6.3 Construction Plan of Water Distribution Facilities

Construction works required for the water distribution system are summarized below:

- Pipe setting works with a diameter of 50 or 65 mm amount to 4.7 km; and,
- Construction works of the related facilities such as check valves, air valves, blow off and division boxes for inhabitants and livestock are 39 numbers a whole.

Since the facilities to be constructed for the water distribution system are rather small in work quantities and scattering in the beneficiary area in comparison with the Embung construction works, almost all the works will be basically executed by man-power in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Organization for implementation

After the reorganization enforced in August 1994, the Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works (PU) is responsible for managing overall water resources development and conservation in the whole country. At the provincial level, the Provincial Water Resources Services (PRWS) of the Provincial Public Works Service (DPUP) under the direct control of the Governor is the principal organization which is responsible for planning, design, and implementation aspects regarding water resources development, operation and maintenance of water source, irrigation and flood control facilities, and watershed management. The Regional Office of PU (Kanwil PU) is established in each Province bearing the responsibility of maintaining coordination between PU and DPUP, and providing support and assistance to the DPUP as well as planning and implementing projects of a national nature.

In NTT, there are four provincial service offices; Water Resources (Pengairan), Road/Bridge (Bina Marga), Water Supply/Building (Cipta Karya) and Technical Quality Management (Tata Laksana Teknik). In terms of domestic water supply to urban and rural areas in NTT, PRWS is responsible for creating and supplying raw water and Cipta Karya has to treat and distribute clean water to end-users in urban areas.

The organizational structure of PRWS consists of a general administrative unit and four technical sections for design, construction, and operation and maintenance (O&M), and project benefit promotion. Under the chief of DPUP, there are nine functional project offices established for the specific purposes. Of these, Embung development is handled by the both Timor Water Resource Construction and Conservation Project Office (Proyek PKSA Timor) and Flores-Sumba Water Resources Construction and Conservation Project Office (Proyek PKSA Flores-Sumba) in case of the Central Government's financing projects and the Provincial Embung Development Project Office (Embung APBD) in case of the Provincial Government's financing projects. After completion of Embungs, O&M works are transferred to the O&M Section according to the direction from the Minister for Home Affairs to the Governor in response to the request by the Minister for PU. The present organization chart of PRWS and two PKSAs are shown in the Volume 4.

In implementing Oebuain Embung Project as one component of the package development program, it is proposed that PRWS is in charge of overall arrangement and the PKSA Timor Project Office is responsible for all of the actual management works. Under the Project Office, one special section or sub-project office needs to be established to represent the following functions:

- Design and construction supervision of all the Project works including water distribution system; and

- Accounting and management of construction works.

(2) Expatriate assistance

In NTT, accumulation of technical know-hows to construct a larger Embung are still insufficient resulting in that the implementation of Oebuain Embung requires experienced professional manpower, especially management of supervision on the construction works. For the successful prosecution of the Project, therefore, it is proposed to introduce appropriate expatriate assistance.

A vital part of the functions of expatriate assistance will be the training of the local professional and sub-professional staff on effective management to supervise the earth and construction works and further to provide substantial experience and techniques to the PKSA Timor Project Office.

(3) Organization for O&M

After completion of the proposed Oebuain Embung, the O&M Section of PRWS is responsible for operating and maintaining Embung as well as water intake and distribution facilities. Among various O&M works to be done by this Section, the reservoir operation is the main function and needs to be conducted on the basis of operation rule to be established. In order to operate and maintain the Project facilities effectively according to the said rule, it is prerequisite to upgrade the capability of O&M staff and the level of O&M equipment.

As for maintenance works of water distribution facilities, it is proposed for PRWS to organize the beneficiary people aiming at their participation in routine works such as cleaning of water division boxes, clearing of animal excreta around water division boxes, repairing of fence along the reservoir and so on.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for development of the Oebuain Embung is estimated on the basis of assumptions as follows:

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 10% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTT area as of June 1994 and the data collected from the on-going projects in NTT. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the Government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to recent other project costs in NTT;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow area and land for pipe line and other permanent structure is estimated at 0.5% of the direct construction cost taking into considerations the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of; direct construction cost, administration cost, engineering service cost, physical contingency, contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Oebuain Embung is estimated at Rp. 4,040 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works for this scheme is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total Project cost for constructing the Oebuain Embung is summarized below.

Summary of the Project Cost for Oebuain Embung

Unit : Rp. million

Item		Project cost
I.	Direct construction cost	2,419
1.1	Preparatory works	115
1.2	Embung construction	2,075
1.3	Domestic water supply	229
1.4	Operation & maintenance road	-
1.5	Irrigation facilities	-
II.	Administration cost	121
III.	Engineering services	363
IV.	Physical contingencies	435
V.	Contract tax	322
VI.	Land acquisition	12
VII.	Price contingency	367
	Grand Total	4,040

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries for O&M staff, cost for maintaining the Project facilities, materials and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are assumed at Rp. 20.2 million, which is equivalent to 0.5% of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

In general, it is impossible to quantify benefits attributable to improvement of the existing water supply system for the domestic and livestock use in rural areas of NTT. The water supply benefits anticipated in the beneficiary area of Oebuain Embung comprise two main portions: reduced time fetching water from distant sources and reduced health problems or morbidity. It is also hard to evaluate the values of gains prospected in newly available working time and those of decreased incidence of water borne diseases in quantitative manner.

