of more than 90 MW in terms of actual output capacity in the Negros during 1985 through 1995. Therefore the surplus power can be imported from the Negros system to the Panay system, where continuance power supply of 50 MW and swapping of 40 MW will be possible.

From Figure X. 5-1, it is clear that the Panay system will be in short of power after 1995, even if the interconnection is established. Therefore a new power plant should be constructed to make up the deficit of supply capacity after 1995. Hydropower project derived from the present study will be one of the candidate plants to be put into the system around 1995.

5.2 Implementation of Hydropower Projects

(1) Hydropower schemes

As discussed in Appendix V, a hydropower scheme of Panay B dam was identified as a prospective development project.

The Panay B dam will be implemented as part of the 1st stage flood control project, and a tentative schedule assumes its completion in 1994. This scheduling will allow the Panay B hydropower scheme to be put in service in 1995, provided that the installation of power facilities will be undertaken simultaneously with the dam construction.

The Panay B scheme is planned to have an installed capacity of 7,100 kW. The plant will produce 31.4 GWh of annual energy. On condition that the plant is operated at a daily capacity factor of around 0.25, the plant is stacked in the middle to upper portion of daily load duration curve as shown in Figure X. 5-2.

(2) Transmission Line and Substation

Under the Panay B project, a new 69 kV transmission line will be constructed between the power station and the existing Panitan substation at which the power is fed to the system through the existing 69 kV bus.

The main features of the transmission line are as follows;

Length	:	45.0 km
Voltage	:	69 kV
Number of circuit	:	1
Structure of support	:	Steel tower

The proposed power transmission system is shown in Figure X. 5-3.

It is proposed to construct an incoming transmission line bay of 69 kV circuit at the Panitan substation. The main features of substation are show below:

Panitan Substation:

- Voltage	:	138/69/13.8 kV
- Transformer capacity	:	30 MVA x 1 set (for substation) 10 MVA x 1 set (for Panitan diesel power station and power distribution)
- Existing 69 kV circuits:		power supply to the cooperatives; AKELCO and CAPELCO

Construction costs of the transmission line and the substation extension work will be US$1.71 x 10^6 and US$0.50 x 10^6, respectively.

TABLES

FOR

APPENDIX X

TABLE X. 2-1 GENERATING FACILITIES IN PANAY ISLAND (1984)

Name of power station	Location	Type	Engine	Generator	Completion	Name of capacity	Unit dependable capacity	No. of units	Station capacity
			Manufacturer, rpm, Hp	Manufacturer, volt, KVA, power factor					
1. NPC Panay Diesel Power Plant 1 (PDPP I)	Bray Tinucuan, Dingle, Iloilo	Diesel	PIELSTICK 16:PC2.5 - 514 rpm - 544.8 Hp	JEUMONT SCHNIDER 13.8 kV, 9,300 kVA 0.8 P.F.	Nov. 1979	7,300 kW	0.85 x 7300 kW = 6,205 kW	4	24,820 kW
2. NPC Power Plant Barge 2 (PBP-2)	WESVICO, Luboc, La Paz Iloilo	Gas Turbine	HITACHI-ZOSEN - 514 rpm	SIEMENS 13.8 kV 10 MVA 0.8 P.F.	1981 in Cebu, then re-commissionned 1984 July in Panay	8,000 kW	0.85 x 8000 kW = 6,800 kW	4	27,200 kW
3. NPC PDPP II	Panitan,Capiz	Diesel	SENIT PIELSTICK 12:PC2.5 V-400 - 514 rpm - 7800 Hp	CEM FRANCE 13.8 kV 6,900 kVA 0.80 P.F.	1977	5,500 kW	3,800 kW	2	7,600 kW
4. PECO	Iloilo City	Diesel	VULCAN PIELSTICK MIRRIES	N.A.	N.A.	19,750 kW in total	2,500 kW 4,200 kW 3,300 kw	2 1 1	12,500 kW

Source: NPC Panay Power Grid and PDPP II

TABLE X.2-2 PRESENT STATUS OF ELECTRIC SUPPLY

(IN 1982, PANAY & GUIMARAS ISLAND)

No.	PROVINCE	COOPERATIVE	Municipalities Coverage	Municipalities Energized	Barangays Coverage	Barangays Energized	House Connections Potential	House Connections Actual	Energy Consumption %	Energy Consumption MWH	Sold MWH	Loss %	Revenue X 1000₱	Power Rate ₱/kwh	Peak Load KW	Load Factor %	Established Date	No. of Member	Amount of loan Million ₱
1.	Aklan	AKAELCO	19	19	353	200	54,133	21,172	39	10,740	7,992	25	11,196	1.04	4,000	31	Apr. 25,1972	23,370	45.9
2.	Antique	ANTECO	15	15	518	172	45,297	8,106	18	3,096	1,968	36	3,780	1.22	1,000	29	Dec. 10,1972	8,809	50.2
3.	Capiz	CAPELCO	17	17	468	212	74,289	26,621	36	26,064	14,184	41	21,204	0.81	7,300	41	Jun. 16,1971	28,059	83.1
4.	Iloilo	ILECO I	16	16	704	297	62,210	24,859	40	21,444	17,196	20	15,888	0.74	5,700	42	Jun. 10,1971	25,935	34.2
5.	Iloilo	ILECO II	28	28	840	231	104,709	18,851	18	14,232	10,848	23	11,988	0.84	3,986	41	Oct. 18,1975	19,325	47.4
6.	Guimaras	GUIMELCO	-3	-	96	-	14,419	-	-	-	-	-	-	-	-	-	Jun. 29,1979	-	15.3
7.	Iloilo City	PECO	-	-	-	-	37,838	21,328	56	-	-	-	-	-	-	-	Non Membership	0	-
	TOTAL		98	95	2,979	1,112	392,895	120,937	30	75,576	52,188	30	64,056	0.84	22,046	39		105,498	276.1

Source : NEA Year book 1983

TABLE X.2-3 PROVINCIAL ELECTRIC SUPPLY CONDITION

Year & Item	PECO	ILECO II	AKELCO	CAPELCO	ILECO I	ANTECO
1979						
Service hour	371	-	-	-	-	-
Load factor	40	-	-	-	-	-
Power factor	n.a.	-	-	-	-	-
1980						
Service hour	708	722	563	576	-	-
Load factor	66	43	n.a.	51	-	-
Power factor	n.a.	n.a.	n.a.	n.a.	-	-
1981						
Service hour	723	722	714	666	719	-
Load Factor	57	45	34	56	43	-
Power factor	88	n.a.	n.a.	n.a.	74	-
1982						
Service hour	721	709	648	705	665	-
Load factor	44	46	61	33	47	-
Power factor	83	74	n.a.	n.a.	73	-
1983						
Service hour	723	712	712	707	719	635
Load Factor	46	49	34	55	52	35
Power factor	83	75	n.a.	n.a.	73	78

(Note) 1. Service hour : 730/month for average
2. Load factor : Percent in average ; Monthly LF = $\frac{\text{Sold kwh X 100}}{\text{Service hours X peak kw}}$ (%)
3. Power factor : Percent in average
4. n.a. means no metered

Source : NPC Panay Power Grid

TABLE X.2-4 SUMMARY OF INTERRUPTION INDICES

1982

Classification	IFR	RT
I. Distribution		
a. Outages		
System Trouble	17.12	1.327
Transient	7.70	0.768
Effective Sub-Total, Outages	24.82	1.154
b. Pre-Arranged	11.83	2.287
Effective Sub-Total, Distribution	36.65	1.520
II. Generation	37.04	2.367
Effective Total	73.69	1.945

1983

Classification	IFR	RT
I. Distribution		
a. Outages		
System Trouble	26.507	0.7198
Transient	6.507	1.0045
Customers System Failure	13.28	1.969
Effective Sub-Total, Outages	46.294	1.1114
b. Pre-Arranged	36.084	1.952
Effective Sub-Total, Distribution	82.378	1.4795
II. Generation	51.315	1.4456
Effective Total	133.693	1.4665

As of June 1984

Classification	IFR	RT
I. Distribution		
a. Outages		
System Trouble	16.205	0.698
Transient	1.328	0.5635
Customer's Failure	3.379	1.397
Effective Sub-Total, Outages	18.7174	0.874
b. Pre-Arranged	0.3979	7.52
Effective Sub-Total, Distribution	19.6694	1.028
II. Genration	0	0
Effective Total	19.6694	1.028

(Note) 1. IFR : interruption frequency ratio, unit = times

$$IFR = \frac{\text{No. of occurrence X interrupt power (kw) X duration (hour)}}{\text{gross generation (kwh)}}$$

2. RT : restoration time, unit = hours

$$RT = \frac{\text{Sum (interrupt power (kw) X duration (hour))}}{\text{Sum (interrupt power (kw))}}$$

Source : NPC Panay Power Grid.

TABLE X.2-5 HISTORICAL DISTRIBUTION FOR POWER SUPPLY AND CONSUMPTION IN PANAY ISLANDS

Cooperative	N P C Generated MWH	N P C Sold MWH	Cooperative Own Generation MWH	Cooperative -:Sold to +:Purchased from MWH	Cooperative Energy Consumption MWH	Peak Load KW	Annual Load Factor %	Sold Residential MWH	Sold Commercial MWH	Sold Industry MWH	Sold Others MWH	Sold Amount MWH	Plant Service MWH	Losses MWH
1978			113,479		113,479	n.a.	n.a.	30,521	17,521	29,506	6,136	84,134	5,957	23,388
CAPELCO			20,041	-4,669	15,372	5,800		5,442	2,506	815	1,668	10,431	1,700	3,241
AKELCO			0	+4,669	4,669	1,970		2,137	901	73	466	3,577	76	1,016
PECO			84,722	0	84,722	16,100		20,018	13,846	26,600	3,250	63,714	3,913	17,095
ILECO I	NON	NON	8,016	-1,287	6,729	2,800		2,100	463	2,002	500	5,065	141	1,523
ANTECO			0	+1,287	1,287	590		510	110	16	121	757	30	500
ILECO II			700	0	700	n.a.		314	145	0	131	590	97	13
1979	2,747	2,747	122,929		125,670	31,280	45.9	35,324	19,871	32,647	6,982	94,824	5,551	25,295
CAPELCO	NON	NON	24,029	-6,209	17,820	6,200		5,800	2,510	1,065	1,800	11,175	1,500	5,145
AKELCO			0	+6,209	6,209	2,300		2,749	1,100	287	609	4,745	64	1,400
PECO		2,741	83,489	0	86,230	16,400		21,100	14,800	27,622	3,558	67,080	3,750	15,400
ILECO I	NON	NON	10,528	-1,601	8,927	3,480		3,072	521	2,900	600	7,093	134	1,700
ANTECO			0	+1,601	1,601	700		603	140	23	165	931	20	650
ILECO II	NON	NON	4,883	0	4,883	2,200		2,000	800	750	250	3,800	83	1,000
1980	82,690	73,930	65,861		139,791	34,110	46.8	40,102	21,752	35,497	7,831	105,182	5,070	29,539
CAPELCO		4,536	20,567	-4,703	20,400	6,600		6,100	2,556	1,571	2,000	12,227	1,280	6,893
AKELCO		2,253	0	+4,703	6,956	2,850		3,228	1,294	445	650	5,617	62	1,277
PECO		59,036	30,473	0	89,509	16,900		22,360	15,700	28,100	3,900	70,060	3,500	15,949
ILECO I		NON	14,107	-2,094	12,013	4,100		4,097	612	3,900	676	9,285	128	2,600
AMTECO			0	+2,094	2,094	810		817	190	31	217	1,255	19	820
ILECO II		8,105	714	0	8,819	2,850		3,500	1,400	1,450	388	6,738	81	2,000
1981	112,689	102,604	51,965		154,569	36,870	47.9	45,025	23,615	38,336	8,659	115,635	4,648	34,286
CAPELCO		13,471	9,539	0	23,010	7,000		6,500	2,645	2,395	2,200	13,740	1,070	8,200
AKELCO		9,517	0	0	9,517	3,350		4,035	1,627	748	661	7,071	60	2,386
PECO		56,664	36,323	0	92,987	17,450		24,020	16,567	28,500	4,300	73,387	3,300	16,300
ILECO I		11,166	6,103	-2,493	14,776	4,650		5,012	722	4,800	720	11,254	122	3,400
ANTECO		NON	0	+2,493	2,493	920		970	254	43	258	1,525	18	950
ILECO II		11,786	0	0	11,786	3,500		4,488	1,800	1,850	520	8,658	78	3,050
1982	111,409	97,794	69,046		166,840	39,420	48.3	49,790	25,555	40,450	9,494	125,289	4,226	37,325
CAPELCO		15,986	9,699	0	25,685	7,500		6,921	2,713	2,741	2,406	14,781	860	10,044
AKELCO		10,704	0	0	10,704	4,000		4,492	1,690	982	736	7,900	58	2,746
PECO		38,675	57,756	0	96,431	17,200		25,531	17,700	28,700	4,600	76,531	3,100	16,800
ILECO I		19,958	1,591	-3,096	18,453	5,760		6,464	914	5,965	794	14,137	116	4,200
ANTECO		NON	0	+3,096	3,096	1,000		1,232	338	62	308	1,940	17	1,139
ILECO II		12,471	0	0	12,471	3,960		5,150	2,200	2,000	650	10,000	75	2,396
1983	134,360	122,623	58,070		180,693	42,450	48.6	54,552	27,565	42,160	10,367	134,644	3,823	42,226
CAPELCO		20,776	6,324	0	27,100	7,800		7,243	2,828	2,900	2,502	15,473	652	10,975
AKELCO		11,721	0	0	11,721	4,200		5,083	1,846	1,150	953	9,032	55	2,634
PECO		48,674	51,746	0	100,420	18,500		27,330	18,894	29,000	4,919	80,143	2,919	17,358
ILECO I		22,920	0	-1,628	21,292	6,000		7,549	1,087	6,866	846	16,348	110	4,834
ANTECO		2,252	0	+1,628	3,880	1,150		1,680	432	96	354	2,562	16	1,302
ILECO II		16,280	0	0	16,280	4,800		5,667	2,478	2,148	793	11,086	71	5,123

Source: NEA Manila and PECO

Note : Some figures are modified by the result of study

TABLE X.2-6 POWER GENERATION AND SALES IN KWH, AND NO. OF CUSTOMERS
(Historical Data in Capiz Province)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1. Power Generation by CAPELCO	78,560	1,326,809	3,040,275	4,915,142	6,796,598	20,040,914	28,139,559	20,573,016	11,929,600	10,088,800	6,323,700
2. Power Purchased from NPC	—	—	—	—	—	—	—	4,969,000	13,176,400	15,596,241	21,042,673
3. Total Energy kwh	78,560	1,326,809	3,040,275	4,915,142	6,796,598	20,040,914	28,139,559	25,542,016	25,106,000	25,685,041	27,366,373
4. Station Uses	18,010	177,082	280,540	491,354	722,708	1,258,270	1,616,400	1,382,659	882,300	1,014,370	568,520
5. Losses in Distribution kwb	52,940	430,270	837,449	1,304,297	1,261,251	10,079,418	16,891,730	14,159,194	12,039,690	12,262,245	15,169,852
and Percent	66%	32%	27%	26%	19%	50%	60%	55%	48%	43%	55%
6. Sold kwh	8,610	719,457	1,922,286	3,119,491	4,812,639	8,703,226	9,631,429	10,000,163	12,184,010	12,408,426	11,628,001
1) Residential (kwh)	5,937	649,140	1,707,422	2,205,158	3,666,621	5,442,169	5,824,269	5,854,346	7,191,154	6,935,629	7,243,301
(Nos.)	172	2,289	3,877	5,683	8,499	12,123	15,401	15,829	22,131	23,697	23,697
2) Commercial (kwh)	720	65,852	209,177	362,472	404,077	2,579,169	2,915,186	2,555,717	2,569,095	2,662,872	2,594,803
(Nos.)	14	175	197	206	284	772	899	883	904	1,017	1,017
3) Industrial (kwh)	0	0	0	545,114	734,429	673,769	882,972	1,571,400	2,395,150	2,741,002	1,761,161
(Nos.)	0	0	0	12	14	23	24	22	33	42	42
4) Street Lights (kwh)	1,953	4,465	5,687	6,747	7,512	8,119	9,002	18,700	28,611	27,373	28,736
(Nos.)	35	143	307	364	497	573	613	575	594	528	528
7. Peak Load kw	—	1,080	1,230	1,672	1,672	5,300	9,300	8,900	7,150	7,500	7,500
8. Annual Load Factor %	—	14.02	28.22	33.56	46.40	43.17	34.54	32.76	40.08	39.09	41.65
9. Amount of Revenue Pesos	3,242	503,594	1,085,182	1,694,473	4,167,327	10,007,178	10,305,819	11,122,354	14,419,255	17,717,763	20,731,243
10. Average Tariff (₱/kwh)	0.43	0.70	0.56	0.54	0.87	1.15	1.07	1.11	1.18	1.43	1.78

Source: CAPELCO and PDPP II

Note: Some records are discrepant between this Table and Table X. 2-5.

Table X. 3-1 DEMAND FORECASTS BY NPC AND UNDER THIS STUDY

Panay System

Year	Sales target 1/		NPC forecast 2/		This study
	Peak power (MW)	Energy (GWh)	Peak power (MW)	Energy (GWh)	Peak power (MW)
1984	45.9	210.7	40	211	41.2
85	51.8	243.5	41	216	44.8
86	57.3	265.8	46	240	48.3
87	63.4	293.2	47	249	51.8
88	70.6	325.3	50	264	55.4
89	75.7	344.5	58	303	58.9
1990	81.6	365.8	62	324	62.4
91	87.3	400.6	64	343	66.0
92	93.9	434.7	67	362	69.5
93			69	392	73.0
94			72	413	76.6
95			74	437	80.1
96					83.6
97					87.2
98					90.7
99					94.3
2000					97.8
01					101.3
02					104.9

Sources: 1/ By NPC Panay Grid, 1983

2/ By NPC, 1984

Table X. 3-2 <u>FORECAST OF POWER DEMAND IN NEGROS GRID</u>

(Rivised in July 1983)

Year	Sales Target		Demand Forecast	
	MW	GWh	MW	GWh
1983	120	613	109	666
1984	146	672	119	730
1985	165	894	159	972
1986	184	1,055	175	1,147
1987	187	1,085	179	1,179
1988	190	1,111	184	1,208
1989	193	1,136	88	1,235
1990	231	1,403	232	1,525
1991	234	1,428	236	1,552
1992			(258)1/	(1,775)1/
1983			(265)	(1,684)
1994			(272)	(1,851)
1995			(280)	(1,894)
	8.7	11.1	8.2	9.1

1/ Figures between parentheses show extrapolated values by the study team

TABLE X. 4-1 POWER DEVELOPMENT PLANS BY NPC

(1) Panay Grid before Interconnection

Year	Power Plant	Total Station Capacity	MW Balance		GWh Balance	
			Depend. Cap.	Peak Demand	Depend. Cap.	Energy Require
1984	Existing Facilities	72.1	41	40	317	211
1985	Dingle D., 7.3 MW	78.9	47	41	362	216
1986	Power Barge B, 32 MW	106.1	75	46	558	240
1988	-	106.1	75	50	558	264
1989	Interconnection with Negros	66.4 1/	47	58	259 1/	303

1/ Decrease due to transfer of power barge B to other system, and retired PECO's diesel plant.

(2) Negros Grid before Interconnection

Year	Power Plant	Total Station Capacity	MW Balance		GWh Balance	
			Depend. Cap.	Peak Demand	Depend Cap.	Energy Require
1982	Amlan Hydro, 0.8 MW Amlon Diesel, 11.0 MW Tolisay Diesel, 14.6 MW Bacoloo Diesel, 13.5 MW Palinpinon Geo, 6.0 MW Power Barge No.2, 32.0 MW	77.9	68	34	466	173
1983	Palimpinon Geo 1, 37.5 MW " 2, 37.5 MW " 3, 75.5 MW CDCP Diesel, 31.8 MW MMIC Diesel, 30.0 MW	252.2	224	109	947	666
1984	Pullout Barge No.2 32.0 MW	220.2	196	119	1,464	730
1985	-	220.2	196	159	1,464	972
1987	-	220.2	196	179	1,464	1,179
1988	-	220.2	196	184	1,464	1,208
1989	-	220.2	196	188	1,464	1,235

(3) Negros-Panay Grid after Interconnection

Year	Power Plant	Total Station Capacity	MW Balance		GWh Balance	
			Depend. Cap.	Peak Demand	Depend Cap.	Energy Require
1989	Palimpinon Geo 4, 37.5 MW " 5, 37.5 MW Panay Grid Inter, 47.5 MW	342.2	315	246	2,265	1,538
1990	Palimpinon Geo 6, 37.5 MW	379.7	351	307	2,536	2,017
1991	-	379.7	351	316	2,536	2,076
1992	-	379.7	351	(325)	2,536	2,137
1993	-	379.7	351	(334)	2,536	2,200
1994	-	379.7	351	(344)	2,536	2,264
1995	-	379.7	351	(354)	2,536	2,330

FIGURES

FOR

APPENDIX X

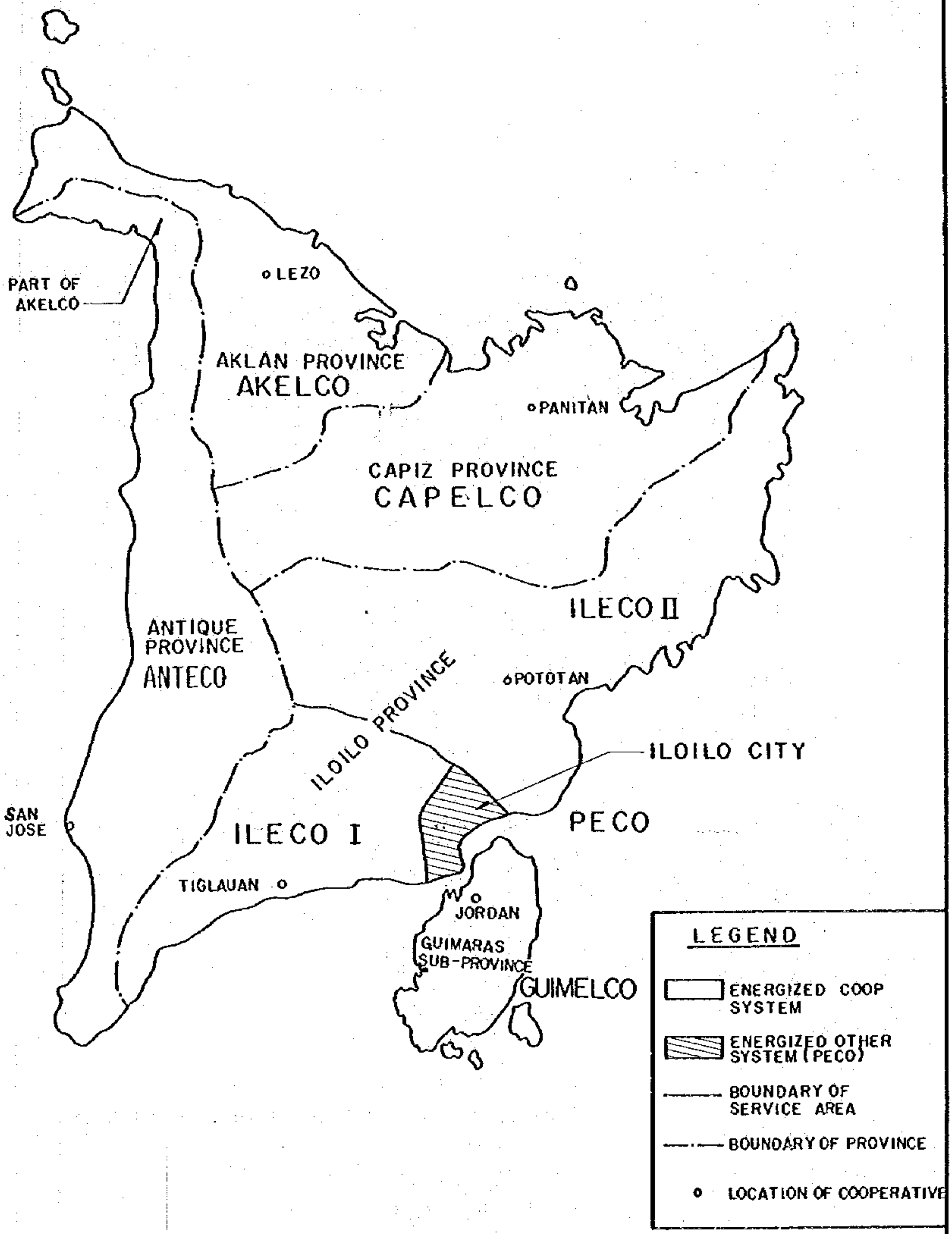


Fig. X.2-1 MAP OF COOPERATIVE SERVICE AREA

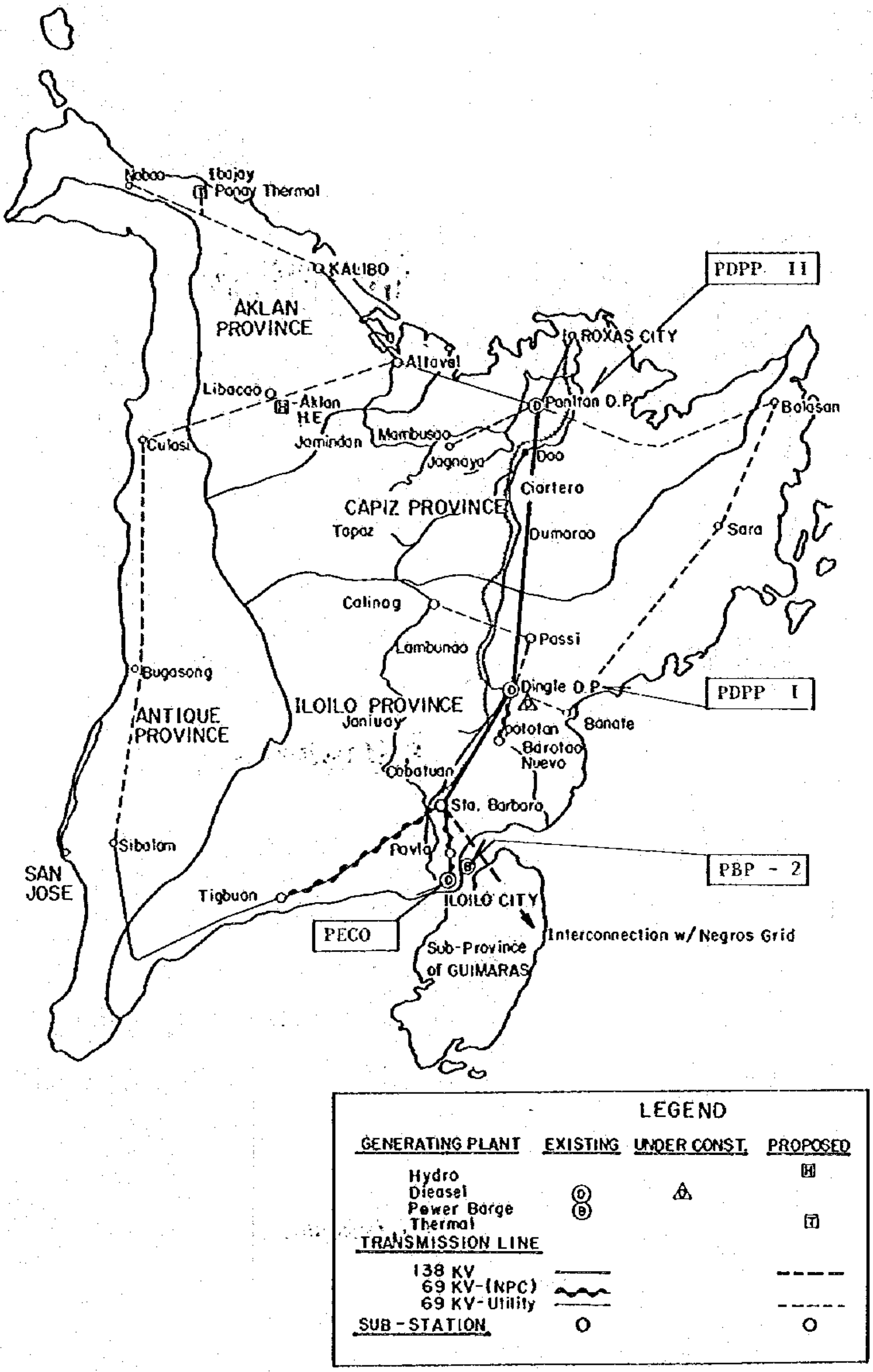


Fig. X. 2-2 PANAY POWER SYSTEM 1984

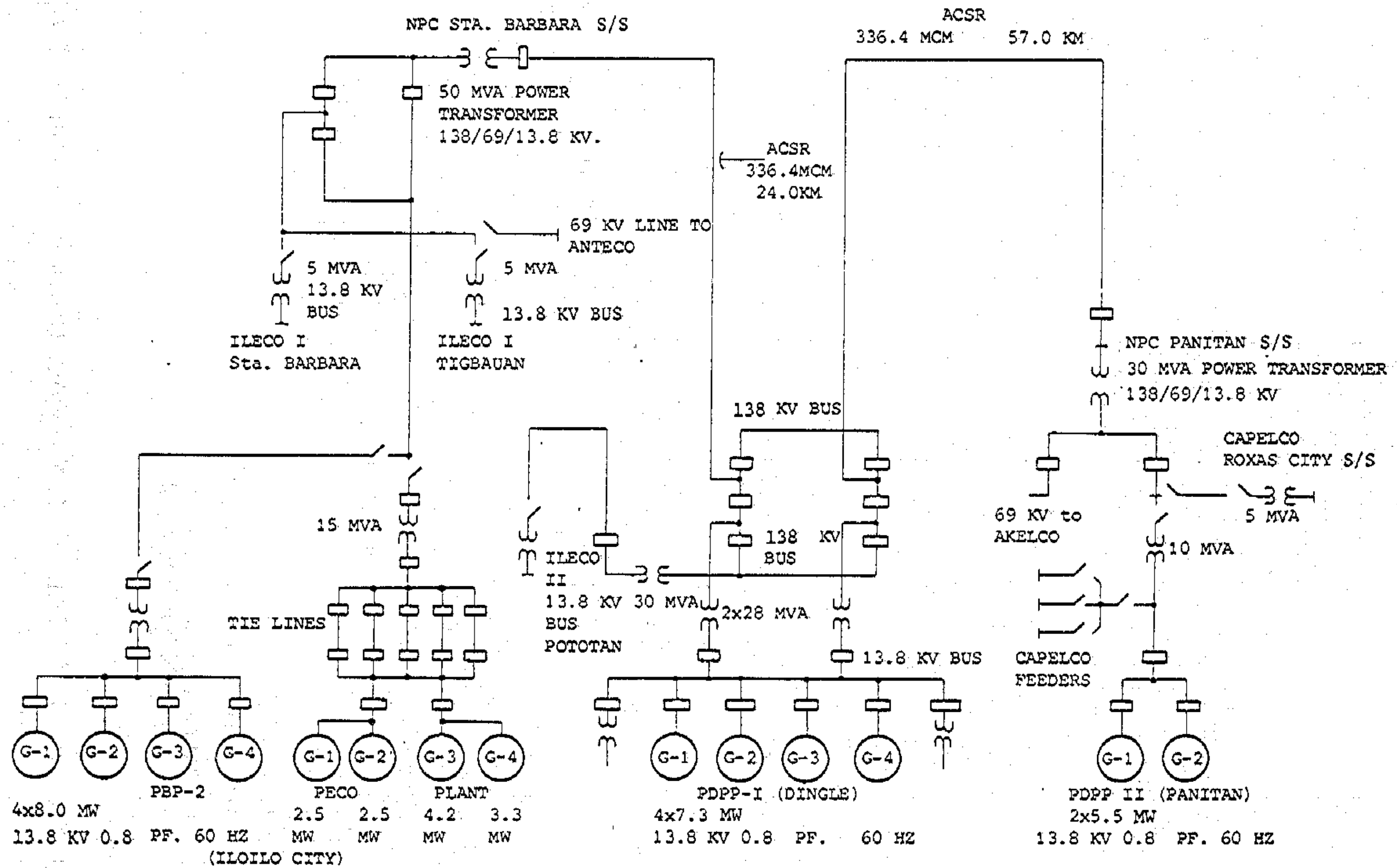
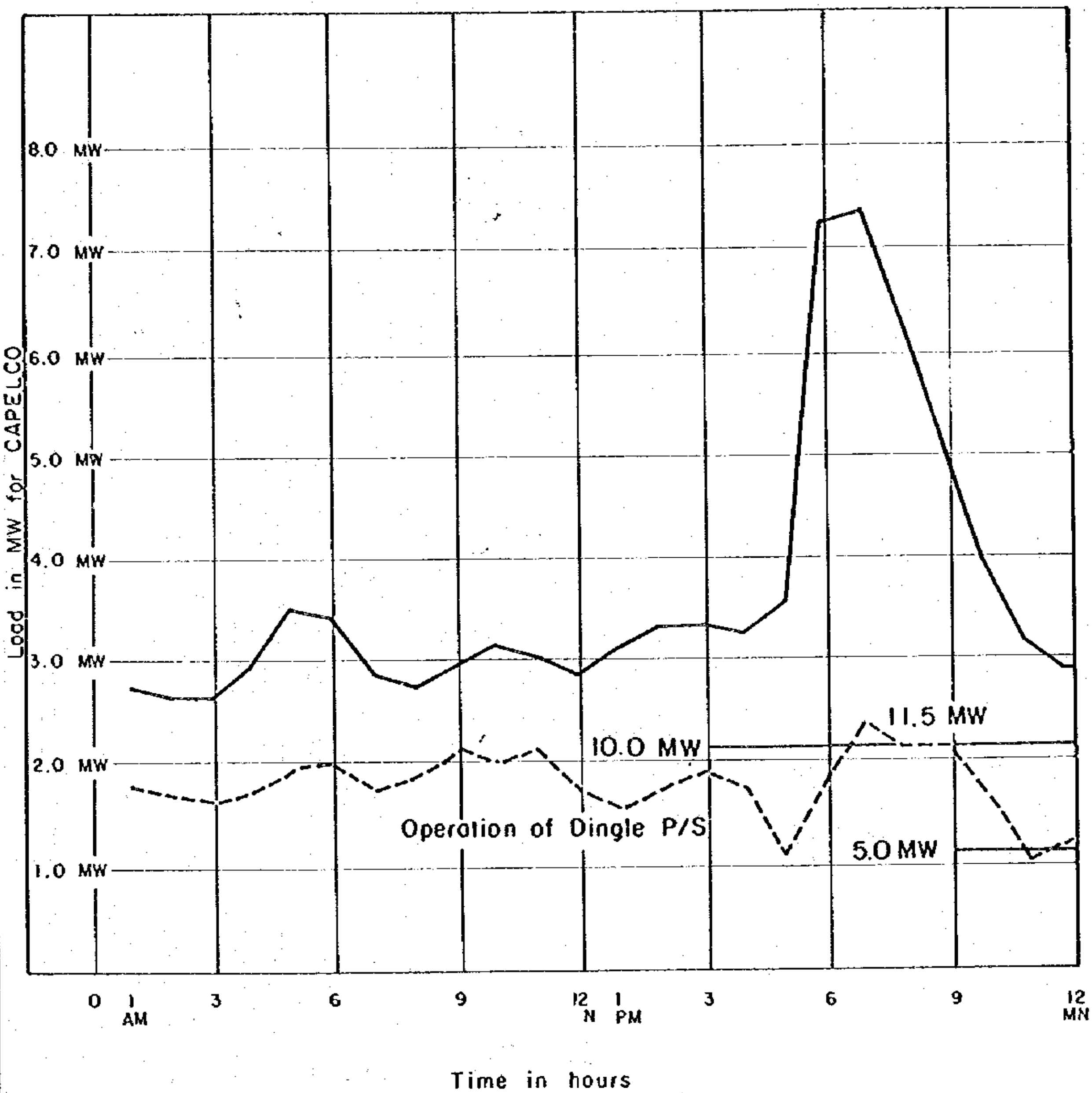


Fig.X.2-3 ELECTRICITY SUPPLY SYSTEM IN PANAY ISLAND (1984)



Note ;

—— Daily load curve on Nov. 5, 1983

----- Operation of Dingle P/S on July 16, 1984 (for reference)

Fig. X.2-4 TYPICAL DAILY LOAD CURVE IN CAPIZ GRID

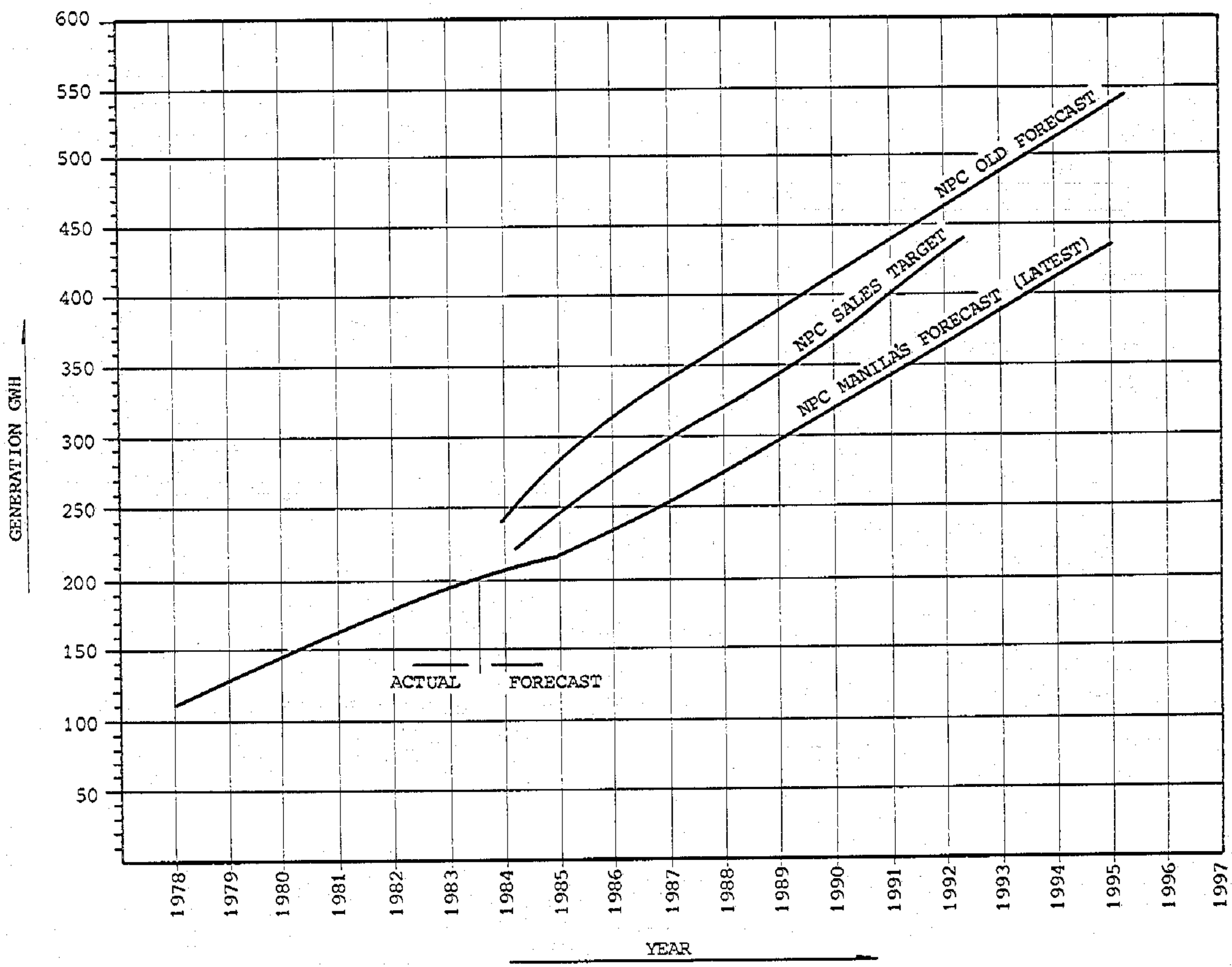
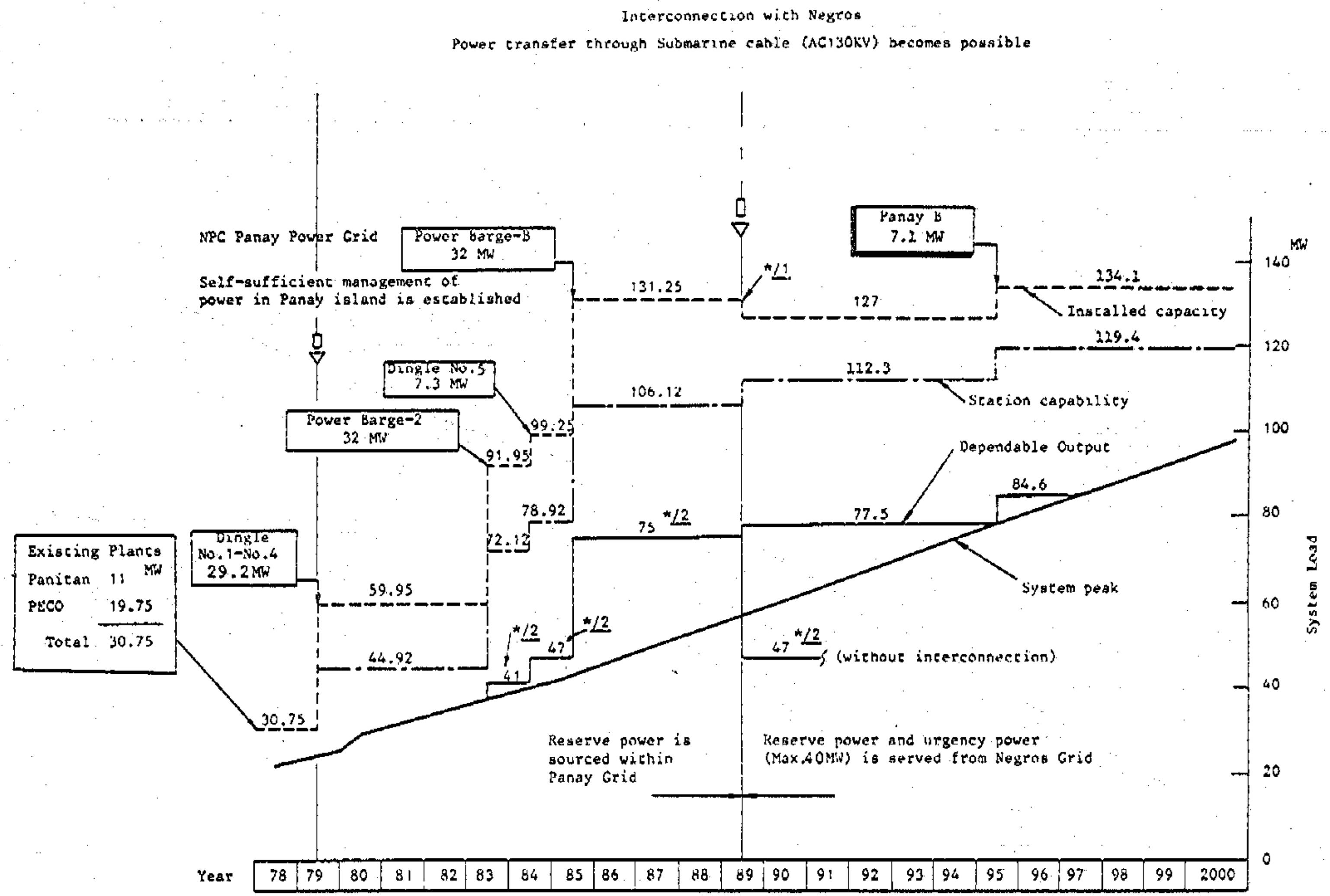