Under the Study, thus, the benefits to be born from satisfaction of BHN by creating a new water source facility are to be indicated as the value of water and the investment amount to each beneficiary inhabitant. The investment amount is given by deducting the administration and land acquisition costs from the Project cost, because these could not be defined as the direct construction cost due to the mode of payment. The value of water is obtained by dividing the investment amount by the effective storage capacity, while that of supplied water is given by dividing the investment amount by the annual supply amount of domestic and livestock water.

The total Project cost for constructing the Oebuain Embung with the effective storage capacity of 0.0588 MCM is estimated to be Rp. 4,040 million. The total number of beneficiary water users is 1,773 inhabitants and 438 heads of cows with the annual water demand of 0.04522 MCM. The investment amount estimated is Rp. 3,873 million. The value of effective storage water to be created by the Oebuain Embung is estimated to be Rp. 65,867/m^3, while that of supplied water is estimated to be Rp. 85,648/m3. The estimated investment amount to the respective beneficiary people is Rp. 2.18 million. As the prospected unit water consumption rate of cow is equivalent to that of 0.67 inhabitant, the estimated investment amount to the respective people and livestock is Rp. 1.87 million.

8.2 Economic Consideration

With provision of permanent water source facilities, no economic activities can be expected in the beneficiary area of Oebuain Embung due to insufficient storage capacity derived from the limitation of topographic condition and available run-off from the catchment area. As a result, there is no economic benefit attributable to water supply from the Oebuain Embung. Taking such situation into account, economic evaluation is skipped over in this case.

8.3 Environment Impact Assessment

(1) Environmental features of the Project area

Principal human and physical environment features in the Project area are summarized below.

Human and Physical Environmental Features

Items		Descriptions
Human environment		
Social	:	Insufficiency of reliable water sources and facilities for domestic use
Human use	:	Use of spring water and well water (not useful in the dry season)
Health and sanitation	:	Prevalence of waterborne diseases
Physical environment		
Geology/land	:	Coral limestone
Surface/ground water	:	Surface water is not perennially observed
Endemic fauna and flora	:	none
Others	:	none

(2) Environmental impact assessment

In the Project area, environmental issues assessed as negative environmental problems are only human activities using trees in the catchment area. Trees in both the reservoir and the catchment areas have been utilized by inhabitants for their economic activities producing water-carriers and other baskets, firewood, timber, alcoholic beverage, sap of sugar, and so on. Decrease of vegetation caused by logging has severely incurred a deterioration of water conservation and acceleration of soil erosion in the catchment area.

The countermeasures to eliminate this environmental impact is to establish an effective watershed management rule and conduct a campaign for participation of inhabitants in forest conservation activities. Additional incentives are required to encourage inhabitants to diversify their economic activities on on-forest basis.

(3) Primary information of environmental assessment

To support undertaking of environmental analysis presentation for the proposed Project on the Indonesian rule, primary information on environmental assessment is compiled in Attachment 3.

8.4 Contribution to Women in Development

With provision of permanent water source facilities, women and children of 329 families can be quite free from their daily hard job to carry their domestic water at the average distance of 1,560 m. As a result, women will be able to utilize the saved time for improving their activities in relation to not only agriculture and livestock but also small business and cottage industry. Since housewives in the Project area manage their family budgets, an increasing family income would encourage women in investing surplus in improvement and diversification of their economic activities.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The Oebuain Embung development plan has been formulated as one of the six urgent water resource development schemes in NTT aiming to meet BHN for upgrading the living standard of the Project area. The present Study is made to confirm technical feasibility and socio-economic impact of the Project in conformity with this concept.

The Project consists of such structural components as main dam, water leakage protection measure and domestic and livestock water distribution system. All of these components have to be implemented without any missing components for the purpose of achieving the development concept.

As the results of the Study, it is clarified that each of the Project components are technically possible and the Project is socially and socio-economically desirable for enabling 1,773 inhabitants of 329 families and 438 heads of cow to get permanent water source, to be quite free from daily hard job to carry their domestic water at the average distance of 1,560 m and to decrease frequency of water born disease.

It is therefore concluded that the construction of Oebuain Embung is worthy of urgent implementation.

9.2 Recommendations

As the conclusion of the Study is aforementioned, it is recommended that necessary steps for the implementation of the Oebuain Embung Project are to be taken. Such steps will be composed of administrative issues and technical matters.

Main issues of the administrative matters to be taken up will be the determination of executing agency, the procurement of necessary fund in foreign currency and the preparation of budget in domestic currency as a counterparts fund.

Necessary technical matters to be made are composed of introduction of advanced technology and management know-hows in terms of smooth construction of higher Embung on permeable foundation for shorter period. As the development of Oebuain Embung aims to supply raw water for domestic and livestock use, it is recommended to take necessary action for appropriate watershed management including afforestation and for no entry of inhabitants and livestock to the reservoir area so as to keep water quality.