Fig.X.3-1 PANAY GRID GENERATION LEVEL FORECAST



(Note) */1 : Pullout Power Barge-B -32MW
Retire PECO Diesel -19.75MW
Interconnection +47.5MW

*/2 : Figure of present dependable output is based on the information from NPC

Fig. X.5-1 PROPOSED INSTALLATION PROGRAM OF POWER PLANTS IN PANAY ISLAND

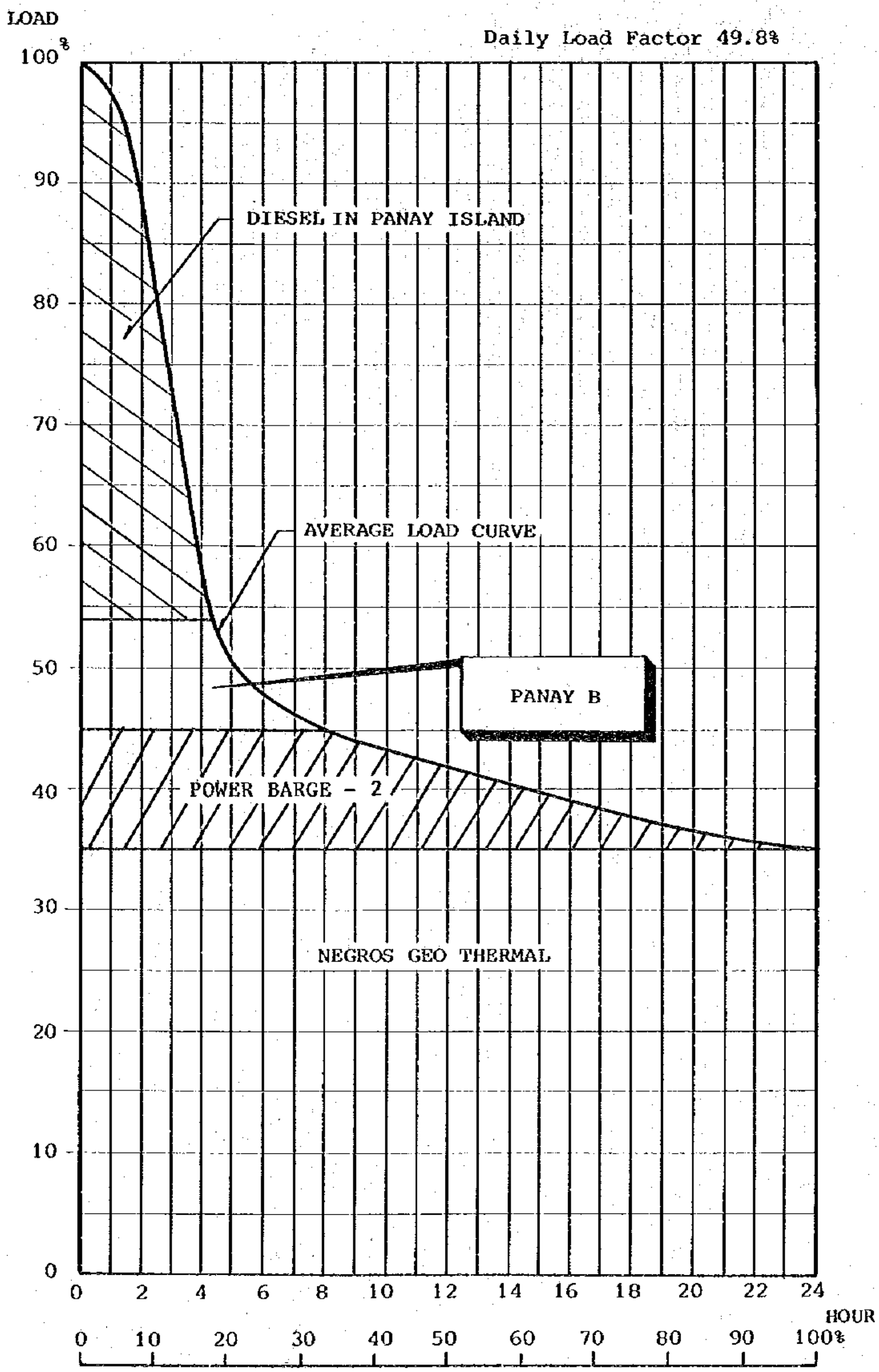
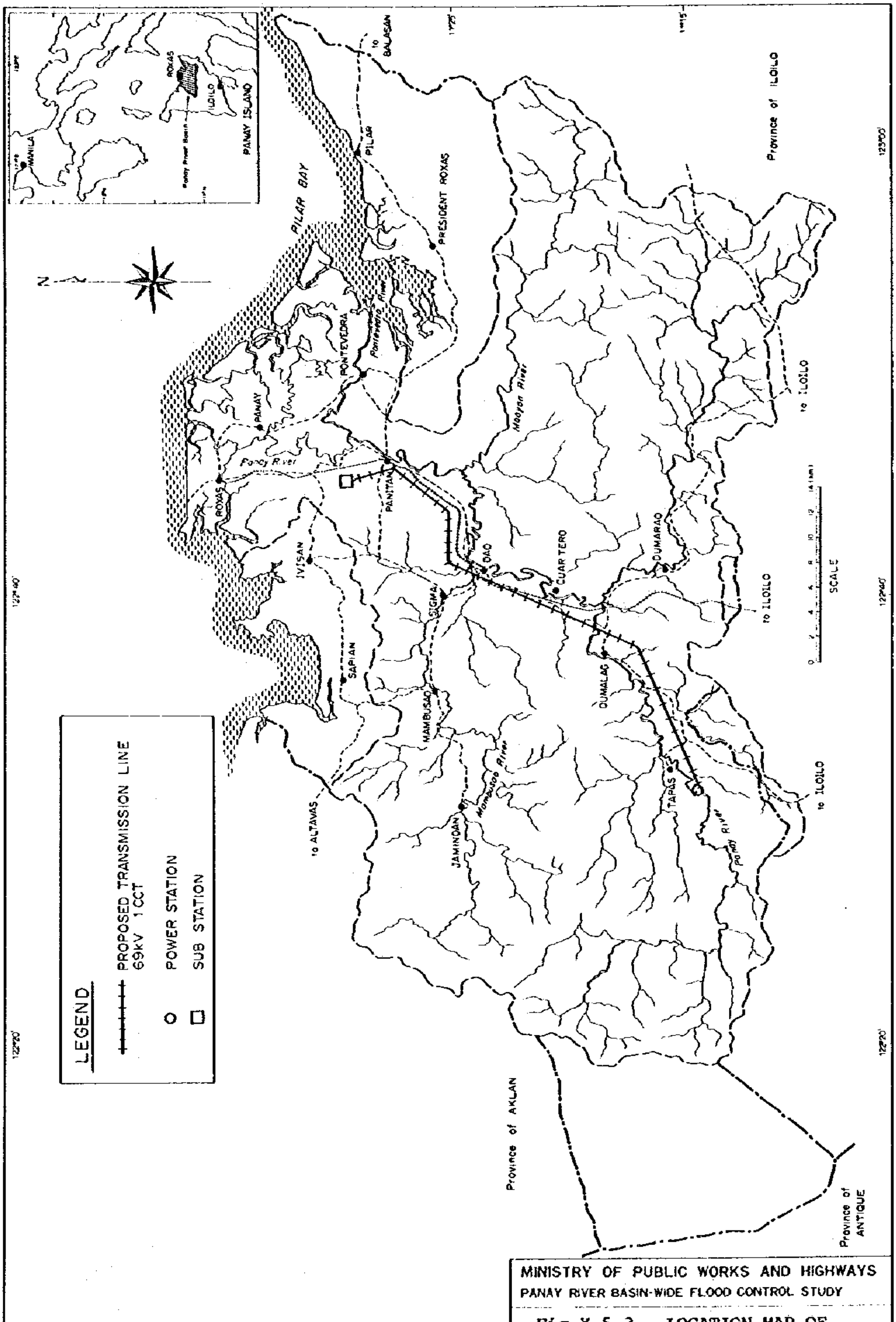


Figure X.5-2 LOAD DURATION CURVE IN PANAY SYSTEM AND ALLOCATION OF POWER SOURCES IN 1995



MINISTRY OF PUBLIC WORKS AND HIGHWAYS
PANAY RIVER BASIN-WIDE FLOOD CONTROL STUDY

Fig.X.5-3 LOCATION MAP OF TRANSMISSION LINE

JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX XI

ENVIRONMENT STUDY

FOR

FINAL REPORT

ON

THE PANAY RIVER BASIN-WIDE

FLOOD CONTROL STUDY

APPENDIX XI ENVIRONMENT STUDY

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1. Introduction

This Appendix XI presents the results of the environmental study conducted as a part of the Panay River Basin-wide Flood Control Plan. The Study is based on the field inspection, interviews with local officials, interpretation of aerial photographs and documents provided by relevant authorities. The reconnoitered area during the field trips are roughly shown in Figure XI.1-1.

The major part of this Study is devoted to indentifying potential environmental problems caused by the proposed flood control plan, comprising mainly the river channel improvement and dam construction. The assessment of the environmental impact is to be performed from the qualitative aspects rather than quantitative aspects, due mainly to lack of available data.

2. Present Condition of Environment in the Panay River Basin

2.1 Natural Environment

The topography of the Panay River basin is characterized by narrow Plains surrounded by low mountains in the middle reach and an extensive delta plain in the lower reach. The western mountain ridges descend gradually to the middle of the basin and formulate the southern rilly terrain which extends to the undulating mountains in the east.

The Panay river originates near the Aklan-Capiz boundary. It runs down to the eastern direction passing by the towns of Tapaz, Dumalag, Cuartero, Dao and Panitan, before it finally flows into the Sibuyan Sea. The Panay River bifurcates at some 4 km downstream of the Panitan town to the Lower Panay River and the Pontevedra River which is the present mainstream, that is, most of the discharge of the Panay River is drained through the Pontevedra River instead of through the Lower Panay River. In the 152 km course of its journey seaward, the Panay River is joined by three major tributaries; the Badbaran, Mambusao and Maayon Rivers.

The Badbaran River originates in the southeastern part of the basin, that is, municipality of Lemery in Iloilo Province. It runs near the Dumarao town, traversing the paddy and sugarcane fields and confluents to the Panay River near the boundary of Dumalag and Cuartero municipalities. The Mambusao River rises in the western part of the basin, that is, municipality of Jamindan. It runs eastward through the towns of Mambusao and Sigma, before it confluents to the Panay river at the Dao town. The Maayon river starts in Iloilo Province located in the eastern part of the basin and confluents to the Panay River in the southern part of Panitan.

2.2 Water Quality

The streamflow of the Panay is usually turbid in yellowish colour in the middle and lower reaches. If heavy rainfall continues for a few days, the riverflow turns dark brown. The temperature of the streamflow is in the range of 26.5 to 31.8 °C according to the measurement by the Study team. Measurement for water quality of the streamflow was made by using the water sampled from the five river stretches. The results of the analysis are given in Table XI.2-1.

Although turbid, the water quality of streamflow is generally acceptable to use for irrigation as well as domestic purpose. At storage sites of the proposed dam sites, in particular, since the watershed is mostly covered with shrubs, grasses, and forest, inflow of organic material would be small. In this light, possibility of eutrification in the proposed reservoirs is remote.

Salt water intrusion makes a serious problem in the Lower Panay River basin. During the dry seasons (January to April), the lower Panay River receives very small amount of streamflow, from the main Panay River, due mainly to silted banks at the bifurcation point. In addition, as irrigation water is also taken from the Lower Panay River. That is, the Lower Panay flushes out considerably little or sometimes almost null amount of streamflow. Therefore, at the time of high tides, salt water intrudes upstream in the Lower Panay River, up to the pumping station of Roxas Water District. This causes the problem of salinity for drinking water in the supply areas.

2.3 Soil Erosion

The watershed of the Panay River is widely covered with the Luisiana-Sapian complex developed from highly weathered igneous rock units. The upper watershed of the Panay River up to the elevation of 400 to 500 meters is covered with corn, bean and cassava fields or with shrub. Vegitation in the watershed is sparse. The forests exist only at the elevation 600 meters and above. Therefore, the watershed is considered to be principally erosion-prone.

The speed of erosion was measured from sediment load transported in the streamflow, as part of the meteo-hydrological investigation. As the result, the denudation rate of the watershed was assessed to be 1.44 mm annually. This indicates that the denudation due to erosion of soil is relatively fast in the Panay River basin.

According to BFD, the Office of District Forester, Roxas City, there are four forest preservation projects of state forests, as given below. Although the size of the preserved areas is not large enough, continued efforts of forest conservation and reforestration is desirable in the light of effective watershed management against erosion.

List of Reforestration Projects in the Panay River Basin

	Name of Project	Project Area
1.	Tapaz Reforestration Project	Tapaz
2.	Dumalag Reforestration Project	Dolores, Dumalag
3.	Baye Reforestration Project	Baye, Mambusao
4.	Dumarao Integrated Reforestration Project	Tumulaud, Dumarao

Source : BFD, Office of District Forester, the City of Roxas

2.4 Fish Fauna and Wildlife

The study of the fish fauna in the rivers of the basin was conducted based on existing documents1/, interviews with specialists of SEAPDEC2/, with officials and local residents in the towns of Dumalag, Dumarao, Dao, Sigma, Mambusao and Panitan. The fish species downstream of the proposed dam sites are summarized in Table XI.2-2.

According to the specialists of SEAFDEC, no original species of freshwater fish exist in the Panay Island. In thie regard, no serious potential problems are conceived on the fish fauna relevant to the proposed storage development.

Fish species such as Pantad, Batod, Puyo and Gourami inhabbit in the ditches along paddy fields. In freshwater fishponds, Panat, Tilapia,

Note 1/ Source : Feasibility Study of the Amnay Multipurpose Project, Sablayan, Occidental Mindoro

2/ The Southeast Asian Fisheries Development Center

Carpa and Puyo are bred. In general, freshwater fishes are hardly exploited as food resource in the Philippines, except those bred in fish ponds. Thus, adverse effect of development on food supply, too, is assessed to be minor.

No information was provided concerning the wildlife in the Panay River basin. The areas along the middle and lower reaches of the Panay river are open and flat, but large-sized wild annimals were scarecely seen during the investigation. At most the big lizards with the body length of more than 1 m are sometimes appear in the swanps or bushes.

2.5 Water Use

2.5.1 Riverine fishery

There are no full-time riverine fishermen in the Panay River basin, though those living near the estuary are engated in coastal fishery.

Fishing by the local residents is mostly occational and for the purpose of home consumption only. Exceptionally, when they catch merchantable fish, it is peddled or sold on the road sides to the passers-by. The riverine fish caught by the local residents are hardly brought to twice-a-week fish market.

Recently, fish in the rivers and in the ditches decrease its number, due mainly to use of chemical fertilizer and pesticide. Instead, the marine fish become more available by development of road network.

2.5.2 Domestic Water Use

There are ten water supply systems in service, capitalizing on the streamflow of the Panay River. The largest system is the waterworks of the Roxas City Water District with the supply capacity of 30.4 liter/sec. Others are minor works for the municipalities of Dao, Dumalag, Dumarao, Ivisan, Mambusao, Pilar, Sigma, Panitan and Jamindan. New waterworks are under construction for the municipalities of President Roxas, Panay and Tapaz. The areas not covered by the above waterworks are served by public or private well, most of which were constructed by the former BPW. The type, source and capacity of the existing water supply systems are shown in Table XI.2-3.

2.5.3 Riverine Transportation

No regular service of transportation is accommodated in the Panay River, except in the stretches near the estuary of the Pontevedra river and in the San Anton River. When the river water is high, a power boat can travel from the estuary up to the town of Cuartero and Dumalag, though no regular service is available. River crossing by ferry boats are conventionally in practice in the towns such as Dumarao across the Badbaran, Hagnaya across the Mambusao and Panay across the Panay River.

The only through-the-river transport is conveyance of bamboo trees in rafts. The bamboo trees are rafted from the largest producing areas of Tapaz and Dumalag to the Roxas City, through the main stretches of the Panay. Production of bamboo is an important industry to the local residents, underlain by extensive demands as house materials. Riverine transportation provides a low cost means of haulage of products.

2.6 Public Health

According to the City Health Office of the Roxas City, the local residents are prone to a parasistic disease by parasites, locally called "lugay". This disease is reported to be common in the Philippines, the infection process of which is attributed partly to insanitary drinking water and infected foods. (Refer to Table XI.2-4)

There are no reports of endemic disease such as schistosomiasis infected through tremadodes or nematodes living on fish or snail. Also no reports are accepted by the Provincial Health Office concerning the epidemic diseases such as malaria, dengue and H fever, infected through bacteria-bearing insects such as flies and chigger. The occurrence of such epidemic diseases is yet to be investigated.

3. Environmental Impacts by Proposed Flood Control Plan

3.1 Water Quality

One of the potential areas of environmental impacts inherent to the proposed development plan is eutrophication of reservoir water. In the case of prospective reservoirs in the upper Panay river basins, however, the issue of eutrophication would not take a severe form, on the grounds that the drainage area of the reservoirs is mostly shrub and forest, inhabited sparesely. Besides, stratification of the reservoir water temperature is unlikely to take place, due to generally high water temperature (presumably 24 to 30 °C) and the organic matter decomposes quickly.

Eutrophication issue is assessed to be slightly different for the Badbaran reservoir. The catchment area of the Badbaran reservoir is covered with cultivated land; 17 % of the area with paddy, 31 % with sugar cane. Inflow load of the organic matter is relatively high in the Badbaran reservoir, as compared with the reservoirs in the upper Panay basins. Even in this case, maintaining the proper water quality in the reservoir would be devised by positive countermeasures, such as seawage treatment, to reduce the inflow of organic matter.

Another area of potential problem is the afflux of toxic substances. In the current years, use of chemical fertilizer, pesticide and herbicide is on the rise, and it is inferred that the effluence of the chemicals may aggravate the water quality of the streamflow. Use of chemicals would naturally increase in the Panay basin, as the fertility of the farmland declines owing to curbed inundation which brings fertile soil. To protect the streamflow from contamination by toxic chemicals, it is important to restrict the use of fertilizer to the safe, pollution-free types only.

3.2 Sedimentation

As shown in the Appendix I, the issue of sedimentation is studied in terms of sediment materials, yielded, transported and trapped in the prospective reservoirs. The storage reservoirs were designed based on the sediment level corresponding to the 100 years of sedimentation. In the long term, therefore, the reservoirs are safe against sediment inflow through the life time, normally assumed to be 50 years. However, continuous sampling of streamflow and measurement of suspended load should be carried out to further ensure the estimated sediment load.

3.3 Soil Conservation

Soil conservation is a long-term theme of a great importance. For the purpose of establishing a comprehensive assessment on the need for soil conservation, a comparative study of the four sub-basins, corresponding to the dam sites of Panay "B", "C", Badbaran and Mambusao, was formulated by using the land suitability maps and land use maps. The outline of the study methodology is presented in Figure XI.3-1. First, Erosion Hazard Classification Map was prepared, as shown in Figure XI.3-2, on the basis of the criteria formerly established for the Land Capability Classification Guide, by the Bureau of Soils in 1976. In parallel with the above, composition of land uses in the sub-basins were read on the land use maps. Accordingly, the necessity for soil conservation was assessed in terms of the percentages of erosion hazard classification and present land use. The results of the erosion hazard classification and present land use are presented in Tables XI.3-1 and XI.3-2, respectively.

The sub-basin of the Panay "B" bears the highest aptitude for erosion. All the area of the sub-basin is classified as being very severe (Class 5) in erosion hazard. Besides, shrub covers more than 70 % of the area, comparing with the forest of 30 %. The sub-basin of the Panay "C" bears an equally high aptitude for erosion, with the Class 5 area covering 76 % of the whole area. The land use of the Panay "C" sub-basin is also predominantly shrub (86.2 %), and the need for protective measures is high.

The Mambusao sub-basin is ranked as slightly lower than the Panay "C" sub-basin in the aptitude for erosion, with the Class 5 areas accounting for 73 % of the total area. The index for the Badbaran is even lower than this, with the Class 5 areas being 45 % of the total area.

As the overall assessment, the sub-basins are deemed to be prone to erosion, judging from the criteria prepared by the Bureau of Soils.

Practically, reforestation of shrub areas, resulted from "slash and burn" agriculture, is desirable in view of soil conservation of the sub-basins. In parallel with this, the preservation of the existing forests should be given by a policy consideration.

3.4 Fish Fauna and Wildlife

As discussed in the Section 2.3, no significant loss of fish fauna is foreseeable from the scientific view point. Concerning the wildlife in the Panay River basin, storage development would have no major impacts.

3.5 Water Use

Adverse effect associated with supply of riverine fish for home consumption is only minor, as the dependence of the local residents on the river products is low. Conversely, creation of reservoirs would have a positive benefit, as the confined water body with the large surface area would enable the development of fish culture. The plankton feeders, such as Telepia, Common Carp and Chinese Carp would be the suitable freshwater fishes to bigin with.

Contamination of streamflow water is causing a significant decrease in the number of freshwater fishes in the rivers and ditches. The same problem will arise in the proposed reservoirs. The issue of river water contamination is closely nested with the use of chemical fertilizer and pesticide, and thus an utmost care and attention should be paid on the type of chemicals used at present and in the future.

The impact of storage development on the riverine transportation would be minor, too, as the utilization of the river for transportation in itself is in practice only on a restricted extent. Transportation of bamboo trees in rafts would be hampered by the development of reservoir at the Panay "C" dam site, in which case, the haulage will have to be changed into inland transportation, such as truck.

3.6 Public Health

The sanitary condition of the river basin is bound to be improved, if the water supply plan is implemented. Sufficient amount of potable water would minimize, even if it does not prevent totally, the infection of waterborne diseases.

4. Conclusions

In conclusions, the environmental study undertaken hereabove are summarized by the following points:

(a) No serious problem inherent to the environmental impacts of the proposed plan are conceived,

(b) Eutrophication of reservoir water is unlikely to take place, due mainly to light organic load and generally high temperature of water,

(c) Constant attention should be paid to the use of chemicals included in the fertilizer and pesticide, in view of water quality control,

(d) Soil conservation needs to be advanced as a policy issue, by means of reforestation of shrub areas and conservation of existing forests,

(e) Alternative means for inland transportation should be provided in place of the riverine transportation for the houlage of bamboo trees, and

(f) A positive effect is conceived in relation to the public health, due mainly to improved supply condition of potable water, if the water supply plan is to be implemented.

TABLES

FOR

APPENDIX XI

Table XI.2-1 Water Quality of the Panay River

Parameter	Panay "C"	Badbaran	Cuartero	Panitan	Lower Panay /1
Date, Time	Oct.16, 10:00	Oct.16, 11:40	Oct.16, 14:30	Oct.17, 15:00	Oct.17, 14:00
pH	7.9	7.6	7.5	7.5	7.1
EC, μs/cm	300	165	265	225	290
Alkalinity, mg/ℓ $CaCO_3$	140	80	125	100	110
Chloride, mg/ℓ Chloride	8.5	10	8.5	10	30
Hardness, mg/ℓ $CaCO_3$	110	60	100	90	115
Total Iron, mg/ℓ Total Iron	0.003	0.15	0.007	0.32	0.05
$N-NH_4$, mg/ℓ ammonia nitrogen	0.05	0.41	0.006	0.82	0.49
$N-NO_3$, mg/ℓ nitrite nitrogen	2.2	3.1	0.4	3.9	2.3

Note /1 ; Near the intake of Roxas City district.

Table XI.2-2 Fish Species in the Panay River Basin

Scientific Name	English Name	Local Name (Ilongo)
Clarias SP.	Catfish	Pantat
Tilapia mossabica	Tilapia	Tilapia
Anguilla	Freshwater eel	Bais
Ophiocephalus striatus	Murel	Batod
Cyprinus carpio	Carp	Carpa
Anabas testudeneus	Climbing perch	Puyo
Osphronemus gourami	Gourami	Gourami
Megalops cyprinoides	Tarpon	Bulan-bulan
Macrobrachium rosenbergii	Freshwater shrimps	Ulang

Table XI.2-3 The Type, Source and Capacity of The Existing Waterwork Systems

Name of Waterworks	Type	Source	Capacity (ℓ/sec.)
a. Dao Waterworks	Pumping	River	6.3
b. Dumalag Waterworks	Gravity	River	3.78
c. Dumarao Waterworks	Gravity	River	3.78
d. Ivisan Waterworks	Gravity	River	2.52
e. Jamindan Waterworks	Pumping	River	5.00
f. Mambusao Waterworks	Gravity	River	3.15
g. Panitan Waterworks	Pumping	Deep well	3.3
h. Pilar Waterworks	Gravity	River	5.04
i. Sigma Waterworks	Pumping	River	5.00
j. Roxas City Water District	Gravity & Pumping	River	30.4 (10 hours operation)

Table XI.2-4 Common Parasites Existing in the Roxas City

Local Name	Common Parasites: Scientific Name	Common Parasites: English Name	Name of Carrier	Approximate No. of Patients, in 1983
Lugay	Ascaris lumbricoides	Large intestinal roundworm of man	Fly, Man & Water	103
"	Trichuris trichiura	Whipworm	"	118
"		Hookworm	"	14
"	Entamoeba histolytica		"	13
"	Entamoeba coil		"	45
"	Giardia lamblia		"	16
"	Enterobius vermicularis	Pinworm or Seatworm	"	1
"	Strongyloides stercorales	Threadworm	"	2
"	Trichomonas intestinales		"	3
Total				315

Source: City Health Office, Roxas City

Table XI.3-1 Classification of Soil Conservation Necessity from Land Suitability Map

Soil Conservation Necessity Class		Erosion Hazard	Class or Subclass of Suitability	Panay "B"	Panay "C"	Badbaran	Mambusao
				km^2 (%)	km^2 (%)	km^2 (%)	km^2 (%)
low	1	None	A BW Bs CW X	-	16.9 (3.5)	15.9 (6.2)	3.4 (1.6)
	2	Slight	Be Cs	-	-	8.8 (3.4)	9.6 (4.3)
	3	Moderate	Ce	-	-	21.7 (8.4)	3.4 (1.6)
	4	Severe	De	-	103.5 (20.3)	96.9 (37.5)	41.7 (19.3)
high	5	Very severe Extreme	M Y	238.8 (100)	387.8 (76.2)	115.1 (44.5)	158.5 (73.2)
Total				238.8 (100)	509.2 (100)	258.4 (100)	216.6 (100)

Remark : Figures in the parentheses indicate the proportion to the total area.

Table XI.3-2 Breakdown of Catchment Area as to Land Use

Land Use	Panay "B"	Panay "C"	Badbaran	Mambusao
	km^2 (%)	km^2 (%)	km^2 (%)	km^2 (%)
Lowland/Paddy rice area	-	13.6 (2.7)	43.5 (16.7)	6.8 (3.1)
Sugarcane	-	132.4 (26.0)	80.5 (31.2)	51.9 (24.0)
Pasture/Grassland	-	-	5.3 (2.1)	2.1 (1.0)
Shrub	167.4 (70.1)	277.0 (54.4)	129.1 (50.0)	147.6 (68.1)
Orchard (Coconut)	-	-	-	7.5 (3.5)
Forest	71.4 (29.9)	86.2 (16.9)	-	0.7 (0.3)
Total	238.8 (100)	509.2 (100)	258.4 (100)	216.6 (100)

Remark : Figures in parentheses indicate the proportion to the total area.

FIGURES

FOR

APPENDIX XI

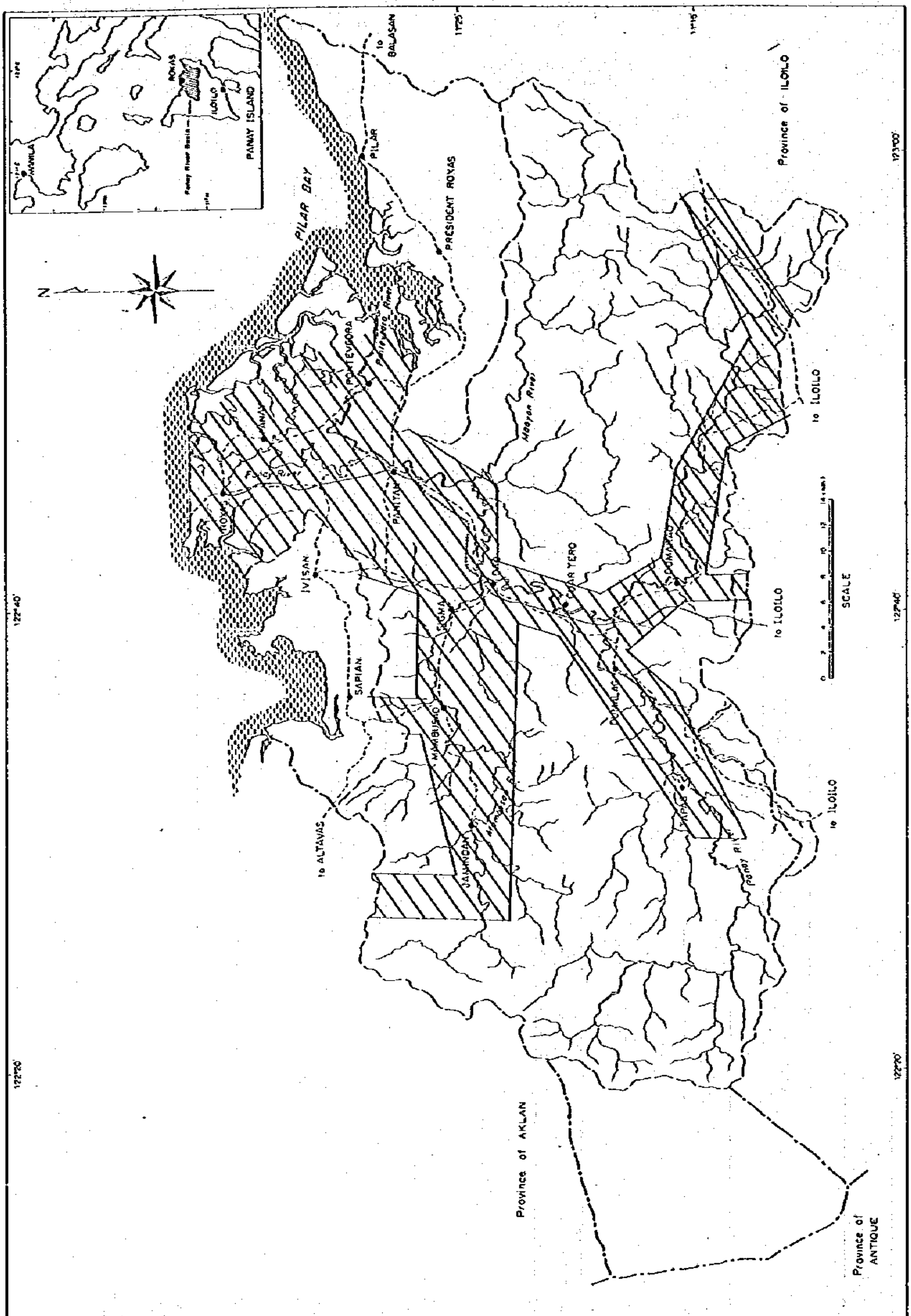

Fig.XI.1-1

Location Map of Field Inspection and/or Interview Survey

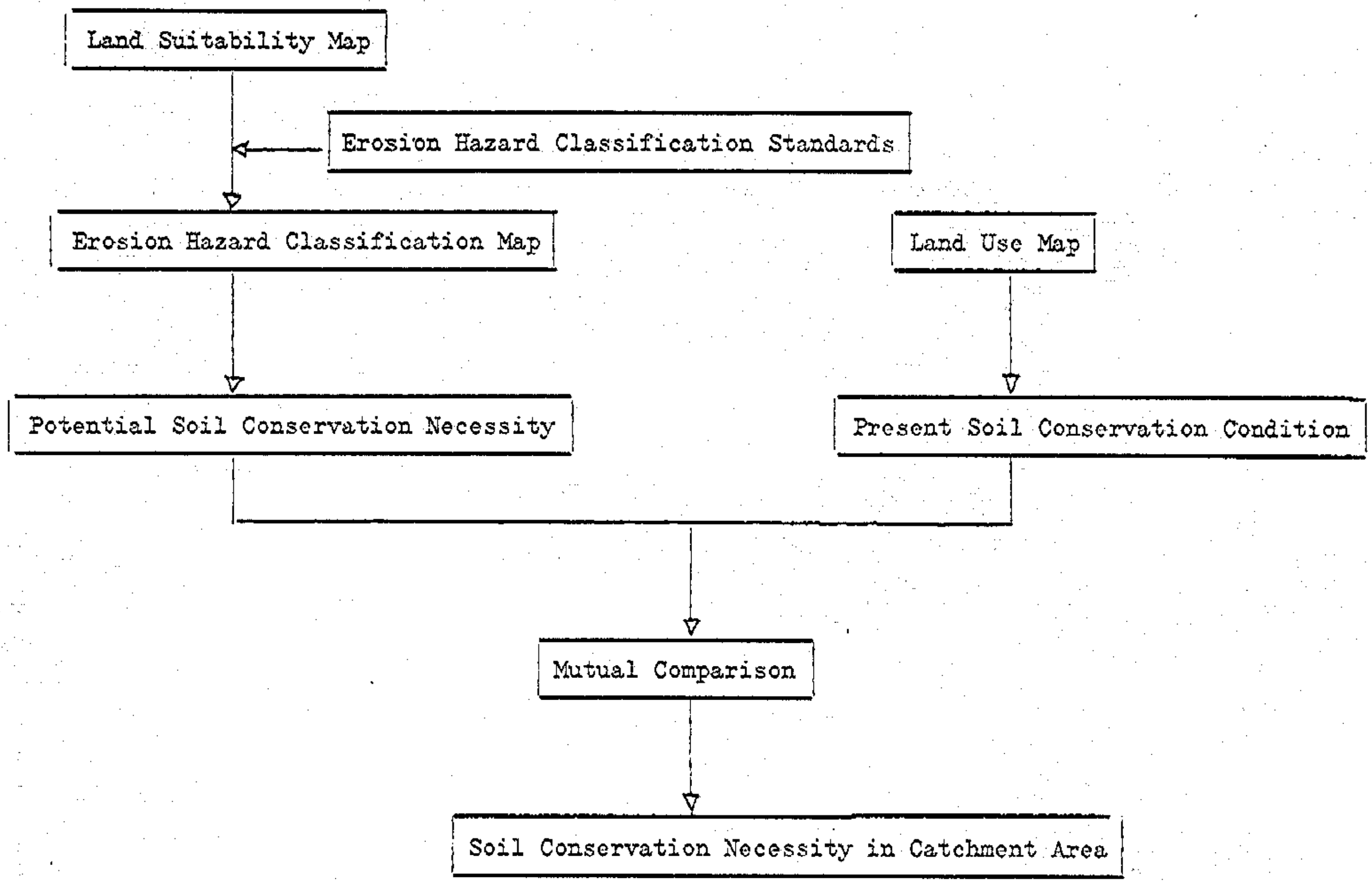

Fig. XI.3-1 Flow Chart for Analysis of Soil Conservation Necessity

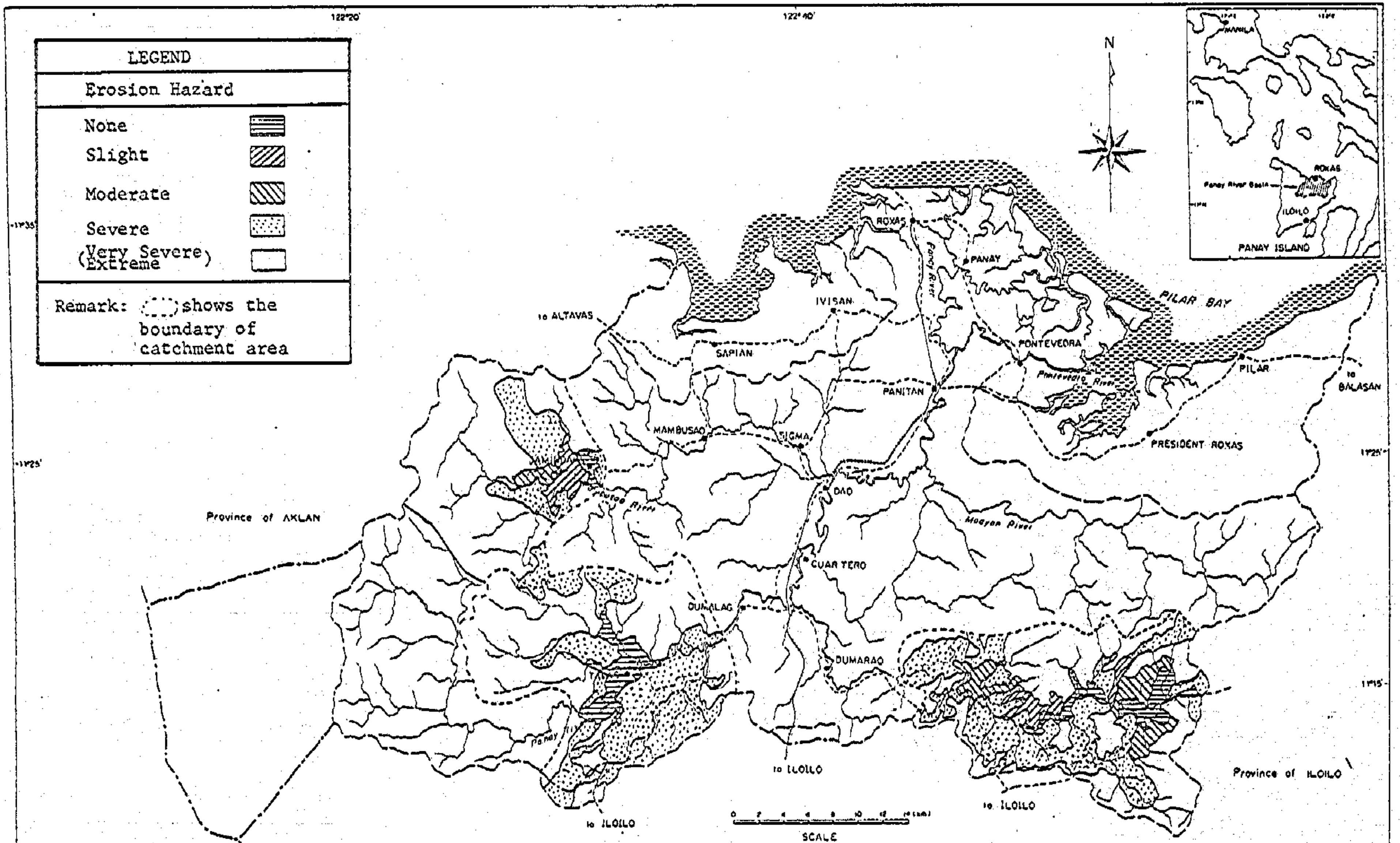

Fig. XI.3-2 Erosion Hazard Classification Map in Catchment Area of Selected Damsites