The Study on The Embung Development Project
in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on
Oebuain Embung Development Project

Tables

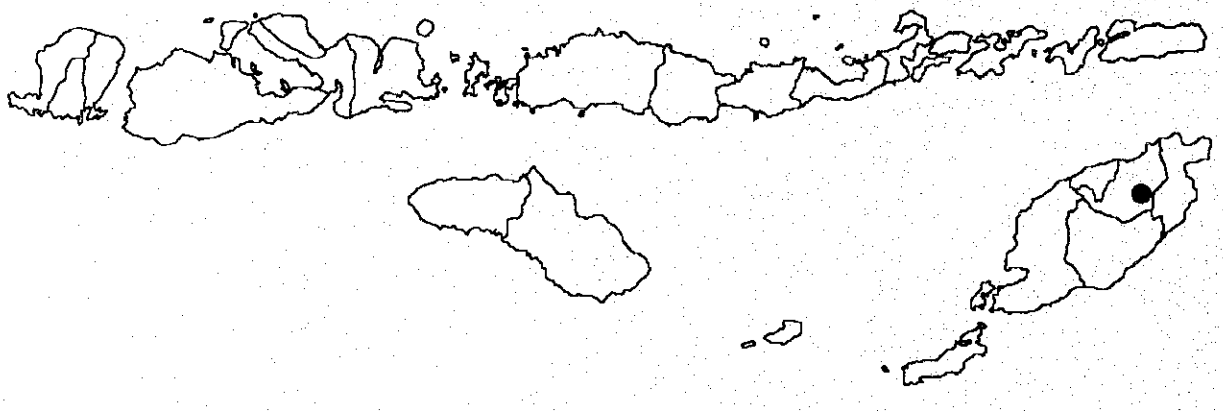


Table 1.1 Monthly Rainfall Record

Station : Kefamenanu

Unit : mm

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug		Sep.		Oct.		Nov.		Dec.		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1975																					17	34	30	88	
1976	62	11	19	31	126	82	0	14	5	2	17	12	0	12	1	2	0	0	0	59	29	90	50	132	755
1977	142	30	123	133	187	54	55	16	26	11	12	2	6	3	0	0	0	0	0	0	0	0	133	118	1.049
1978	115	133	142	126	71	19	24	4	95	126	39	2	88	5	28	1	1	10	2	2	3	53	111	129	1,328
1979	17	55	101	143	125	118	22	0	16	90	16	4	4	4	0	0	0	0	2	0	0	10	54	78	859
1980	182	210	115	198	44	34	8	65	23	16	0	11	2	2	1	0	0	0	0	2	42	80	116	120	1,269
1981	175	89	96	36	67	25	27	9	63	33	25	9	32	23	0	2	20	92	0	0	33	138	159	133	1.284
1982	42	142	106	76	119	67	32	36	9	43	0	13	6	0	11	1	0	0	0	0	4	4	41	72	823
1983	59	100	232	160	74	59	167	54	36	0	67	0	0	0	0	0	0	0	57	88	70	45	32	49	1,348
1984	93	52	100	130	97	99	31	38	60	29	40	4	2	17	2	5	12	26	0	28	0	21	53	125	1.065
1985	89	130	133	134	48	48	61	14	0	7	45	0	0	0	0	0	0	27	0	76	2	37	74	123	1.049
1986	55	179	42	81	87	35	30	0	0	33	6	18	0	61	0	0	0	0	0	29	9	15	28	44	753
1987	151	135	61	86	9	96	4	19	5	58	33	13	32	0	4	0	0	0	0	0	0	60	138	63	969
1988	112	116	82	73	66	142	74	4	2	5	1	0	42	12	0	3	20	0	12	0	15	101	83	94	1.061
1989	54	66	103	45	249	84	50	131	33	5	14	26	5	19	16	1	3	0	0	0	94	0	38	30	1.066
1990	145	143	86	59	71	19	7	165	64	89	4	9	0	5	0	1	0	0	0	0	0	0	196	93	1.156
1991	22	78	98	221	23	5	119	10	8	7	3	15	4	0	0	0	0	0	0	0	122	81	94	113	1.023
1992	116	27	43	53	154	67	28	20	2	134	13	4	0	0	0	0	0	0	0	0	0	0	0	0	662
1993	197	185	99	52	0	0	0	0	0	23	8	17	9	8	0	0	0	0	0	6	0	40	13	67	721
1994	69	75	147	32																					
Average	100	103	101	98	90	59	41	33	25	39	19	9	13	9	3	1	3	9	4	16	23	43	76	88	1.005

Source : Data Klimatologi di Nusa Tenggara Timur, Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.2 Climate Data

Station: Kefamenanu **Latitude : 9.4000S**
Island : Timor **Longitude : 124.4667E**
Kabupaten : TTU **Elevation : 450 m**

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Average
Temperature (mean)	26.1	25.9	25.9	25.6	25.1	23.9	23.1	23.8	24.7	26.7	27.7	26.8	1975-1992	25.4
Temperature (max)	29.2	30.2	29.2	29.8	30.2	30.8	29.2	27.0	30.8	29.8	31.0	29.8	1975-1992	29.8
Temperature (min)	22.8	22.2	22.2	20.2	21.1	17.2	18.2	19.8	15.0	19.5	22.0	22.5	1975-1992	20.2
Relative Humidity (mean)	89.8	89.9	90.2	87.5	90.7	89.4	87.7	83.7	80.7	83.6	81.0	89.3	1975-1992	87.0
Relative Humidity (max)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.0	100.0	1975-1992	99.9
Relative Humidity (min)	43.0	0.0	0.0	56.0	68.0	56.0	57.0	0.0	1.0	0.0	0.0	62.0	1975-1992	28.6
Sunshine Hours (hr/day)	5.1	5.2	6.7	7.5	6.7	6.2	7.2	8.4	8.7	9.0	7.7	6.1	1975-1992	7.0
Wind Velocity (km/day)	51.1	54.3	36.6	28.4	27.5	42.0	58.7	71.9	55.8	61.9	43.9	34.3	1975-1992	47.2