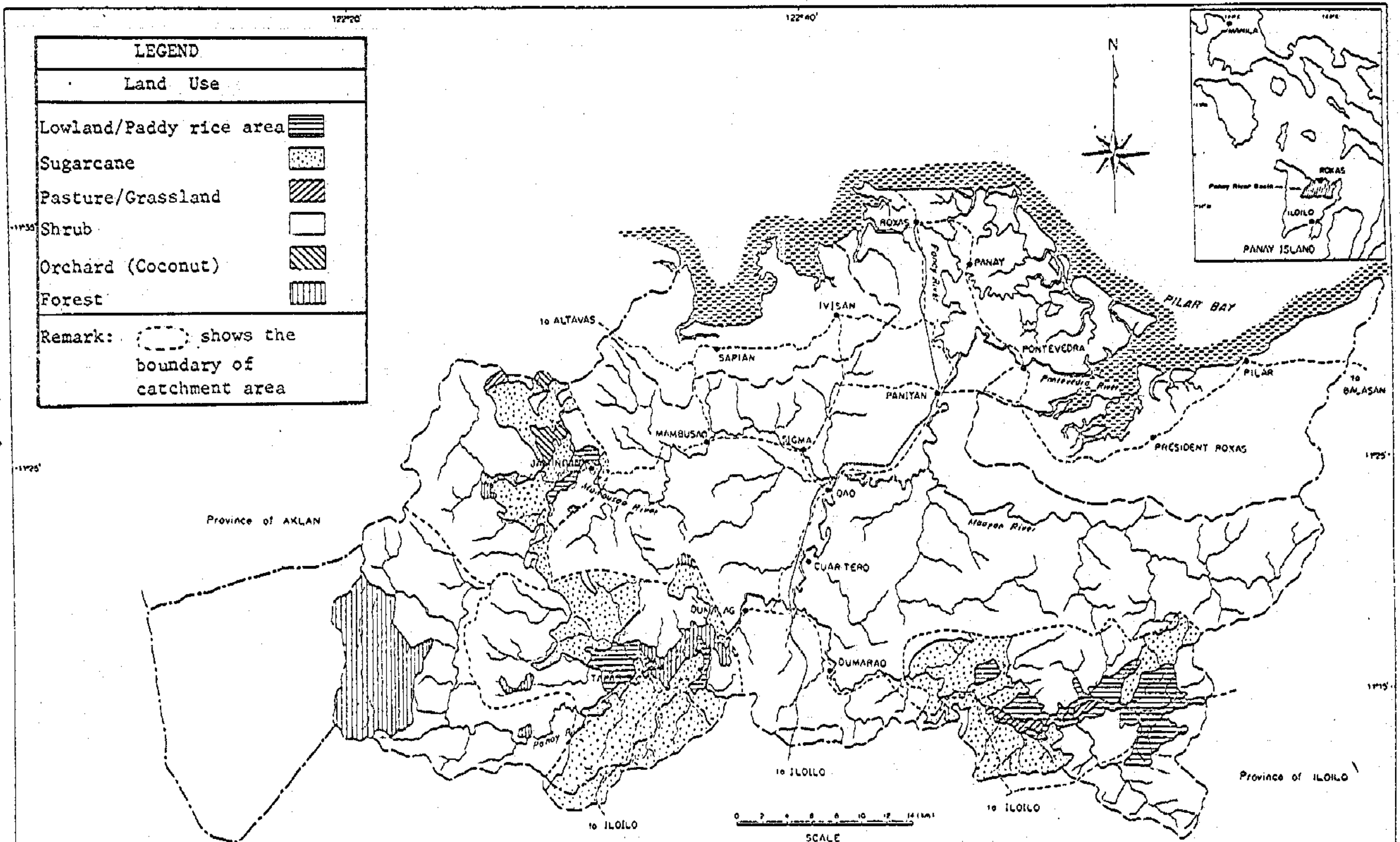

Fig. XI.3-3 Land Use Map in Catchment Area of Selected Damsites

APPENDIX XII

CONSTRUCTION COST STUDY

FOR

FINAL REPORT

ON

THE PANAY RIVER BASIN-WIDE

FLOOD CONTROL STUDY

THE PANAY RIVER BASIN - WIDE FLOOD CONTROL STUDY

APPENDIX XII CONSTRUCTION COST STUDY

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LIST OF TABLE

1. Introduction

The construction cost for the basic study of the Panay river project is estimated on the basis of the current cost data under the following condition and assumption.

(1) Unit price are based at the price level as of July 1984.

(2) The exchange rate of one (1) United States Dollar ($) employed in the conversion into Philippine Peso (₱) and Japanese Yen (¥) are ₱18 and ¥234, respectively, in consideration of the prevailing exchange rates during the period from the end of June to early July 1984, at the time of execution of data collection.

(3) Price escalation rate per annum is assumed to be 7 percent for foreign currency and 10 percent for local currency portion.

(4) The project will be implemented by the Government or Government agency with the employment of engineering consultant and the construction works will be carried out by the contract system through the tendering.

2. Constitution of Construction Cost

The construction cost consists of two main items that are the direct cost and indirect cost. The direct cost is categolized into three items for this study, i.e. preparatory works, main works and miscellaneous works.

The cost of main works, which covers more than eighty percent of the total direct cost, is estimated based on the work items and quantities derived from the basic design layout. This includes the material, labor and equipment cost plus the contractor's indirect cost.

The costs of preparatory works and miscellaneous works are estimated with a certain percentage of main works for minor work items. The indirect cost includes the costs of land acquisition, government administration and engineering services.

As for the contingency, the physical contingency is computed into direct and indirect cost accordingly and the price contingency is estimated for escalation of cost on the financial cost estimate.

On the other hand, the estimated cost is divided into foreign and local currency components according to their sources.

The constitution of construction cost is illustrated is Table XII 2-1.

3. Construction Cost Estimate

3.1 Direct Cost

3.1.1 General

The construction cost to be required for the project is estimated for the works items as follows;

(1) River improvement
(2) Dam
(3) Irrigation
(4) Water supply

These works are mainly divided into the civil works and electro-mechanical works.

The direct cost of these works are estimated by applying the following three estimating method;

(1) Unit price multiplied by work quantities
(2) Statistical method using the cost of other similar projects
(3) Supplier's quotation

The first method is mainly applied for the civil works and the second and third method are used for electro-mechanical work. The statistical method is also applied for the minor items of civil works.

The back data for estimating the unit cost are attached in Data Book II.

3.1.2 Civil Works

The direct cost of civil works is estimated through the method of unit price multiplied by the corresponding quantity of work. The statistical method is applied for estimating cost of preparatory works and minor work items (miscellaneous works).

The unit price of each work item consists of cost of materials, labor and equipment. The contractor's indirect cost and mark-up are incorporated in the unit price for each work item. Development of the unit price is based on the standard construction method which is described in the following section.

The estimated unit price for each work items adopted for the cost estimate is shown in Table XII 3-1.

(1) Labor cost

The labor cost is considered in as part of the local currency component of cost estimates and is calculated based on the rates listed in Table XII 3-2. Data of labor wages were gathered in Roxas City and Manila.

The labor wages include labor's fringe benefits given additionally to the basic payment, as itemized below:

(1) living allowance
(2) vacation and sick leaves
(3) Bonus
(4) Charge of social security system
(5) medicare
(6) state insulance and others

The basic monthly wage is principally based on twenty six (26) working days per month and eight (8) hours per day.

(2) Material cost

Prices of material available in local markets were canvassed in Manila and Roxas City in July 1984. They are principally counted into the local currency component but their certain proportions are considered into foreign currency component according to their usage of imported raw material and production facilities.

Prices of imported materials are the prevailing prices in Japan at the end of June 1984. Cost of freight, insurance, landing, handling and other incidental cost are included as part of the prices of imported material.

The unit price of material used for cost estimate is shown in Table XII 3-3.

(3) Equipment cost

Prices of equipment are based on the current price in Japan.

The equipment cost consists of the depreciation cost, repairing cost and administration cost, which are calcurated by a ratio against delivered cost as shown in Table XII 3-4. Purchase cost of equipment is also shown in Table XII 3-5.

Equipment cost is divided into local and foreign compoment as follows,

Foreign currency component

- C.I.F. purchase cost
- Spare parts cost

Local currency component

- Landing cost
- Delivery cost
- Labor cost of repairing
- Administration cost

(4) Contractor's indirect cost

Contractor's expenses are taken account by including them proportionately in the unit prices.

It is assumed to be 30% of direct cost as detailed below:

(a) 20% for
- field overhead and administration cost,
- material warehousing and handling,
- camp operation and maintenance,
- security and transportation service,
- communication charges,

(b) 10% for
- corporate overhead,
- profit,
- estimated risk,
- taxes, and
- other incidentals.

3.1.3 Electro-mechanical Works

Cost estimate of electro-mechanical works is based on past tendered record of similar project with considerations made on locality of this project.

Cost estimate of the above works includes cost on engineering design, material, manufacturing, painting, testing, packing, delivery to the site and installation works.

Principally, F.O.B. cost on imported item, ocean freight and insulance premium are considered as part of the foreign currency component while other costs are counted in local component.

3.2 Indirect Cost

3.2.1 Land Acquisition and Compensation Cost

The cost of right of way and compensation is estimated on the basis of the prevailing government expropriation cost for the land, buildings and other private properties. These unit cost are obtained at Roxas City.

3.2.2 Government Administration Cost

An allowance of 5 percent of the total estimated direct cost is provided for the government administration cost of the project.

3.2.3 Engineering Services Cost

The cost of the engineering services for implementation of the project is estimated as 3 percent of the total estimated direct cost.

3.3 Contingency

The contingency is provided to cope up with the unpredictable physical conditions and price escalation due to inflation. The physical contingency amounting to 10 percent of direct cost is assumed.

Price contingency for financial cost is estimated by applying the inflation rate of 10 percent per annum for the local currency component and 7 percent for the foreign currency component.

4. Construction Method

4.1 Basic Condition

In studying the construction method, the basic conditions and assumptions are considered as follows.

(1) Construction will be executed by a contractor or contractors in a modern mechanized construction method.

(2) The conventional method and type of equipment will be principally applied, giving consideration to the local condition. For the excavation in water, however, the dredging method is selected from the economical view point.

(3) Daily working hour and shift is applied on an 8 hour shift principally. Then 6 hour per day out of 8 hour working shift is assumed to be effective operation hour by taking 0.75 for efficiency of working hours.

(4) Hourly production rate of construction equipment is estimated to meet with the site condition according to the following volume change factor of material.

Material	Loose/Bank	Embank/Bank
Common	1.25	0.88
Coarce/Sand & gravel	1.15	1.02
Rock	1.60	1.15

The result of estimate is shown in Table XII 4-1.

4.2 River Improvement Works

(1) Enlargement of river course and shortcut

Works for enlargement of river course are executed by a combination of equipment for dredging and excavation.

The dredging work is mainly applied to the excavation in water by using pump suction dredger with a capacity of 1,400 HP, which is transported from the sea.

The work is proceeded from the river mouth toward the upstream side as providing spoil bank along the river where is located outside of levee. Average distance from the river to spoil bank is assumed to be about one (1) km.

The excavation above water level is performed by using back hoe, bulldozer and dump truck.

The excavated material is utilized for levee embankment to the spoil bank provided along the river in case of excess to the embankment. Average hauling distance of material is estimated at 500 m.

(2) Levee embankment

The levee is constructed along the river by means of embankment of earth material.

The embankment material is obtained from surrounding area and utilize the excavated material of river used for excavation with assistance of bulldozer and for loading the material into dump truck.

Dump truck is used for handling the material to embankment site or spoil bank. Embankment is executed by using tamping roller for compaction, bulldozer for spreading and water tanker for sprinkling the water to control moisture contents of material.

Inspection road supplemented to the levee is constructed together with levee. After embankment, gravel metaling is performed by using motor grader, pneumatic roller and macadam roller.

Sod facing is conducted by man power for slope protection.

(3) Revetment and related structure

The revetment and related structure, such as bridge, drainage aluice, diversion weir and others, are constructed gradually according to the progress of enlargement of river course.

These construction works consist mainly of excavation, embankment, backfill, concrete, massonry, gabion and piling, which are conducted by conventional method and equipment described as follows;

Works	Method & Equipment
a) Excavation	
- excavation & loading	Back hoe & Bulldozer
- hauling	Dump truck
- spoiling	Bulldozer
b) Embankment	
- spreading	Bulldozer
- compaction	Vibration roller or tamper
c) Backfill	
- backfill	Tamper and manpower
d) Concrete	
- mixing	Concrete mixer
- transportation	Agitator truck or concrete cart
- placing	Truck crane or direct placing with chute and conveyor
- compaction	Concrete vibrator
e) Massonry	
- placing boulder & concrete	Manpower
- mixing concrete	Concrete mixer
f) Gabion	
- production & placing	Manpower
g) Piling	
- piling	Diesel pile hammer

4.3 Dam construction

Dam construction is proceeded from the construction of diversion tunnel for river diversion. After completion of diversion tunnel, the river is diverted to the tunnel and cofferdam is constructed. Subsequently, main dam is constructed in parallel with various structures ie, intake, spillway, waterway, power station, switchyard and other related structures.

(1) Tunnel

The diversion tunnel is excavated by top heading bottom bench cut excavation method, using following equipment.

Works	Equipment
- Drilling	Leg hammer
- Loading	Dozer shovel
- Hauling	Dump truck
- Air supply	Air compressor
- Ventilation	Fan
- Water supply	Submersible pump

The steel support is planned to be installed for stabilization of excavated tunnel periphery.

After excavation, tunnel is lined by reinforced concrete, which is placed by concrete pump and sliding steel form. Concrete is produced by batcher plant and transported by agitator truck to the concrete pump.

(2) Excavation

Excavation for dam and structures is conducted by a combination of bulldozer, dozer shovel and dump truck. Addition to those equipment, crawler drill, leg hammer and air compressor are used for rock excavation.

(3) Embankment

For embankment of dam, soil compactor is used for core and filter embankment and bulldozer is used for rock embankment.

(4) Concrete

Concrete work is mainly devided into two kind, dam concrete and structural concrete.

Dam concrete is placed by using cable crane. Concrete is produced by batcher plant and transported by transfer car on the banker line to the cable crane.

Structural concrete is placed by a combination of truck crane with bucket, agitator truck and batcher plant.

Concrete vibrator powered by compressed air is used for concrete compaction.

4.4 Irrigation works

Major construction works of irrigation are head works, canal for irrigation and drainage, and related structures, such as siphon, turn out, culvert, drop and so on.

The head works and canal are constructed during the same period and the construction of related structures are carried out gradually as corresponding to the progress of canal construction.

The canal construction consists mainly of excavation and embankment, which are conducted by using backhoe with assistance of bulldozer for excavation and loading, dump truck for hauling, bulldozer for spreading and vibration roller for compaction.

The embankment material is obtained from borrow pit located surrounding area of canal and also utilize the excavated material of canal excavation.

Construction method and equipment to be applied for head works and related structures are the same as those of related structures of river improvement work.

TABLES

FOR

APPENDIX XII

TABLE XII 2-1 CONSTITUTION OF CONSTRUCTION COST

Construction Cost	(A) Direct Cost	(a) Preparatory 5-10% of (b) & (c)			F.C L.C
		(b) Direct Cost	Equipment Cost		F.C L.C
			Labour Cost		L.C
			Material Cost		F.C L.C
			Contractor's Indirect Cost		F.C L.C
		(c) Miscellaneous Works 3-10% of (b)			F.C L.C
		(d) Physical Contingency 10 % of (a), (b) & (c)			F.C L.C
	(B) Indirect Cost	(e) Compensation Cost			L.C
		(f) Administration Cost 5% of (A)			L.C
		(g) Engineering Service 5% of (A)			F.C L.C
		(h) Physical Contingency 10% of (e), (f) & (g)			F.C L.C
	(C) Price Contingency F.C 7%, L.C 10%				F.C L.C

TABLE XII 3-1 UNIT PRICE FOR CONSTRUCTION COST (1)

A. Excavation and Dredging

		Unit	F.C ($)	L.C ($)	Total ($)
A - 1	Common for Cofferdom	m^3	1.46	0.77	2.23
A - 2	Common				
	(a) L = 250 m	m^3	1.10	0.69	1.79
	(b) L = 500 m	"	1.25	0.78	2.03
	(c) L = 1000 m	"	1.51	0.95	2.46
	(d) L = 2000 m	"	2.15	1.35	3.50
A - 3	Common by Man Power	m^3	-	1.07	1.67
A - 4	Rock				
	(a) L = 250 m	m^3	5.51	4.25	9.76
	(b) L = 500 m	"	5.75	4.39	10.14
	(c) L = 1000 m	"	6.05	4.59	10.64
	(d) L = 2000 m	"	6.86	5.09	11.95
	(e) L = 5000 m	"	8.51	6.12	14.63
A - 5	Rock, Loading & Hauling				
	(a) L = 2000 m	m^3	3.02	1.89	4.91
	(b) L = 1000 m	"	2.21	1.39	3.60
	(c) L = 500 m	"	1.91	1.19	3.10
	(d) L = 250 m	"	1.67	1.05	2.72
	(e) L = 5000 m	"	4.67	2.92	7.59
A - 6	Rock, Spreading	m^3	0.34	0.21	0.55
A - 7	Rock, Blasting	m^3	3.50	2.99	6.49
A - 8	Tunnel	m^3	33.06	13.35	46.41
A - 9	Dredging	m^3	1.60	1.05	2.65

(to be continued)

TABLE XII 3-1 UNIT PRICE FOR CONSTRUCTION COST (2)

B. Embarkment

		Unit	F.C ($)	L.C ($)	Total ($)	
B - 1	Common, for Cofferdom	m^3	1.68	0.91	2.59	
B - 2	Common, Utilizing Excavated Material	m^3	0.47	0.38	0.85	
B - 3	Common, Borrowed Material	m^3	1.72	1.16	2.88	
B - 4	Common, Compaction	m^3	0.69	0.56	1.25	
B - 5	Sand & Gravel Pavement	m^2	3.07	2.28	5.35	30 cm
B - 6	Sand & Gravel, Spreading & Compaction	m^2	0.29	0.22	0.51	
B - 7	Backfill	m^3	1.31	1.73	3.04	
B - 8	Backfill by Tamper	m^3	0.21	1.04	1.25	

C. Concrete Works

		Unit	F.C ($)	L.C ($)	Total ($)
C - 1	Concrete, Type A (180 kg)	m^3	32.14	24.92	57.06
C - 2	Concrete, Type B (210 kg)	m^3	35.55	25.68	61.23
C - 3	Concrete, Type C (300 kg)	m^3	39.78	27.95	67.73
C - 4	Concrete Material, Type A	m^3	24.85	18.06	42.91
C - 5	Concrete Material, Type B	m^3	28.26	18.82	47.08
C - 6	Concrete Material, Type C	m^3	32.49	21.09	53.58
C - 7	Aggregate, L = 5000 m	m^3	14.09	10.15	24.24

(to be continued)

TABLE XII 3-1 UNIT PRICE FOR CONSTRUCTION COST (3)

	Unit	F.C ($)	L.C ($)	Total ($)
C - 8 Aggregate, L = 2000 m	m^3	12.11	8.92	21.03
C - 9 Aggregate Processing	m^3	3.37	2.44	5.81
C - 10 Concrete Mixing	m^3	2.19	1.62	3.81
C - 11 Concrete Transportation				
(a) L = 2000 m	m^3	2.21	1.48	3.69
(b) L = 1000 m	m^3	1.57	1.05	2.62
(c) L = 500 m	m^3	1.25	0.85	2.10
C - 12 Concrete Placing by 15-t Truck Crane and Curing	m^3	3.53	4.19	7.79
C - 13 Concrete Placing by Man-Power & Curing	m^3	-	3.44	3.44
C - 14 Concrete for Dam	m^3	30.73	23.26	53.99
C - 15 Concrete Mixing, Transportation & Placing for Dam	m^3	5.88	5.20	11.08
C - 16 Concrete for Tunnel Lining	m^3	45.05	33.05	78.10
C - 17 Concrete Transportation, Placing & Curing for Tunnel	m^3	10.37	10.34	20.71
C - 18 Form	m^3	1.48	9.09	10.57
C - 19 Production of Form	10 m^2	1.06	51.66	52.72

D. Steel Works

	Unit	F.C ($)	L.C ($)	Total ($)
D - 1 Reinforcement Bar	ton	475.42	218.87	694.29
D - 2 Steel Support	ton	803.82	553.45	1,357.27

(to be continued)

TABLE XII 3-1 UNIT PRICE FOR CONSTRUCTION COST (4)

E. Others

		Unit	F.C ($)	L.C ($)	Total ($)
E - 1	Clearing, Grubbing, Stripping	m^2	0.38	0.43	0.81
E - 2	Sod Facing	m^2	-	3.11	3.11
E - 3	R.C Pipe				
	(a) 1 m	m	1.16	55.43	56.59
	(b) 0.6 m	m	0.77	36.95	37.72
	(c) 0.4 m	m	0.29	13.86	14.15
	(d) 0.2 m	m	0.19	9.24	9.43
E - 4	Steel Sheet Pile	m	40.33	12.40	52.73
E - 5	Wet Rubble Massony	m^2	7.78	7.17	14.95
E - 6	Gabion, Mattress	m	14.05	6.25	20.30
E - 7	Gabion, Cylinder	m	4.87	3.87	8.74
E - 8	Wooden Pile	m	0.87	8.19	9.06
E - 9	Cow Groyne				
	(a) Large	set	393.00	423.45	816.45
	(b) Medium	set	322.47	338.68	661.15
	(c) Small	set	76.50	103.03	179.53
E -10	Rubber dam (3 m x 7 m)	set	660,000	100,000	760,000

F. Hydromechanical Equipment

	Unit	F.C ($)	L.C ($)	Total ($)
1. Diversion Gate	ton	4,000	400	4,400
2. Intake Gate	ton	5,000	500	5,500
3. Tailrace Gate	ton	4,000	400	4,400
4. Spillway Gate	ton	4,500	450	4,950
5. Intake Screen	ton	3,0002	300	3,300

TABLE XII 3-1 UNIT COST FOR CONSTRUCTION COST (5)

		Unit	F.C ($)	L.C ($)	Total ($)
6.	Penstock Steel Pipe	ton	2,500	250	2,750
7.	Butterfly Valve	ton	5,500	550	6,050
8.	Steel Lining in Tunnel	ton	2,000	200	2,200

Note, Exchange rate: 1 US$ = ¥ 234

TABLE XII 3-2 LABOR RATES

	Description	Unit	Cost (₱)	Equivalent ($)
1.	Foreman	md	76	4.22
2.	Common Labor	md	35	1.94
3.	Operator			
	Operator	md	63	3.50
	Assistant Operator	md	45	2.50
4.	Mechanic			
	Mechanic	md	63	3.50
	Assistant Mechanic	md	45	2.50
5.	Welder	md	55	3.06
6.	Electrician	md	63	3.50
7.	Driver	md	45	2.50
8.	Skilled Labor	md	51	2.83
9.	Dredger Master	md	90	5.00
10.	Dredging Crew	md	60	3.33

Note, Exchange rate: 1 US$ ≒ ¥234

TABLE XII 3-3 UNIT PRICE OF MATERIAL (1)

Unit: US$
(1 US$ = 18P = 234 ¥)

Description	Unit	Price	COMPONENT Foreign %	Foreign Price	Local %	Local Price
1. Fuel and Lubricant						
Gasoline	l	0.46	60	0.28	40	0.18
Diesel	l	0.35	60	0.21	40	0.14
Motor Oil	l	1.22	60	0.73	40	0.49
Gear Oil	l	1.47	60	0.88	40	0.59
Grease	kg	0.87	60	0.52	40	0.35
2. Reinforcing Steel Bar	kg	0.47	75	0.35	25	0.12
3. Portland Cement	ton	72.22	65	46.94	35	25.28
4. Aggregate and Sand						
River Run (non screened)	m^3	5.56	0	-	100	5.56
River Run (screened)	m^3	8.89	35	3.11	65	5.78
Sand	m^3	6.11	0	-	100	6.11
Boulder (20-30 cm)	m^3	6.67	0	-	100	6.67
5. Wood						
Coconut Trunk	no	2.78	0	-	100	2.78
Plywood 1/4 x 4' x 8'	pcs	4.17	0	-	100	4.17
Timber, Squer	6 foot	0.33	0	-	100	0.33
Bamboo	pcs	2.22	0	-	100	2.22
6. Concrete Product						
R.C Pipe 1 m	L.M	33.33	0	-	100	33.33
R.C Pipe 0.6 m	L.M	22.22	0	-	100	22.22
R.C Pipe 0.4 m	L.M	8.33	0	-	100	8.33
R.C Pipe 0.2 m	L.M	5.56	0	-	100	5.56
7. Electric Power	KWH	0.11	60	0.07	40	0.04

(to be continued)

TABLE XII 3-3 UNIT PRICE OF MATERIAL (2)

Unit: US$
(1 US$ = 18P = 234 ¥)

Description	Unit	Price	COMPONENT			
			Foreign		Local	
			%	Price	%	Price
8. Blasting						
Dynamite	kg	5.18	50	2.59	50	2.59
Detonator	pc	1.50	50	0.75	50	0.75
AN - FO Powder	kg	2.14	50	1.07	50	1.07
9. Bit and Rod						
Cross Bit 34	pc	35.19	85	29.91	15	5.28
Cross Bit 65	pc	140.78	85	119.66	15	21.12
Rod 22 L = 1.7 m	pc	45.25	85	38.46	15	6.79
Rod for Crawler Drill	pc	145.90	85	123.93	15	21.87
Pick Steel	pc	10.06	85	8.55	15	1.51
10. Steel Material						
Steel Plate	t	467.96	80	374.36	20	93.60
H Shape Steel	t	532.05	80	425.64	20	106.41
Steel Pipe Piles	t	705.13	80	564.10	20	147.44
Sheet Pile	t	705.13	80	564.10	20	141.03
11. Metal Form & Access						
Metal Form 300 x 1500	pc	15.08	85	12.82	15	2.26
Form Tie	pc	0.25	85	0.21	15	0.04
Separator	pc	0.33	85	0.28	15	0.05
Pipe Support	pc	17.60	85	14.96	15	2.64
Cone	pc	0.22	85	0.19	15	0.03
Washer	pc	0.15	85	0.13	15	0.02
12. P.V.C Water Stop	m	11.56	85	9.83	15	1.73

(to be continued)

TABLE XII 3-3 UNIT PRICE OF MATERIAL (3)

Unit: US$
(1 US$ = 18P = 234 ¥)

Description	Unit	Price	COMPONENT			
			Foreign		Local	
			%	Price	%	Price
13. Others						
Barbed Wire	kg	0.75	70	0.53	30	0.22
Nail	kg	1.06	70	0.74	30	0.32
Machine Bolt & Nut	kg	0.89	70	0.62	30	0.27
Welding Rod	kg	2.11	70	1.48	30	0.63
Tire 8.25 - 20 - 14	pc	144.38	50	72.19	50	72.19
Tire 9.00 - 20 - 14	pc	212.39	50	106.19	50	106.19
Tire 11.00 - 20 - 14	pc	247.73	50	123.86	50	123.86

TABLE XII 3-4 HOURLY / DAILY EQUIPMENT COST (in US$) (1)

Item	Description		Purchase Cost			Life Time	Rate			Depreciation			Repairing			Administration		Total Hourly / Daily Equipment Cost	
			F.C	L.C	Total		Depreciation	Repairing	Administration	Rate	F.C	L.C	Rate	F.C	L.C	Rate	L.C	F.C	L.C
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	/1	/2	/3	/4	/5	/6	/7	/8	/9	/10
1	Bulldozer	32-t	155,747	38,937	194,684	6,900	90	90	42	0.013	20.25	5.06	0.013	17.72	3.80	0.006	11.68	37.97	20.54
2	Bulldozer w/ripper	32-t	176,172	44,043	220,215	6,900	90	110	42	0.013	22.90	5.73	0.016	24.66	5.29	0.006	13.21	47.56	24.23
3	Bulldozer	21-t	104,556	26,139	130,695	6,000	90	75	42	0.015	15.68	4.92	0.0125	11.44	2.45	0.007	9.15	27.12	15.52
4	Bulldozer w/ripper	21-t	116,111	29,028	145,139	6,000	90	80	42	0.015	17.42	4.35	0.0133	13.51	2.90	0.007	10.16	30.93	17.41
5	Bulldozer	11-t	51,811	12,953	64,764	6,000	90	75	42	0.015	7.77	1.94	0.0125	5.67	1.21	0.007	4.53	13.44	7.68
6	Swamp Bulldozer	13-t	59,974	14,994	74,968	6,000	90	80	42	0.015	9.00	2.23	0.0133	6.98	1.50	0.007	5.25	15.98	9.00
7	Back Hoe	0.6-m^3	78,579	19,645	98,224	6,500	90	65	35	0.0138	10.84	2.71	0.01	6.88	1.47	0.0054	5.30	17.72	9.48
8	Tractor Shovel	2.2-m^3	88,313	22,078	110,391	6,600	90	80	42	0.0136	12.01	3.03	0.0121	9.35	2.00	0.0064	7.07	21.36	12.07
9	Dump Truck	10-t	39,899	9,975	49,874	6,600	90	70	40	0.0136	5.43	1.36	0.0106	3.70	0.79	0.0061	3.04	9.13	5.19
10	Dump Truck	6-t	27,073	6,768	33,841	6,000	90	70	40	0.015	4.06	1.02	0.0117	2.77	0.59	0.0067	2.27	6.83	3.88
11	Flat Bed Truck	6-t	18,111	4,528	22,639	5,400	90	65	40	0.0167	3.02	0.76	0.0120	1.90	0.41	0.0120	1.68	4.92	2.85
12	Motor Grader	3.7-m	68,823	17,206	86,029	5,400	90	60	42	0.0167	11.49	2.87	0.0111	6.68	1.43	0.0078	6.71	18.17	11.01
13	Road Roller	10-t	27,922	6,981	34,903	5,600	90	60	49	0.0161	4.50	1.12	0.0107	2.61	0.56	0.0083	3.07	7.11	5.39
14	Pneumatic Roller	8-t	33,048	8,262	41,310	5,600	90	60	49	0.0161	5.32	1.33	0.0107	3.09	0.66	0.0088	3.64	8.41	5.63
15	Soil Compactor	17-t	128,990	32,248	161,238	6,650	90	75	49	0.0135	17.41	4.35	0.0113	12.75	2.73	0.0074	11.93	30.16	19.01
16	Vibratory Roller	3-t	16,446	4,112	20,558	3,900	90	55	42	0.0231	3.80	9.50	0.0141	2.03	0.43	0.0103	2.22	5.83	15.76
17	Vibratory Roller	0.6-t	5,655	1,414	7,069	3,250	90	55	25	0.0277	1.57	3.92	0.0169	0.84	0.18	0.0077	0.54	2.41	6.51
18	Tamper	80-Kg	1,054	264	1,318	375	90	50	15	0.24	2.53	0.63	0.1333	1.23	0.26	0.04	0.53	3.76	1.42
19	Track Crane	30-t	165,742	41,436	207,178	7,700	90	45	49	0.0117	19.39	4.85	0.0058	8.41	1.80	0.0061	13.26	27.80	19.91
20	Track Crane	20-t	110,695	27,674	138,369	7,700	90	45	49	0.0117	12.95	3.24	0.0058	5.62	1.20	0.0061	8.86	18.57	13.30
21	Track Crane	15-t	97,980	24,495	122,475	7,700	90	45	49	0.0117	11.46	2.87	0.0058	4.97	1.27	0.0064	7.84	16.43	11.78
22	Water Tanker		26,717	6,679	33,396	5,500	90	60	35	0.0164	4.30	1.10	0.0109	2.55	0.55	0.0064	2.14	6.93	3.79
23	Agitator Car	3-m^3	31,818	7,995	39,773	5,000	90	55	35	0.018	5.73	1.43	0.011	3.06	0.66	0.007	2.78	8.79	4.87
24	Concrete Pump	8"	113,535	28,384	141,919	4,800	90	80	28	0.0188	21.34	5.34	0.0167	16.59	3.56	0.0058	8.23	37.93	17.13
25	Concrete Vibrator	34 ϕ	484	121	605	360[d]	90	40	15	0.25	1.21	0.30	0.1111	0.47	0.10	0.0417	0.25	1.68	0.65
26	Concrete Vibrator	80 ϕ	599	150	749	360[d]	90	40	15	0.25	1.50	0.38	0.1111	0.58	0.12	0.0417	0.31	2.08	0.81
27	Air Compressor	17-m^3/min	32,700	8,175	40,875	720[d]	90	60	30	0.125	40.86	10.22	0.0833	23.83	5.11	0.0417	17.04	64.71	32.37
28	Air Compressor	10.5-m^3/min	23,283	5,821	29,104	720[d]	90	60	30	0.125	29.10	7.28	0.0833	16.97	3.64	0.0417	12.14	46.07	23.06
29	Leg Hammer		1,013	253	1,266	260[d]	90	25	10	0.346	3.50	0.88	0.0962	0.85	0.18	0.0385	0.49	4.35	1.55
30	Crawler Drill	3"	33,687	8,422	42,109	3,400	90	45	28	0.0265	8.93	2.23	0.0132	3.89	0.83	0.0082	3.45	12.82	6.51

(to be continued)

TABLE XII 3-5 PURCHASE COST OF CONSTRUCTION EQUIPMENT (in US$) (2)

Item	Description		Specification M/T	W/T	HP	F.O.B (F)	Freight(F)	Insurance	C.I.F (F)	Landing & Delivery Cost (L)	Delivered Cost F.C	L.C	Total	Remarks
(a)	(b)		(c)	(d)	(e)	(f)	/1	/2	/3	/4	(k)=/3	(l)=/4	(m)=(k)+(l)	
31	Submersible Pump 30 m	6"	0.7	0.3	22.0	2,600	60	27	2,687	672	2,687	672	3,359	
32	Submersible Pump 20 m	4"	0.5	0.09	7.5	1,200	43	13	1,256	314	1,256	314	1,570	
33	Submersible Pump 15 m	2"	0.3	0.029	1.5	450	26	5	481	120	481	120	601	
34	Belt Conveyor	7-m	1.5	0.21	3.5	810	128	9	947	237	947	237	1,184	
35	Concrete Mixer	$0.2\text{-}m^3$	5.0	0.59	3.7	1,750	425	22	2,197	549	2,197	549	2,746	
36	Concrete Cart	$0.1\text{-}m^3$	1.0	0.015	-	130	85	2	217	54	217	54	271	
37	Winch	4-t	2.0	3.1	37.0	9,000	170	93	9,263	2,316	9,263	2,316	11,579	
38	Dredger	1,400-HP	1,300		1,400	2,529,000	110,500	26,673	2,667,071	666,768	2,667,071	666,768	3,333,839	
39	Dredger	600-HP	800		600	1,209,400	68,000	12,900	1,290,300	322,575	1,290,300	322,575	1,612,875	
40	Anchor Barge		50	10	60	53,400	4,250	582	58,252	14,558	58,232	14,558	72,790	
41	Chain Saw	500-mm	0.5	0.006	60^{cc}	750	43	8	801	200	801	200	1,001	
42	Crushing Plant	60-t/h	800	200	200	359,000	68,000	4,313	431,313	107,828	431,313	107,828	539,141	
43	Batcher Plant	$30\text{-}m^3/h$	350	50	75	213,700	2,975	2,189	218,864	54,716	218,864	54,716	273,580	
44	Diesel Pile Hammer	2.5-t	85	57.6	102	183,333	7,225	1,925	192,483	48,121	192,483	48,121	240,604	
45	Cable Crane	9-t	1,200	193	480^{kW}	1,196,600	102,000	13,117	1,311,717	327,929	1,311,717	327,929	1,639,646	
46	Batcher Plant	$3\text{-}m^3$	550	122	80^{kW}	297,900	46,750	3,481	348,131	87,033	348,131	87,033	435,164	
47	Transfer Car	$3\text{-}m^3$	80	10	20^{kW}	82,100	6,800	898	89,798	22,450	89,798	22,450	112,248	

Remarks: /1 (g) = (c) x $85

/2 (h) = (f) + (g) / 99

/3 (i) = (f) + (g) + (h)

/4 (j) = (i) x 0.25

TABLE XII 3-5 PURCHASE COST OF CONSTRUCTION EQUIPMENT (in US$) (1)

Item	Description		Specification M/T	Specification W/T	Specification HP	F.O.B (F)	Freight(F)	Insurance	C.I.F (F)	Landing & Delivery Cost (L)	Delivered Cost F.C	Delivered Cost L.C	Delivered Cost Total	Remarks
(a)	(b)		(c)	(d)	(e)	(f)	/1	/2	/3	/4	(k)=/3	(l)=/4	(m)=(k)+(l)	
1	Bulldozer	32-t	54	33.5	319	149,600	4,590	1,557	155,747	38,937	155,747	38,937	194,684	
2	Bulldozer w/ripper	32-t	66	38.6	319	168,800	5,610	1,762	176,172	44,043	176,172	14,043	220,215	
3	Bulldozer	21-t	46	22.1	211	99,600	3,910	1,046	104,556	26,139	104,556	26,139	130,695	
4	Bulldozer w/ripper	21-t	50	25.0	211	110,700	4,250	1,161	116,111	29,028	116,111	29,028	145,139	
5	Bulldozer	11-t	30.5	11.9	108	48,700	2,593	518	51,811	12,953	51,811	12,953	64,764	
6	Swamp Bulldozer	13-t	35	13.7	112	56,400	2,975	599	59,974	14,994	59,974	14,994	74,968	
7	Back Hoe	$0.6\text{-}m^3$	70.5	18.7	108	71,800	5,993	786	78,579	19,645	78,579	19,645	98,224	
8	Tractor Shovel	$2.2\text{-}m^3$	38	21.4	200	84,200	3,230	883	88,313	22,078	88,313	22,078	110,391	
9	Dump Truck	10-t	60	9.3	314	34,400	5,100	399	39,899	9,975	39,899	9,975	49,874	
10	Dump Truck	6-t	41.2	7.0	242	23,300	3,502	271	27,073	6,768	27,073	6,768	33,841	
11	Flat Bed Truck	6-t	38	4.4	175	14,700	3,230	181	18,111	4,528	18,111	4,528	22,639	
12	Motor Grader	3.7-m	51	12.0	126	63,800	4,335	688	68,823	17,206	68,823	17,206	86,029	
13	Road Roller	10-t	20.5	8.0	90	25,900	1,743	279	27,922	6,981	27,922	6,981	34,903	
14	Pneumatic Roller	8-t	15.5	8.5	89	31,400	1,318	330	33,048	8,262	33,048	8,262	11,310	
15	Soil Compactor	17-t	60	17.7	172	122,600	5,100	1,290	128,990	32,248	128,990	32,248	161,238	
16	Vibratory Roller	3-t	9.2	3.7	22.6	15,500	787	164	16,446	4,112	16,446	4,112	20,558	
17	Vibratory Roller	0.6-t	3.5	0.6	6.0	5,300	298	57	5,655	1,414	5,655	1,414	7,069	
18	Tamper	80-kg	0.5	0.08	5.0	1,000	43	11	1,054	264	1,054	264	1,318	
19	Truck Crane	30-t	121	34.4	300	153,800	10,285	1,657	165,742	41,436	165,742	41,436	207,178	
20	Truck Crane	20-t	97.5	22.0	230	101,300	8,288	1,107	110,695	27,674	110,695	27,674	138,369	
21	Truck Crane	15-t	80	19.8	230	90,200	6,800	980	97,980	24,495	97,980	24,495	122,475	
22	Water Tanker		50	11.0	160	22,200	4,250	267	26,717	6,679	26,717	6,679	33,396	
23	Agitator Car	$3\text{-}m^3$	60	7.4	220	26,400	5,100	318	31,818	7,955	31,818	7,955	39,773	
24	Concrete Pump	8"	80	14.7	200	105,600	6,800	1,135	113,535	28,384	113,535	28,384	141,919	
25	Concrete Vibrator	34 ∅	0.1	0.04	-	470	9	5	484	121	484	121	605	
26	Concrete Vibrator	80 ∅	0.15	0.036	-	580	13	6	599	150	599	150	749	
27	Air Compressor	$17\text{-}m^3/min$	17.5	4.1	177	30,900	1,488	312	32,700	8,175	8,175	8,175	40,875	
28	Air Compressor	$10.5\text{-}m^3/min$	30	2.3	116	20,500	2,550	233	23,283	5,821	23,283	5,821	79,104	
29	Leg Hammer	30-kg	0.5	0.031	-	960	43	10	1,013	253	1,013	253	1,266	
30	Crawler Drill ($10\ m^3$)	3"	30	4.5	-	30,800	2,550	337	33,687	8,422	33,687	8,422	42,109	

(to be continued)

TABLE XII 3-4 HOURLY / DAILY EQUIPMENT COST (in US$) (2)

Item	Description		Purchase Cost F.C	Purchase Cost L.C	Purchase Cost Total	Life Time	Rate Depreciation	Rate Repairing	Rate Administration	Depreciation Rate	Depreciation F.C	Depreciation L.C	Repairing Rate	Repairing F.C	Repairing L.C	Administration Rate	Administration L.C	Total Hourly / Daily Equipment Cost F.C	Total Hourly / Daily Equipment Cost L.C
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	/1	/2	/3	/4	/5	/6	/7	/8	/9	/10
31	Submersible Pump	6"	2,687	672	3,359	600d	90	110	25	0.15	4.03	1.01	0.1833	4.31	0.92	0.0417	1.40	8.32	3.33
32	Submersible Pump	4"	1,256	314	1,560	600d	90	110	25	0.15	1.88	0.47	0.1833	2.10	0.43	0.0417	0.65	3.89	1.55
33	Submersible Pump	2"	481	120	601	600d	90	100	25	0.15	0.74	0.18	0.1833	0.77	0.17	0.0417	0.25	1.49	0.60
34	Belt Conveyor	7-m	947	237	1,184	180d	90	60	75	0.5	4.74	1.19	0.3333	2.76	0.59	0.0417	0.49	7.50	2.27
35	Concrete Mixer	0.2-m^3	2,197	549	2,746	600d	90	70	25	0.15	3.30	0.82	0.1167	2.24	0.48	0.0417	1.15	5.54	2.45
36	Concrete Cart	0.1-m^3	217	54	271														
37	Winch		9,263	2,316	11,579	1,040d	90	120	40	0.0865	8.01	2.00	0.1154	9.35	2.00	0.0385	4.46	17.36	8.46
38	Dredger	1,400-HP	2,667,071	666,768	3,333,839	21,420	90	85	49	0.0042	112.02	26.00	0.0040	93.35	20.00	0.0023	76.68	205.37	127.68
39	Dredger	600-HP	1,290,300	322,575	1,612,875	17,640	90	65	49	0.0051	65.81	16.45	0.0037	41.77	8.95	0.0037	59.68	107.58	85.08
40	Anchor Barge		58,232	14,558	77,790	22,400	90	125	70	0.0040	2.33	0.58	0.0056	3.05	0.65	0.0031	2.41	5.38	3.64
41	Chain Saw	500-mm	801	200	1,001	360d	90	85	20	0.25	2.00	0.50	0.2361	1.65	0.35	0.0556	0.56	3.65	1.41
42	Crushing Plant	60-t/h	431,313	107,828	539,141	9,000	90	55	44	0.01	43.13	10.78	0.0061	23.02	4.93	0.0049	26.04	66.15	41.75
43	Batcher Plant	30-m^3/h	218,864	54,716	273,580	7,000	90	70	49	0.0129	28.23	7.01	0.01	19.15	4.10	0.007	19.15	47.38	30.31
44	Diesel Hammer	2.5-t	192,483	48,121	240,604	5,250	90	60	35	0.0171	32.91	8.23	0.0114	19.20	4.11	0.0067	16.12	52.11	28.46
45	Cable Crane	9-t	1,311,717	327,929	1,639,646	11,600	90	40	49	0.0078	102.31	25.58	0.0034	39.02	8.36	0.0042	68.87	141.33	102.81
46	Batcher Plant	50-m^3/h	348,131	87,033	435,164	13,000	90	75	49	0.0069	24.02	6.01	0.0058	17.67	3.79	0.0038	16.54	41.69	26.34
47	Transfer Car	3-m^3	89,798	22,450	112,248	12,000	90	70	35	0.0075	6.73	1.68	0.0058	4.56	0.98	0.0029	3.26	11.29	5.92