Source : Data Klimatologi di Nusa Tenggara Timur, Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.3 Present and Projected Demographic Condition

Village	Sub-village	Population			Household		
		1994	1999	2004	1994	1999	2004
Letmafo	Oemopu	413	450	488	75	82	89
	Kiupasan RT 03	183	200	217	38	42	45
	Kiupasan RT 04	298	325	352	55	61	65
	Ds. III	315	343	372	60	66	71
	Ds. IV	291	317	344	50	55	59
	Total	1,500	1,635	1,773	278	306	329

Source : Provincial Statistic Office, NTT

Table 1.4 Present and Projected Livestock Population

Year and Village	Sub-villaga	Cow & Buffalo	Horse	Sheep & Goat	Pig	Chicken & Duck	Equiv't Total
1994							
Letmafo	Oemopu	150	11	0	65	147	173
	Kiupasan RT 03	18	0	4	22	53	22
	Kiupasan RT 04	27	1	7	32	80	35
	Ds. III	12	0	17	93	183	31
	Ds. IV	37	0	15	118	216	60
	Total	244	12	43	330	679	321
1999							
Letmafo	Oemopu	171	12	0	82	202	198
	Kiupasan RT 03	21	0	5	28	73	27
	Kiupasan RT 04	31	1	9	41	110	41
	Ds. III	14	0	21	118	252	38
	Ds. IV	42	0	18	149	297	71
	Total	279	13	53	418	934	375
2004							
Letmafo	Oemopu	194	13	0	104	278	227
	Kiupasan RT 03	24	0	6	35	100	32
	Kiupasan RT 04	35	1	10	52	152	47
	Ds. III	16	0	25	149	347	47
	Ds. IV	48	0	22	189	409	85
	Total	317	14	63	529	1,286	438

Source : Provincial Livestock Office, NTT and JICA Study Team

Table 1. 5 Summary of Farm Economic Survey

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Average
1	Sex and Age		Male 45	Male 45	Male 50	Male 35	Male 40	Male 60	Male 52	Male 38			46
2	No. of Family Member		M-2/F-4	M-5/F-1	M-4/F-2	M-2/F-1	M-2/F-4	M-3/F-3	M-1/F-4	M-1/F-4			M-2/F-3
3	Type of Side Job		Civil Servant	None	None	Civil Servant	Enterprneur	None	None	None			
4	Own Farmland	ha	4.50	2.00	2.00	1.27	1.57	1.50	3.30	3.00			1.91
	(Paddy field)	ha	0.50	0.00	0.50	0.25	0.00	0.50	2.00	0.50			0.43
5	Cropped Area	ha	4.50	2.00	1.40	0.55	1.58	2.25	6.04	3.70			2.20
	(Paddy)	ha	1.00	0.00	0.50	0.25	0.00	0.50	2.00	0.50			0.48
	(Palawija)	ha	3.50	1.50	0.60	0.30	1.05	1.75	3.03	2.40			1.41
	(Others)	ha	0.00	0.50	0.30	0.00	0.53	0.00	1.01	0.80			0.31
6	Cow/Buffalo	head	4	0	13	3	1	0	3	1			2.5
	Horse	head	0	0	0	0	0	0	0	0			0.0
	Goat/Sheep	head	0	5	0	3	2	1	0	0			1.1
	Pig	head	5	8	3	6	1	4	2	1			3.0
	Chicken/Dug	head	27	6	15	16	4	1	0	0			6.9
7	Gross Income	Rp/yr	2,782,000	678,000	870,000	1,954,000	1,190,000	250,000	450,000	92,500			826,650
	(Crop)	Rp/yr	0	250,000	0	54,000	0	190,000	0	92,500			58,650
	(Livestock)	Rp/yr	850,000	428,000	870,000	700,000	650,000	60,000	450,000	0			400,800
	(Side job)	Rp/yr	1,932,000	0	0	1,200,000	540,000	0	0	0			367,200
8	Expenditure	Rp/yr	1,622,500	1,263,400	887,500	1,640,250	1,146,000	1,713,225	1,044,000	556,100			1,033,798
	(Food/Drink)	Rp/yr	744,000	900,000	300,000	1,128,000	510,000	768,000	672,000	300,000			532,200
	(Living)	Rp/yr	625,500	310,400	430,000	474,000	591,000	448,025	763,500	205,500			384,793
	(Education)	Rp/yr	180,000	35,000	60,000	0	24,000	12,000	0	18,000			32,900
	(Production)	Rp/yr	73,000	18,000	97,500	38,250	21,000	485,200	73,500	32,600			83,905
9	Surplus/Deficit	Rp/yr	1,159,500	-585,400	-17,500	313,750	44,000	-1,463,225	-594,000	-463,600			-207,148

Source : JICA's Agro-economy Survey

Table 2.1 Projected Domestic and Livestock water Demand

Unit : m3

Village	Sub-village	1999			2004		
		Domestic	Livestock	Total	Domestic	Livestock	Total
Letmafo	Oemopu	9,855	2,896	12,751	10,687	3,311	13,998
	Kiupasan RT 03	4,380	393	4,773	4,752	460	5,212
	Kiupasan RT 04	7,118	598	7,716	7,709	691	8,400
	Ds. III	7,512	556	8,068	8,147	682	8,829
	Ds. IV	6,942	1,037	7,979	7,534	1,244	8,778
	Total	35,807	5,480	41,287	38,829	6,388	45,217

Source : JICA Study Team

Table 3.1 Estimated Half Monthly Discharge at Proposed Embung Site

Embung Oebuain

Unit : 1000 m3

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug		Sep.		Oct.		Nov.		Dec.		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1976	7.00	21.00	15.00	0.00	0.00	7.00	30.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	7.00	22.00	143.00
1977	12.00	32.00	34.00	7.00	30.00	32.00	45.00	13.00	13.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	224.00
1978	32.00	28.00	28.00	32.00	34.00	30.00	17.00	0.00	6.00	0.00	23.00	30.00	9.00	0.00	21.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	13.00	310.00
1979	27.00	31.00	0.00	13.00	24.00	34.00	30.00	28.00	5.00	0.00	0.00	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	214.00
1980	13.00	19.00	44.00	50.00	28.00	48.00	10.00	8.00	0.00	15.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	19.00	270.00
1981	28.00	29.00	42.00	21.00	23.00	9.00	16.00	6.00	6.00	0.00	15.00	8.00	6.00	0.00	8.00	5.00	0.00	0.00	5.00	22.00	0.00	0.00	8.00	33.00	290.00
1982	38.00	32.00	10.00	34.00	25.00	18.00	29.00	16.00	8.00	9.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	229.00
1983	10.00	17.00	14.00	24.00	56.00	38.00	18.00	14.00	40.00	13.00	9.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	21.00	17.00	11.00	332.00
1984	8.00	12.00	22.00	12.00	24.00	31.00	23.00	24.00	8.00	9.00	14.00	7.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	7.00	0.00	5.00	222.00
1985	13.00	30.00	21.00	31.00	32.00	32.00	12.00	12.00	15.00	0.00	0.00	0.00	11.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	18.00	0.00	9.00	242.00
1986	18.00	29.00	13.00	43.00	10.00	19.00	21.00	8.00	7.00	0.00	0.00	8.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	198.00
1987	7.00	11.00	36.00	32.00	15.00	21.00	0.00	23.00	0.00	0.00	0.00	14.00	8.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	189.00
1988	33.00	15.00	27.00	28.00	20.00	18.00	16.00	34.00	18.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	24.00	248.00
1989	20.00	23.00	13.00	16.00	25.00	11.00	60.00	20.00	12.00	32.00	8.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.00	0.00	269.00
1990	9.00	7.00	35.00	34.00	21.00	14.00	17.00	0.00	0.00	40.00	15.00	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	213.00
1991	47.00	22.00	5.00	19.00	24.00	53.00	5.00	0.00	29.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.00	19.00	252.00
1992	23.00	27.00	28.00	7.00	10.00	13.00	37.00	16.00	7.00	0.00	0.00	32.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	200.00
1993	0.00	0.00	47.00	44.00	24.00	12.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	142.00
Average	19.17	21.39	24.11	24.83	23.61	24.44	21.44	13.44	9.67	6.56	5.33	8.72	3.33	0.33	2.61	1.11	0.39	0.00	0.56	1.89	0.78	3.72	5.22	9.94	232.61

Table 3.2 Estimated Flood Discherge

Oebuain Scheme

Characteristics of the catchment area								
Catchment Area	(km2)	0.80						
Eelevation at Dam Site (1)	(m)	366						
Maximum elevation in the catchment area (2)	(m)	681						
Height (3)=(2)-(1)	(h)	315						
Length of Catchment Area (l)	(m)	1,600						
Flow velocity	W2 (km/hr)	27.15						
Time of concentration	T2 (hrs)	0.06						
Estimate of the Design Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	53	73	87	102	124	141	160
Rainfall intensity within the time of concentration	(mm)	45	61	74	86	104	119	134
Designed Flood	(m3/s)	8	11	13	15	18	21	24
Specific Discharge	(m3/s/km2)	10	14	16	19	23	26	30

To estimate design rainfall, the Log Pearson III method is adopted.
The rational method is adopted for estimation of the design flood discharge.
C = 0.8 is used to estimate designed flood discharge by the rational method.