Remarks:
/1 (10) = (7) / (6)
/2 (11) = (10) x (5)
/3 (12) = (10) x (4)
/4 (13) = (8) / (6)
/5 (14) = (13) x 0.7 x (5)
/6 (15) = (13) x 0.15 x (5)
/7 (16) = (9) / (6)
/8 (17) = (16) x (5)
/9 (18) = (11) + (4)
/10 (19) = (12) + (15) + (19)

TABLE XII 4-1 HOURLY PRODUCTION RATE OF CONSTRUCTION EQUIPMENT

(1) Bulldozer

Excavating Work

$$Q = \frac{60 \times q \times F \times E}{Cm}$$

where:

Q = Hourly production (m^3/h)
q = Blade capacity (m^3)
F = Swell factor of material
E = Operating efficiency
Cm = Cycle time (min.)

$$Cm = \frac{L}{V1} + \frac{L}{V2} + tg$$

L = Hauling distance (m)
V1 = Forward speed (m/min)
V2 = Reverse speed (m/min)
tg = Gear change and others

32 ton Bulldozer

Work	q	F	E	L	V1	V2	tg	Cm	Q
Fine	6.94	0.80	0.70	20	42	58	0.33	1.15	203
Coarse	6.94	0.87	0.60	20	42	58	0.33	1.15	189
Rock	6.94	0.63	0.35	20	42	58	0.33	1.15	80

21 ton Bulldozer

Work	q	F	E	L	V1	V2	tg	Cm	Q
Fine	3.19	0.80	0.70	20	42	58	0.33	1.15	94
Coarse	3.19	0.87	0.60	20	42	58	0.33	1.15	87
Rock	3.19	0.63	0.35	20	42	58	0.33	1.15	37

11 ton Bulldozer

Work	q	F	E	L	V1	V2	tg	Cm	Q
Fine	1.63	0.80	0.7	20	42	58	0.33	1.15	48
Coarse	1.63	0.87	0.6	20	42	58	0.33	1.15	44

Spreading Work

$$Q = \frac{W \times V \times D \times F \times E}{N}$$

where:

- Q = Hourly production (m^3/h)
- W = Effective spreading width (m)
- V = Operating speed (m/hr)
- D = Spreading depth (m)
- F = Swell factor of material
- E = Operating efficiency
- N = Number of spreading

21 ton Bulldozer

Work	W	V	D	F	E	N	Q
Fine	3.96	1,700	0.3	0.80	0.60	5	194
Coarse	3.96	1,700	0.3	0.87	0.55	5	193
Rock	3.96	1,700	0.3	0.63	0.50	5	127

11 ton Bulldozer

Work	W	V	D	F	E	N	Q
Fine	3.05	1,700	0.3	0.80	0.6	5	150
Coarse	3.05	1,700	0.3	0.87	0.55	5	149

13-t Swamp full

Work	W	V	D	F	E	N	Q
Fine	3.50	1,200	0.2	0.80	0.4	3	90

Compacting Work

$$Q = \frac{W \times V \times D \times F \times E}{N}$$

Where:

- Q = Hourly production (m^3/h)
- W = Effective compacting width (m)
- V = Compacting speed (m/h)
- D = Compacted depth (m)
- F = Swell factor of material
- E = Operating efficiency

21 ton Bulldozer

Work	W	V	D	F	E	N	Q
Fine	0.8	4,000	0.3	0.8	0.6	6	77
Coarse	0.8	4,000	0.3	0.87	0.6	6	84

11 ton Bulldozer

Work	W	V	D	F	E	N	Q
Fine	0.6	4,000	0.3	0.80	0.6	6	58
Coarse	0.6	4,000	0.3	0.87	0.6	6	63

(2) Loader

$$Q = \frac{3,600 \times q \times K \times F \times E}{Cms}$$

Where:

Q = Hourly production (m^3/h)
q = Bucket capacity (m^3)
K = Bucket coefficiency
F = Swell factor of material
E = Operating efficiency
Cms= Cycle time (sec)

0.7 m^3 Back hoe

Work	q	K	F	E	Cms	Q
Fine	0.7	0.85	0.80	0.7	21	57
Coarse	0.7	0.80	0.87	0.7	21	58
Rock	0.7	0.75	0.63	0.7	21	40

2.2 m^3 Tractor Shovel

Work	q	K	F	E	Cms	Q
Fine	2.2	1.0	0.80	0.7	42	106
Coarse	2.2	0.7	0.87	0.7	42	80
Rock	2.2	0.5	0.63	0.7	42	42

1.4 m^3 Tractor Shovel

Work	q	K	F	E	Cms	Q
Fine	1.4	1.0	0.80	0.7	42	67
Coarse	1.4	0.7	0.87	0.7	42	51
Rock	1.4	0.5	0.63	0.7	42	26

6 m^3 Wheel Loader

Work	q	K	F	E	Cms	Q
Fine	6.0	1.0	0.80	0.7	36	336
Coarse	6.0	0.7	0.87	0.7	36	256
Rock	6.0	0.5	0.63	0.7	36	132

3.5 m^3 Wheel Loader

Work	q	K	F	E	Cms	Q
Fine	3.5	1.0	0.80	0.7	36	196
Coarse	3.5	0.7	0.87	0.7	36	149
Rock	3.5	0.5	0.63	0.7	36	77

2.1 m^3 Wheel Loader

Work	q	K	F	E	Cms	Q
Fine	2.1	1.0	0.80	0.7	36	118
Coarse	2.1	0.7	0.87	0.7	36	90
Rock	2.1	0.5	0.63	0.7	36	46

(3) Dump Truck

$$Q = \frac{60 \times C \times F \times Et}{Cmt}$$

Where:

Q = Hourly production (m^3/h)

C = Vessel capacity (m^3)

F = Swell factor of material

Et = Operating efficiency of dump truck

Cmt= Cycle time of dump truck (min)

$$Cmt = \frac{Cms \times n}{60 \times Es} + \frac{D}{V1} + \frac{D}{V2} + t1 + t2$$

Cms = Cycle time of loader (min)

n = Number of loading

$$n = \frac{C}{q \times k}$$

q = Bucket capacity of loader (m^3)

K = Bucket coefficient

Es = Operating efficiency of loader

D = Hauling distance (m)

V1 = Travel speed with load (m/min)

V2 = Travel speed without load (m/min)

t1 = Unloading time (min)

t2 = Waiting, setting and others (min)

15 ton Dump truck

Work	C	F	Et	Cmt	Cms	n	q	K	Es	D	V1	V2	t1	t2	Q
5,000 m (Aggregate)															
Coarse	9.0	0.87	0.9	27.2	36	4.3	3.5	0.6	0.7	5,000	417	500	1.0	0.5	16
Rock	9.0	0.63	0.9	27.9	36	5.1	3.5	0.5	0.7	5,000	417	500	1.0	0.5	11
2,000 m (Dam Excavation)															
Fine	9.0	0.80	0.9	18.0	36	2.9	3.5	0.9	0.7	2,000	250	333	1.0	0.5	22
Coarse	9.0	0.87	0.9	19.2	36	4.3	3.5	0.6	0.7	2,000	250	333	1.0	0.5	22
Rock	9.0	0.63	0.9	19.9	36	5.1	3.5	0.5	0.7	2,000	250	333	1.0	0.5	15
1,000 m (Others)															
Fine	9.0	0.80	0.9	11.0	36	2.9	3.5	0.9	0.7	1,000	250	333	1.0	0.5	35
Coarse	9.0	0.87	0.9	12.2	36	4.3	3.5	0.6	0.7	1,000	250	333	1.0	0.5	35
Rock	9.0	0.63	0.9	12.9	36	5.1	3.5	0.5	0.7	1,000	250	333	1.0	0.5	24

32 t Dump truck

Work	C	F	Et	Cmt	Cms	n	q	K	Es	D	V1	V2	t1	t2	Q
5,000 m (Quarry)															
Coarse	18.0	0.87	0.9	27.8	36	5	6.0	0.6	0.7	5,000	417	333	1.0	0.5	30
Rock	18.0	0.63	0.9	28.6	36	6	6.0	0.5	0.7	5,000	417	333	1.0	0.5	21
2,000 m (Spillway)															
Coarse	18.0	0.87	0.9	19.8	36	5	6.0	0.6	0.7	2,000	250	333	1.0	0.5	43
Rock	18.0	0.63	0.9	20.6	36	6	6.0	0.5	0.7	2,000	250	333	1.0	0.5	30

10 ton Dump truck

Work	C	F	Et	Cmt	Cms	n	q	K	Es	D	V1	V2	t1	t2	Q
2,000 m															
Fine	5.6	0.80	0.9	17.9	36	2.8	2.1	0.9	0.7	2,000	250	333	1.0	0.5	14
Coarse	4.5	0.87	0.9	19.1	36	4.2	2.1	0.6	0.7	2,000	250	333	1.0	0.5	11
Rock	4.0	0.63	0.9	19.8 (29.1)	36	5.0 (5.0)	2.1	0.5	0.7	2,000	250 (150)	333 (200)	1.0	0.5	7 (6.2)
1,000 m															
Fine	5.6	0.80	0.9	10.9	36	2.8	2.1	0.9	0.7	1,000	250	333	1.0	0.5	22
Coarse	4.5	0.87	0.9	12.1	36	4.2	2.1	0.6	0.7	1,000	250	333	1.0	0.5	18
Rock	4.0	0.63	0.9	12.8	36	5.0	2.1	0.5	0.7	1,000	250	333	1.0	0.5	11
500 m															
Fine	5.6	0.80	0.9	7.4	36	2.8	2.1	0.9	0.7	500	250	333	1.0	0.5	33
Coarse	4.5	0.87	0.9	8.6	36	4.2	2.1	0.6	0.7	500	250	333	1.0	0.5	25
Rock	4.0	0.63	0.9	9.3	36	5.0	2.1	0.5	0.7	500	250	333	1.0	0.5	14
250 m															
Fine	5.6	0.80	0.9	5.7	36	2.8	2.1	0.9	0.7	250	250	333	1.0	0.5	42
Coarse	4.5	0.87	0.9	6.9	36	4.2	2.1	0.6	0.7	250	250	333	1.0	0.5	31
Rock	4.0	0.63	0.9	7.6	36	5.0	2.1	0.5	0.7	250	250	333	1.0	0.5	18
5,000 m															
Rock	4.0	0.63	0.9	35.0	36	5.6	2.1	0.5	0.7	5,000	300	400	1.0	0.5	4

Note: Figures in parentheses show the travelling in tunnel

6 ton Dump truck

Work	C	F	Et	Cmt	Cms	n	q	K	Es	D	V1	V2	t1	t2	Q
2,000 m															
Fine	3.3	0.80	0.9	18.7	42	3.2	1.4	0.9	0.7	2,000	250	333	1.0	0.5	7
Coarse	2.7	0.87	0.9	20.3	42	4.8	1.4	0.6	0.7	2,000	250	333	1.0	0.5	6
Rock	2.4	0.63	0.9	21.2	42	5.7	1.4	0.5	0.7	2,000	250	333	1.0	0.5	3.6
1,000 m															
Fine	3.3	0.80	0.9	11.7	42	3.2	1.4	0.9	0.7	1,000	250	333	1.0	0.5	12
Coarse	2.7	0.87	0.9	13.3	42	4.8	1.4	0.6	0.7	1,000	250	333	1.0	0.5	9
Rock	2.4	0.63	0.9	14.2	42	5.7	1.4	0.5	0.7	1,000	250	333	1.0	0.5	6
500 m															
Fine	3.3	0.80	0.9	8.2	42	3.2	1.4	0.9	0.7	500	250	333	1.0	0.5	17
Coarse	2.7	0.87	0.9	9.8	42	4.8	1.4	0.6	0.7	500	250	333	1.0	0.5	13
Rock	2.4	0.63	0.9	10.7	42	5.7	1.4	0.5	0.7	500	250	333	1.0	0.5	7.8
250 m															
Fine	3.3	0.80	0.9	6.5	42	3.2	1.4	0.9	0.7	250	250	333	1.0	0.5	22
Coarse	2.7	0.87	0.9	8.1	42	4.8	1.4	0.6	0.7	250	250	333	1.0	0.5	16
Rock	2.4	0.63	0.9	9.0	42	5.7	1.4	0.5	0.7	250	250	333	1.0	0.5	9

(4) Motor grader

$$Q = \frac{60 \times W \times L \times D \times F \times E}{N \times Cm}$$

Where:

Q = Hourly production (m^3/h)

W = Width of blade

W = Length of blade x sin θ - 0.3

= 3.7 x Sin 60^0 - 0.3

L = Length of grading (m)

D = Depth of layer (m)

F = Swell factor of material

E = Operating efficiency

N = Number of grading

Cm = Cycle time (min)

$$Cm = \frac{L}{V1} + \frac{L}{V2} + 2t$$

V1 = Forward speed (m/min)

V2 = Reverse speed (m/min)

t = Gear change and others (min)

Work	W	L	D	F	E	N	Cm	V1	V2	t	Q
Fine	2.9	200	0.3	0.80	0.4	3	7.0	66.7	100	1.0	159
Coarse	2.9	200	0.3	0.87	0.4	3	7.0	66.7	100	1.0	173

(5) Compacting Equipment

$$Q = \frac{W \times V \times D \times F \times E}{N}$$

Where:

Q = Hourly production (m^3/h)

W = Width of compaction (m)

Road roller = width of roller - 0.3
Vibrating roller = width of roller - 0.2

V = Operating speed (m/h)

D = Depth of layer (m)

F = Swell factor of material

E = Operating efficiency

N = Number of compaction

17 ton Tamping Roller

Work	W	V	D	F	E	N	Q
Fine	3.5	3,000	0.3	0.8	0.5	6	210

15 ton Vibratory Roller

Work	W	V	D	F	E	N	Q
Coarse	1.79	1,000	0.4	0.87	0.6	6	62
Rock	1.79	1,000	1.5	0.63	0.6	6	169

8/10 ton Road Roller

Work	W	V	D	F	E	N	Q
Fine	1.2	1,500	0.3	0.80	0.6	6	43
Coarse	1.2	1,500	0.3	0.87	0.6	6	47

3.0 ton Vibratory Roller

Work	W	V	D	F	E	N	Q
Fine	0.8	1,500	0.3	0.80	0.6	6	29
Coarse	0.8	1,500	0.3	0.87	0.6	6	31

0.6 ton Vibrating Roller

Work	W	V	D	F	E	N	Q
Fine	0.4	1,300	0.3	0.80	0.6	6	12
Coarse	0.4	1,300	0.3	0.87	0.6	6	14

80 kg Tamper

Work	W	V	D	F	E	N	Q
Fine	0.24	900	0.3	0.80	0.6	6	5
Coarse	0.24	900	0.3	0.87	0.6	6	6

(6) Concrete Mixer

$$Q = \frac{60 \times q \times E}{Cm}$$

Where:

Q = Hourly production (m^3/h)

q = Mixing capacity (m^3)

E = Working efficiency

Cm = Cycle time (min)

0.2 m^3 Mixer

Work	q	E	Cm	Q
Concrete	0.2	0.4	4	1.2

(7) Truck Mixer

$$Q = \frac{60 \times q \times E}{Cm}$$

Where:

Q = Hourly production (m^3/h)

q = Capacity of truck mixer (m^3)

E = Operating efficiency

Cm = Cycle time (min)

$$Cm = t1 + t2 + t3 + \frac{L}{V1} + \frac{L}{V2}$$

$t1$ = Charging time (min)

$t2$ = Discharging time (min)

$t3$ = Waiting and setting (min)

L = Hauling distance

$V1$ = Transporting speed (m/min)

$V2$ = Returning speed (m/min)

3.2 m^3 Truck Mizer

Work	q	E	Cm	t1	t2	t3	L	V1	V2	Q
2,000 m	3.2	0.8	24	3	5	2	2,000	250	333	6.4
1,000 m	3.2	0.8	17	3	5	2	1,000	250	333	9.0
500 m	3.2	0.8	13.5	3	5	2	500	250	333	11.4
250 m	3.2	0.8	11.8	3	5	2	250	250	333	13.0
2,000 m			(33.3)					(150)	(200)	(4.6)

(8) Concrete bucket handled by 30 ton Crane

$$Q = \frac{C \times E \times 60}{Cm}$$

Where:

Q = Hourly production

C = Concrete bucket capacity

E = Operating efficiency

Cm = Cycle time

$Cm = t1 + t2 + t3$

$t1$ = Bucket detaching and attaching

$t2$ = Lifting and setting

$t3$ = Discharging

C	E	t1	t2	t3	Cm	Q
1.0	0.7	2	3	1	6	7
1.5	0.7	2	3	1	6	11

(9) Dredger

150 HP, ∅8", Cutter Suction Dredger

Hourly Dredging Capacity

Discharge distance = (S. Pipe) 400 m + (F.Pipe) 100 m = 500 m

Materials to be dredged = Sand and sandy silt

N - Value = 10

Hourly standard capacity of 1,000 HP dredger = 230 m^3/h

Power conversion ratio from electric to diesel = 0.8

$$Q = \frac{230\ m^3 \times 150\ HP \times 0.8}{1,000\ HP} = 28\ m^3/h$$

400 HP, ∅10" Cutter Suction Dredger

Hourly Dredging Capacity

Discharge distance = (S. Pipe) 400 m + (F. Pipe) 100 m = 500 m

Materials to be dredged = Sand and sandy silt

N - Value = 10

Hourly standard capacity
of 1,000 HP dredge = 230 m^3/h

Power conversion ratio
from electric to diesel = 0.8

$$Q = \frac{230\ m^3 \times 400\ HP \times 0.8}{1,000\ HP} = 74\ m^3/h$$

<u>800 HP, ∅12", Cutter Suction Dredger</u>

Hourly Dredging Capacity

Discharge distance = (S. Pipe) 815 m + (F. Pipe) 150 m = 965 m

Materials to be dredged = Sand and sandy silt

N - Value = 10

Hourly standard capacity
of 1,000 HP dredger = 220 m^3/h

Power conversion ratio
from electric to diesel = 0.8

$$Q = \frac{220\ m^3 \times 800\ HP \times 0.8}{1,000\ HP} = 140.8 \doteq 141\ m^3/h$$

<u>1,100 HP, ∅16" Cutter Suction Dredger</u>

Hourly Dredging Capacity

Discharge Distance = (S. Pipe) 815 m + (F. Pipe) 150 m = 965 m

Material to be dredged = Sand and sandy silt

N - Value = 10

Hourly standard capacity
of 1,000 HP dredger = 220 m^3/h

Power conversion ratio
from electric to diesel = 0.8

$$Q = \frac{220\ m^3 \times 1,100\ HP \times 0.8}{1,000\ HP} = 194\ m^3/h$$

<u>1,400 HP, ∅16" Cutter Suction Dredger</u>

Hourly Dredging Capacity

Discharge Distance = (S. Pipe) 815 m + (F. Pipe) 150 m = 965 m

Materials to be dredged = Sand and sandy silt

N - Value = 10

Hourly standard capacity
of 1,000 HP dredger = 220 m^3/h

Power conversion ratio
from electric to diesel = 0.8

$$Q = \frac{220\ m^3 \times 1{,}400\ HP \times 0.8}{1{,}000\ HP} = 246\ m^3/h$$

APPENDIX XIII

ADDITIONAL SURVEY ON NOV. '84 FLOOD

FOR

FINAL REPORT

ON

THE PANAY RIVER BASIN-WIDE

FLOOD CONTROL STUDY

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1. GENERAL

The additional survey on the flood, caused by the typhoon "Undang" which passed by the Panay river basin in November 1984, was performed by JICA team consisting of 4 members during 20 days from June 3 until June 22, 1985.