Table 3.3 Result of Water Quality Test

Oebuain Scheme

DESCRIPTION	UNIT	1 Upstream of proposed embung	2 Embung Site	3 Embung Site	4 downstream of proposed embung	Max. Limit of B Class by GR. NO. 20/1990
I. PHYSICS						
1 Temperature	C	26.50	24.00	24.00	27.50	Normal water temperature
2 Dissolved solid matter	mg/liter	924.00	520.00	736.00	535.00	1000
3 Electric Conductivety	umhos/cm	1265.00	706.00	1007.00	728.00	-
II. CHEMISTRY						
a. Unorganic chemistry						
1 Mercury	mg/liter	0.00	0.00	0.00	0.00	0.001
2 Ammonia	mg/liter	0.00	0.00	0.00	0.00	0.5
3 Aroenic	mg/liter	-	-	-	-	0.05
4 Barium	mg/liter	-	-	-	-	5
5 Ferro	mg/liter	0.03	0.52	0.14	0.00	1
6 Fluoride	mg/liter	0.80	0.90	1.00	0.90	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	19.10	78.10	80.20	35.50	600
9 Chronium, valense-6	mg/liter	0.00	0.00	0.00	0.00	0.05
10 Manganese	mg/liter	0.00	0.00	0.00	0.00	0.5
11 Nitrate, N	mg/liter	0.00	0.00	0.60	0.00	10
12 Nitric, N	mg/liter	0.00	0.00	0.01	0.00	1
13 Dissolved Oxygen	mg/liter	3.86	6.11	5.68	2.81	*
14 pH	-	7.80	7.60	7.70	7.10	5-9
15 Selenium	mg/liter	-	-	-	-	0.01
16 Zinc	mg/liter	0.00	0.00	0.00	0.00	5
17 Cyanide	mg/liter	0.00	0.00	0.00	0.00	0.1
18 Sulphate	mg/liter	92.80	75.00	90.50	23.30	400
19 Sulfide, H2S	mg/liter	0.00	0.00	0.00	0.00	0.1
20 Copper	mg/liter	0.00	0.00	0.00	0.00	1
21 Lead	mg/liter	0.00	0.00	0.00	0.00	0.1
b. Organic Chemistry						
1 Aldrin and Dieldrin	mg/liter	0.00	0.00	0.00	0.00	0.017
2 Chlordane	mg/liter	0.00	0.00	0.00	0.00	0.003
3 DDT	mg/liter	0.00	0.00	0.00	0.00	0.042
4 Endrine	mg/liter	0.00	0.00	0.00	0.00	0.001
5 Fenol	mg/liter	0.00	0.00	0.00	0.00	0.001
6 Heptachlor and Heptachlor Epoxide	mg/liter	-	-	-	-	0.018
7 Carbon Cloroform Ektract	mg/liter	-	-	-	-	0.5
8 Lindane	mg/liter	0.00	0.00	0.00	0.00	0.056
9 Methoxychlor	mg/liter	-	-	-	-	0.035
10 Oil and Fat	mg/liter	0.00	0.00	0.00	0.00	Nil
11 Organofosphate and Carbomate	mg/liter	0.00	0.00	0.00	0.00	0.1
12 PCB	mg/liter	-	-	-	-	Nil
13 Senyawa atife biru (Sulfaktan)	mg/liter	0.00	0.00	0.00	0.00	0.5
14 Toxaphene	mg/liter	0.00	0.00	0.00	0.00	0.005
III MICRO BIOLOGY						
1 Coliform tinja	per 100 ml	7,000	9,400	9,400	14,000	2,000
2 Total Coliform	per 100 ml	13,000	18,000	18,000	17,000	10,000

NOTE:
* = The water level shall be more than or equal to 6.
mg = miligram
ml = Milimeter
Bq = Bequerel

Heavy metals are classified into dissolved matter.

Source : JICA's Water Quality Test

Table 5.1 Design Value of Embankment Materials

Oebuain Scheme

Item		Unit	Design Value
Natural Water Content	(NWC)	%	56.4
Bulk Density	(γ d max)	g/cm3	1.796
Maximum Dry Density	(γ t)	g/cm3	1.58
Saturated Density	(σ sat)	g/cm3	1.944
Optimum Moisture Content	(Wopt)	%	23
Specific Gravity	(Gs)	-	2.65
Liquid Limit	(LL)	%	60.4
Plastic Limit	(PL)	%	21.1
Plastic Index	(PI)	%	39.3
Shrinkage Limit	-	%	25.8
Angle of Internal Friction	(ϕ)	°	24.0
Cohesion (UU/CU)	(C)	kg/cm2	1.1
Permeability	(K)	cm/sec	3.00E-06
Classification of Soil	-	-	CH

Table 6.1 Summary of Construction Equipment

Oebuain Scheme

No.	Equipment	Capacity	Munimum Number
1	Bulldozer	21 ton	2
2	Wheel loder	1.2 m3	1
3	Backhoe	1.2 m3	2
4	Backhoe	0.6 m3	3
5	Dump Truck	11 ton	12
6	Dump Truck	7 ton	3
7	Type roller	10 ton	1
8	Motor grader	3.7 m	1
9	Water Tanker(Sprinkler)	6 kl	1
10	Leg drill	2.8 m3/min	2
11	Sinker	3.3 m3/min	2
12	Air compressor	14 m3/min	1
13	Batching plant	0.75 m3	1
14	Agitator (Trunk mixer)	3.0 m3	2
15	Concrete bucket	1.0 m3	2
16	Concrete vibrator	-	3
17	Truck crane	20 ton	1
18	Water pump	3,7 kw	2
19	Welder	300 A	2
20	Diesel generator	80 KVA	2
21	Truck	7 ton	4
22	Truck with crane	6 ton	1
23	Pickup car	-	4
24	Jeep	-	4
25	Concrete pump	20 m3/hr	1

Table 7.1 Summary of Project Cost

Scheme : OEBAUIN

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	115
1.2 Embung Construction	
1) Main dam	811
2) Spillway	457
3) Intake, outlet & diversion channel	159
4) Leakage protection works	459
5) Miscellaneous	189
Sub-total of 1.2	2,075
1.3 Domestic Water Supply	
1) Pipe line	65
2) Division boxes	143
3) Miscellaneous	21
Sub-total of 1.3	229
1.4 Embung Operation and Maitenace Road	0
1.5 Irrigation Facilities	0
Sub-toal of I.	2,419
II. Administration Cost	121
III. Engineering Services	363
Sub-total of I, II & III	2,903
IV. Physical Contingency	435
Sub-total of I, II, II, & IV	3,338
V. Contract Tax	322
VI. Land Aquisition Cost	12
Sub-total I, II, III, IV, V & VI	3,672
VII. Price Contingency	367
GRAND TOTAL	4,040

Table 7.2 Direct Construction Cost (1/3)

Scheme : OEBUAIN

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Embung				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	8,800	3,520
2) Excavation	m3	5,500	8,800	48,400
3) Embankment	m3	8,000	80,000	640,000
4) Rip-rap protection	m3	15,000	3,000	45,000
1.2 Other miscellaneous works				73,692
Sub-total of 1.				810,612
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	2,100	840
2) Excavation	m3	5,500	16,200	89,100
3) Backfill	m3	5,200	3,800	19,760
2.2 Concrete works				
1) Concrete - A	m3	250,000	100	25,000
2) Concrete - B	m3	170,000	1,000	170,000
3) Reinforcement bar	ton	1,500,000	22	33,000
4) Form	m2	15,000	5,200	78,000
2.3 Other miscellaneous works	L.S			41,570
Sub-total of 2.				457,270
3. Intake, Outlet & Diversion Channel				
3.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,500	1,600	8,800
3) Backfill	m3	15,000		0
3.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000	800	136,000
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
3.3 Other miscellaneous works	L.S			14,480
Sub-total of 3.				159,280
4. Leakage Protection Works				
4.1 Earth works				
1) Clearing	m2	400	28,000	11,200
2) Earth blanket works	m3	8,000	56,000	448,000
4.2 Concrete lining works	m2	170,000		0
Sub-total of 4.				459,200
5. Miscellaneous & Others				188,636
Total of I.				2,074,998

Table 7.2 Direct Construction Cost (2/3)

Scheme : OEBUAIN

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
II. Domestic Water Supply				
1. Pipe line				
1.1 Earth works				
1) Clearing	m2	400	9,400	3,760
2) Excavation	m3	5,000	1,520	7,600
3) Backfill	m3	5,200	1,500	7,800
1.2 Pipe line setting works				
1) Dia 40 mm	m	5,300		0
2) Dia 50 mm	m	7,400	300	2,220
3) Dia 65 mm	m	9,200	4,350	40,020
5) Dia 75 mm	m	13,300		0
6) Dia. 400 mm	m	218,000		0
1.3 Pipe line related structures				
1) Check valve	nos.	624,000	3	1,872
2) Air valve	nos.	506,000	2	1,012
3) Drainage valve	nos.	1,036,000	1	1,036
Sub-total of 1.				65,320
2. Division Boxes				
1) Division box for inhabitants	nos.	6,990,000	18	125,820
2) Division box for livestock	nos.	1,130,000	15	16,950
Sub-total of 2.				142,770
3. Miscellaneous & Others	L.S			20,809
Total of II.				228,899
III. Embung Operation and Maintenance Road				
1. Road Works				
1.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,000		0
3) Embankment	m3	6,300		0
4) Pavement (lime stone)	m3	15,000		0
2. Related structures				
2.1 Cross drain	nos.	4,700,000		0
3. Miscellaneous and others	L.S			0
Total of III				0

Table 7.2 Direct Construction Cost (3/3)