The following are the main items of the survey performed in June 1985.

(a) Collection of Meteo-hydrological data
(b) Collection of Flood inundation data
(c) Collection of Flood damage data
(d) Suggestion for meteo-hydrological observation
(e) Discussion on the draft final report

Note; (d) and (e) are carried out in addition to the survey on the Flood. Therefore, the description of these items are omitted in this Appendix XIII.

The first survey on "Undang" flood was performed in November 1984, during and just after the flood, as the JICA study team stationed in the basin at the time. However the first survey was limited in the capacity due to the following.

(a) Most of the engineers have already left the site before the flood.

(b) As most of the hydrological analysis have been finished before the flood and it was impossible to revise the basic conditions/data at the time for preparing the report in time of the schedule.

Therefore, the first survey was performed as follows, taking account of the importance of the records.

(a) The data which need the clear memory of inhabitants in the flooded area were collected at the representative points.

(b) As a visible evidence of the flood, the photographs during the flood were taken.

(c) The records of water level and rainfall at each gaging station were collected and the doubtful and/or unobserved records were checked.

(d) The discharge measurement during the flood was performed at Panitan.

(e) The flood mark survey was performed along the river.

(f) The inundation conditions were observed by going around the area during the flood.

(g) The information about the damage was unofficially obtained though the data were still on the way of compilation by the government agencies.

The extension of the field assignment was once proposed by a JICA expert stationed in MPWH. However, the proposal was cancelled in consideration of the difficulty to change the assignment contract within a short period. Instead, the proposal of additional survey on "Undang" flood was newly given from MPWH in the meeting between JICA and MPWH held in January 1985. MPWH requested JICA to conduct the additional survey for obtaining more accurate fresh data which are available for making more reliable plan based on the analysis. MPWH mentioned to accept some delay of preparing the final report. These are the reason why JICA head office decide to order the additional survey.

The additional survey team could collect the data almost on schedule owing to the cooperation of the authorities and agencies of the philippine government.

In the following sections, described are the data collected during the additional survey.

2. Meteo-Hydrological Data

2.1 General

In regard to the meteo-hydrological data for "Undang" flood, the data of rainfall and stream flow in the Panay river basin were collected during the survey ended in January 1985. During the additional survey performed in June 1985, the following data are additionally collected.

(a) Rainfall data during "Undang" flood at the stations located outside of the Panay river basin but in the Panay island.

(b) Supplemental stream flow and rainfall data in the Panay river basin which could not be collected during the previous survey.

As it is considered to be easy to understand the contents of data collected, the description of meteo-hydrological data are to be done without separating them by the period of survey; the previous survey and the additional survey. Additionally, it is noted that the meteo-hydrological data were collected not only for "Undang" flood but also for "Openg" flood for comparing the both past biggest two flood.

The following are the brief description of the data collected during the additional survey (June 1985) as well as during the last period (Nov. 1984 - Jan. 1985) of the pervious survey.

2.2 Rainfall Record

(1) Rainfall during Flood

The rainfall records during about the time of "Undang" flood in Nov. 1984 and "Openg" flood in Nov. 1973 are collected as listed below.

Station	Undang flood	Openg flood
Capiz Province		
Roxascity	Collected	Collected
Astonga	"	-
Matec	"	-
President Roxas	"	Collected
Mambusao (NIA)	"	-

Station	Undang flood	Openg flood
Aglinab	Collected	-
Brgy Roxas	"	-
Lenrery	"	-
Villa Froreg	"	-
Jamindan	"	-
Iloilo Province		
Iloilo	Collected	Collected
Eotancia	Not yet	"
Aklan Province		
Balete	Collected	Collected
Kalibo	"	"
Libacao	"	"
Antique Province		
Valderama	Not yet	Collected
Barbaza	Collected	"
San Jose	Not yet	"
Culasi	Collected	"
Pandan	"	-

Note; " - " means no record and "Not yet" means that the records are not yet sent to the head office as of June 1985

The daily rainfall records before, during, and after the floods at the stations listed above are shown in Appendix.

(2) Annual Maximum daily rainfall

During the additional survey the annual maximum 7-days and 3-days rainfall records at the stations which have the records of more than 10 years and located outside of the Panay river basin. The records are available for estimating the probable rainfall. The daily rainfall records in the stations located in the Panay river basin are already collected in the survey performed in late 1983. The stations and the period of which records are available for the estimation of probable rainfall are listed below.

Station	Period of Records
Roxas city, Capiz	1949 - 1984
Iloilo, Iloilo	1949 - 1984
Balete, Aklan	1970 - 1984
Kalibo, "	1955 - 1984
Libacao, "	1966 - 1984
Valderama, Antique	1970 - 1984
Barbaza, "	1955 - 1984
Culasi, "	1966 - 1984

Note; Some unobserved periods and some doubtful records are included in the records at the above listed stations, though they are discarded for the analysis.

The records are attached in Appendix I.

2.3 Streamflow Record

(1) Water Level

The water level records during "Undang" flood at the following streamflow gaging stations are collected.

(a) Dumalag, Panay river
(b) Cuartero, "
(c) Panitan, "
(d) Sigma, Mambusao river
(e) Salocon, Lower panay river
(f) Pontevedra, Pontevedra river

Note; The record at Dumarao gaging station could not be obtained as the gage was washed away during the flood.

At most of the above stations, the peak water level was more or less higher than the maximum reading of gages and additionally a gage keeper couldn't continue the observation as his house suffered serious damage due to the strong wind and flood. Therefore, records during the flood peak and unobserved period are supplemented by the following.

(a) Flood marks near the station
(b) Information from the inhabitants and the gage keeper
(c) Records at the time of discharge measurement (for Panitan G.S.)

(2) Discharge Measurement

The discharge measurement at each stream gaging station except Pontevedra G.S. has been performed since the beginning of 1984 after the establishment of gages. However, the number and range of measurement are not sufficient for making the rating curve of water level and discharge at each station. During "Undang" flood, the discharge measurement was performed at Panitan by the study team. This measurement was the first one performed during flood in the Panay river basin. Owing to this measurement, it become possible to prepare the comparatively reliable rating curve at Panitan which is the most important base point for the hydrological analysis.

The records of discharge measurement are attached in Data Book I.

2.4 Other Meteo-Hydrological Data

(1) Tide Water Level

The tide water level fluctuation at Culasi port during flooding period of not only "Undang" typhoon but also "Openg" typhoon was prepared to see the influence of tide water level to the flood water level in the downstream reach, based on the tide tables at Cebu in November 1973 and November 1984 by using the conversion height explained in Appendix I.

(2) Typhoon Records

The typhoon records including the course with time, the atmospheric pressure and the wind velocity at "Openg" typhoon and "Undang" typhoon are collected at PAGASA. The records are attached in Appendix I. It is noted that the course of the two typhoons is quite similar.

3. FLOOD INUNDATION DATA

3.1 Flood Mark Survey

The flood mark survey along the river has been carried out at about 35 points for "Undang" typhoon. First, the flood water level at each representative points were marked in accordance with the mark line remained on a structure and the information from the residents. Then the elevation survey was carried out from a nearest bench mark. The results of survey are attached in Data Book I.

3.2 Inundation Area Survey

The survey in the inundation area was carried out to get the information of "Undang" flood as well as "Openg" flood on the following items.

(a) Inundation area
(b) Inundation water depth
(c) Duration and time of inundation
(d) Flow direction and velocity
(e) Damage

The members of survey team visited almost all the inundation areas in the Panay river basin and got the information at about 300 points. The inhabitants in the flood prone area showed cooperative answers to the questions given by a JICA mumber. At the time of the survey, the elevation of inundation water level is roughly surveyed from the elevation marks on the map of 1/10,000 in scale by using a hand level. These data collected are available for making the flood rish map.

The summary and results of the inundation area survey are shown in in Figs. XIII.3-1 and XIII.3-2 and Table XIII.3-1.

4. FLOOD DAMAGE SURVEY

4.1 Procedure of Damage Survey

4.1.1 Progress of the Field Research

The investigation of the flood caused by the typhoon "Undang" on November 5, 1984 was carried out during 20 days in June 1985. The investigation covered the collection of meteorological data, hydrological data and the damage data by the typhoon. The progress of the collection of the damage data was shown in Table XIII.4-1.

4.1.2 Objects of the Study

(1) Agricultural Damage

(A) Crop Damage Data

(a) MAF (in Manila)
(b) BFAR (in Manila)
(c) MAF (in Iloilo City)
(d) BAECON (in Iloilo City)
(e) NIA (in Iloilo City)
(f) MAF (in Roxas City)
(g) BEACON (in Roxas City)
(h) Sugar Central (in Pilar, Asturia)
(i) NIA (in Provincial Office of NIA, Mambusao)

(B) Livestock Damage Data

(a) MAF (in Iloilo City)
(b) MAF (in Roxas City)

(C) Fisheries Damage Data

(a) BFAR (in Roxas City)
(b) Municipal Mayor's Office (in Panay, Panitan, Pontevedra)

(2) Building and other damage

(A) Comprehensive Damage Data

(a) NEDA (in Manila)
(b) NEDA, Region VI (in Iloilo City)

(c) NDCC (in Manila)

(d) OOCD (in Manila)

(e) OOCD, Regional Center (in Iloilo City)

(f) OOCD, Provincial Office (in Roxas City)

(B) Building Damage Data

(a) MSSD, Regional Office (in Iloilo City)

(b) MSSD, Provincial Office (in Roxas City)

(c) MSSD, City Office (in Roxas City)

(d) Governor's Office (in Capiz)

(e) Roxas city Mayor's Office

(f) Municipal Mayor's Office (in Cuartero, Dao, Dumalag, Dumarao, Maayon, Mambusao, Panay, Panitan, Pontevedra, Sigma)

(g) PNRC

(C) Intrastructure

(a) MPWH, District engineer's Office

(b) MPWH, City Engineer's Office

(c) NPC (in Municipality of Panitan)

(d) PLDT (in Manila)

(e) PRI (in Iloilo City)

(f) CAPELCO (in Municipality of Panitan)

(D) Relief Operations

(a) NEDA, Region VI

(b) OOCD (in Manila)

(c) Governor's Office (in Capiz)

(d) Roxas City Mayor's Office

4.1.3 Damage Data Collected

(1) Agricultural Damage Data

(a) Typhoon Undang Damage Report as of November 20, 1984

Information Section, Ministry of Agriculture and Food

(b) Final Report on Typhoon Damage Caused by Typhoon Undang, 1984-12-03

Bureau of Fisheries and Aquatic Resource

(c) Summary Report of Damage Caused by Typhoon Undang

Ministry of Agriculture and Food, Region VI

(d) Area Effected and Estimated Crop Production Losses Caused by Typhoon Undang in Region VI, 1984

BAECON, Region VI

(e) Monthly Volume of PALAY and CORN Harvested and Yield Per ha in Western Visayas, January to December, 1984

BAECON, Region VI

(f) Typhoon Damage Caused by Undang in Mambusao

NIA, Region VI

(g) "Typhoon Undang Final Damage Report"

MAF, Capiz

(h) Estimated Damage to Crops Caused by Typhoon Undang

BAECON, Roxas City

(i) Report of Damages Caused by Typhoon Undang on Nov. 5, 1984 in Municipal Fisheries in the Province of Capiz

BFAR, Roxas City

(j) Paddy Damage Caused by Typhoon Undang by Growing Stages by Barangay

Municipal Mayor's office in Panitan, Pontevedra, Panay, Cuartero, Dao, Roxas City, Mambusao, Tapaz

(2) Building and Other Damage Data

(a) "TYPHOON UNDANG, Relief, Recovery and Rehabilitation Plan (1984-1987) Western Visayas (Region VI)", NEDA

(b) Damage Caused by Typhoon Nitang/Undang on Infrastructure Sector, Region VI", NEDA

(c) "Summary of Proposed Infrastructure Rehabilitation Projects", NEDA

(d) "Estimated Cost of Typhoon Damages on Public Works and Highways Projects caused by Typhoon Undang", MPWH

(e) "Comprehensive Report of Typhoon Undang", OOCD

(f) "TYPHOON UNDANG, Relief, Recovery and Rehabilitation Plan (1984-1987), Capiz Province", Governor

(g) "TYPHOON UNDANG, Relief, Recovery and Rehabilitation Plan (1984-1987), Roxas City", Mayor

(h) "Summary Report of Damages caused by "Typhoon Undang", November 27, 1984, OOCD, Regional Office

(i) "Status Report on Extent of Assistance to Victims of Typhoon Undang in Roxas City", PNRC

(j) "Estimated Cost of Repair for Damages on PRI Property caused by Typhoon Undang", PRI

(k) "Summary of CAPELCO's Distribution Line Damages", CAPELCO

(l) Replies to the questionnaire distributed in advance from the following municipal mayor's offices; Cuartero, Dao, Dumalag, Maayon, Mambusao, Panay, Panitan, Pontevedra and Sigma.

4.2 Damages by the Typhoon

4.2.1 Total Damage by the Typhoon

Typhoon "Undang" passed through the central part of the Philippines on November 5, 1984. In particular, northern Panay Island was heavily affected by its attendant destructive forces such as strong gusty winds, maximum center wind of 205 km/h (57 m/s), and a heavy downpour of rain.

According to Table XIII.4-2, casualties were 3,390 persons, 80% of which comes from Capiz province. There were 721 persons dead, 2,145 persons injured and 524 persons missing. Most of them come from Region VI, especially in Capiz province.

On houses, 141,336 units were totally destroyed while 79,740 units were partially damaged. Therefore, 221,096 units were affected, 74% of which comes from Region VI. In Capiz, 78,691 units were damaged, which occupies 35% of the total damaged houses in the country.

The worth of damaged properties such as crops, buildings and infrastructures amounts to ₱1.91 billion. More than half of the worth of damages takes place in Capiz province.

4.2.2 Segregation of the Flood Damage

Table XIII.4-2 shows total damages in the whole country, which is caused by the typhoon "Undang". The figures necessary for this study, however, is the damages caused not by winds or tidal waves but by floods of the typhoon in the Panay river basin. To segregate the flood damages from the whole damages, the following assumptions are adopted in this study:

(1) Agricultural Damages

A summary of crop and livestock damages caused by the typhoon "Undang" in the Western Visayas Region, excluding Negros occidental, is provided in Table XIII.4-3. The total crop damage, except sugarcane, in the region VI was estimated at approximately 271.2 million pesos with the province of Capiz accounting for the highest percentage of 54.7, followed by Iloilo of 24.5, Aklan of 17.0, Antique of 3.4 and Guimaras of 0.4, respectively.

With regard sugarcane damages, suffered by the typhoon Undang were reported only from the province of Capiz and Antique as shown below.

Province	Affected Area (ha)	Damaged Value (₱)
Capiz	3,878	40,189,500
Antique	37	204,000
Total	3,915	40,393,500

The livestock and poultry damages suffered by the typhoon Undang was amounted to an estimated value at about 9.7 million pesos. The province of Capiz accounted for the highest percentage of 71.2, followed by Iloilo of 12.6, Alkan of 12.4 and Antique of 3.7, respectively. Guimaras was negligible small.

In the agricultural field, the cereal, coconut, sugar and fish industries were hardest damaged by the typhoon Undang. In the strict sense of the word, the cause of the agricultural damages were resulted by the wind, flood water and tidal waves. Among the crop damages, the annual crops, as like cereal and vegetables, were damaged by the flood water. The perenual crops such as coconut, mango, banana and so on were mainly resulted by the wind. It was reported that no less than sixty percent of the sugarcane damage was also damaged by the wind.

In fishery marginal fish farmers had lost almost all their boats and fishing gears through twisting fury of the wind and tidal waves. The fry and fingerlings stocked in reserve for the succeeding crops were washed away by flood waters spawned by the typhoon.

For the flood control study the agricultural damages caused by the typhoon Undang segregated by the cause of the damages through field survey.

A summary of agricultural damages caused by the typhoon Undang in the all province of Capiz is shown in Table XIII.4-4.

The agricultural damages caused by the typhoon Undang in the Panay river basin are as shown in Table XIII.4-5.

(2) Building Damages

A lot of damaged buildings are affected by compound causes, that is, a strong gusty wind and a flood. These buildings are considered to be affected by a flood as a flood related damage, even if they are first destroyed by a heavy wind. Because even if they are not affected by the wind, the flood would undoubtfully give a damage to the buildings within the inundation areas.

The number of buildings affected by the typhoon "Undang" is calculated by the river system model. Input data for the model are used meteorological records gathered during the field research in June. Accordingly, the flood damage amount is estimated on the prorated building number basis.

(3) Infrastructure Damages

(a) Whole damages on roads, bridges and river structures are caused by a flood.

(b) Damages on water supply facilities are caused by a flood except a case affected clearly by the wind such as a plant roof blown off.

(c) Damages on the railway facilities are also caused only by the flood.

(d) Most of electricity supply facilities are affected by the heavy wind. Some parts of distribution are damaged by the flood secondary. First roads are destroyed by the flood and, then, the electricity poles on the roads are blown down. Therefore, the flood damage amount for the electricity is estimated on the basis of a proportion of the destroyed road length to the total length of the national roads.

(4) Relief Operations

Relief operations for people affected by the flood are segregated from the total operations on the prorated family number basis.

4.2.3 Crop Damage

The crop damages by the cause resulted by typhoon Undang are as follows.

Crops	By typhoon (10^3P)	By flood water (10^3P)
Paddy	100,243	100,243
Corn	1,664	1,664
Sugar cane	40,189	7,231
Fruit	13,989	–
Banana	14,794	–
Other crop (Veget.)	6,800	6,800
Total	177,679	115,938

4.2.4 Livestock Damage

Livestock damages are as shown below.

Animals	Head	Value (10^3P)
Buffalow	138	552
Cattle	37	146
Swine	2,935	2,347
Goat	1,020	178
Poultry	88,977	2,580
Total		5,803

4.2.5 Fishpond Damage

The fishpond damages by the cause resulted by typhoon Undang are as shown follow.

	By tidal waves (10^3P)	By flood (10^3P)
Fishpond		
Milkfish	–	948
Prawn	–	2,816
Repairing pond	–	104
Fishing Boat		
With motor	6,930	–
Non motor	650	–
	7,580	3,868

Detailed agricultural damages by municipality/city caused by flood water spawned by typhoon Undang is shown in Table XIII.4-6.

4.2.6 Building Damage

In Capiz province, 78,671 units of residential buildings are affected by the typhoon as shown in Table XIII.4-7 (1). The total loss of the damage amounts to ₱284 million. The damages of residential building within the municipalities related to the Panay river basin are shown in Table XIII.4-7 (2). The loss of them amounts to ₱214,614 thousand and the number of damaged houses aggregate to 63,376 units, which accounts for 89.0% of existing housing units. 12,513 units in the basin would be inundated by the flood according to the result of the computational analysis of the river system model. As a result, the damage caused by the flood would amount to ₱42,373 thousand.

In Capiz province, the damages of non-residential buildings amounts to ₱137 million as shown in Table XIII.4-7 (3). The damages in the basin amounts to ₱95,224 thousand as shown in Table XIII.4-7 (4). The number of damaged non-residential buildings in the basin would be estimated at 2,300 units on the assumption that 89.0% of the total number (2,600 Units), which is the same rate as residential building, is affected by the typhoon. 1,154 unit of non-residential buildings would be inundated by the flood according to the computational analysis. Therefore, the damage by the flood would aggregate to ₱47,776 thousand.

4.2.7 Infrastructure Damage

The total damage of the infrastructure in the basin which would be affected by the flood amounts to ₱31,868 as shown in Table XIII.4-8 (1). The details of each facility are shown in Tables XIII.4-8 (2) to XIII.4-8 (7).

4.2.8 Relief Operations

In Capiz Province, emergency relief operations has been executed since calamity occurred. A commodity assistance program for typhoon victims of 124,201 families amounts to ₱34,776 thousand. Therefore, since the number of families affected by the flood aggregate to 12,523, the commodity assistance program for flood victims would amount to ₱3,504 thousand on the assumption that each family affected by the flood gets the same amount as the typhoon victims. Adding it to the preventive measures against epidemics after the flood, the relief operations amounts to ₱4,027 thousand as shown in Table XIII.4-9.

4.3 Analysis of Flood Damage by the Typhoon

Casualities in Capiz province as of November 22, 1984 aggregated to 2,729 including missing as shown in Table XIII.4-10. There are 487 confirmed death, 1965 reported injuries and 277 reported missing.

The total direct damage caused by the flood to private and public properties in the Panay river basin would add up to ₱247,628 thousand as shown in Table XIII.4-11. Crop damage accounts for 47% of the total or ₱115,938 thousand. Of the crop damage, 86% is paddy and 6% is sugar cane. Building damage accounts for 36% or ₱90,149 thousand. Of the building damage, 47% is residential building and 53% is non-residential building.

Infrastructure damage amounts to ₱31,868 thousand. This amount corresponds to 35% of the building damage of ₱90,149 thousand as shown in Table XIII.4-12. This figure is somewhat small in compare with the infrastructure damage rate adopted in the nationwide flood control study. In this study, however, 35% is adopted because this figure reflects the latest conditions of facilities in the basin.