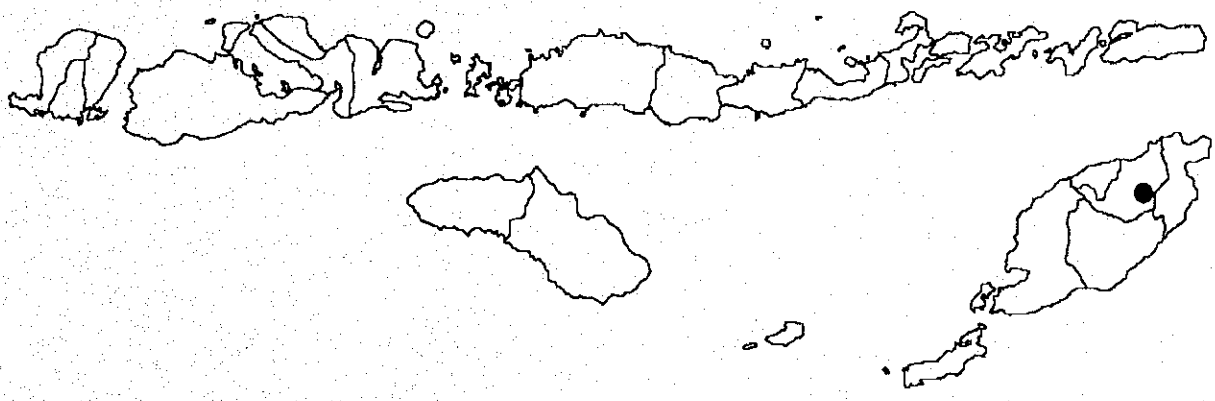
Scheme : OEBUAIN

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
IV. Irrigation Facilities				
1. Canal works				
1.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,000		0
3) Embankment	m3	6,300		0
1.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000		0
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
2. Related structures				
2.1 Irrigation inlet box	nos.	1,600,000		0
2.2 Aqueduct	nos.	2,750,000		0
2.3 Cross drain	nos.	4,700,000		0
2.4 Irrigation division box	nos.	600,000		0
3. Rehabilitation of existing canal				
3.1 Weir rehabilitation	L.S			0
3.2 Canal rehabilitation	L.S			0
4. Miscellaneous & Others	L.S			0
Total - IV				0
GRAND TOTAL				2,303,897

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Oebuain Embung Development Project

Figures



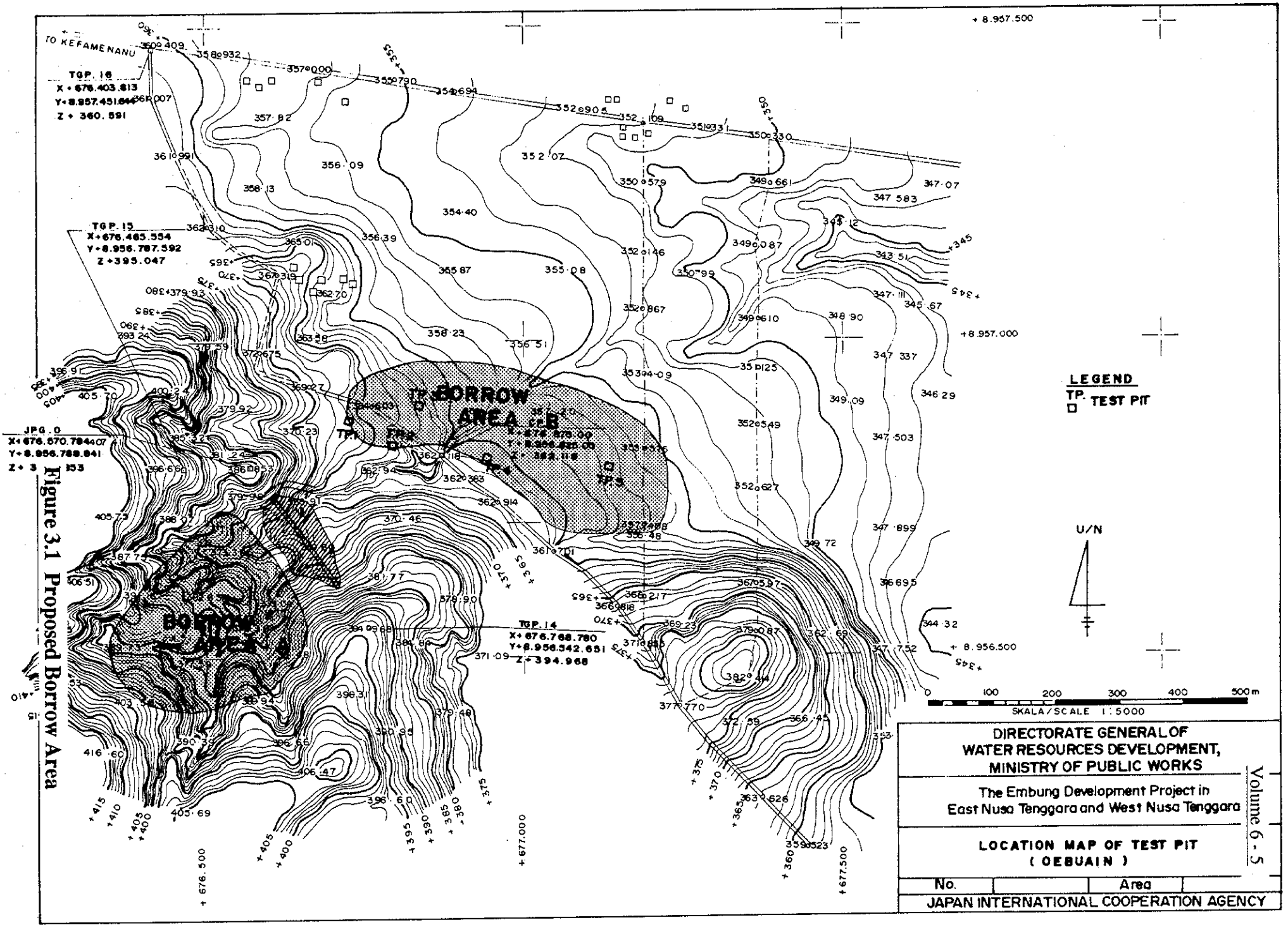


Figure 3.1 Proposed Borrow Area

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

LOCATION MAP OF TEST PIT (OEBUAIN)

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

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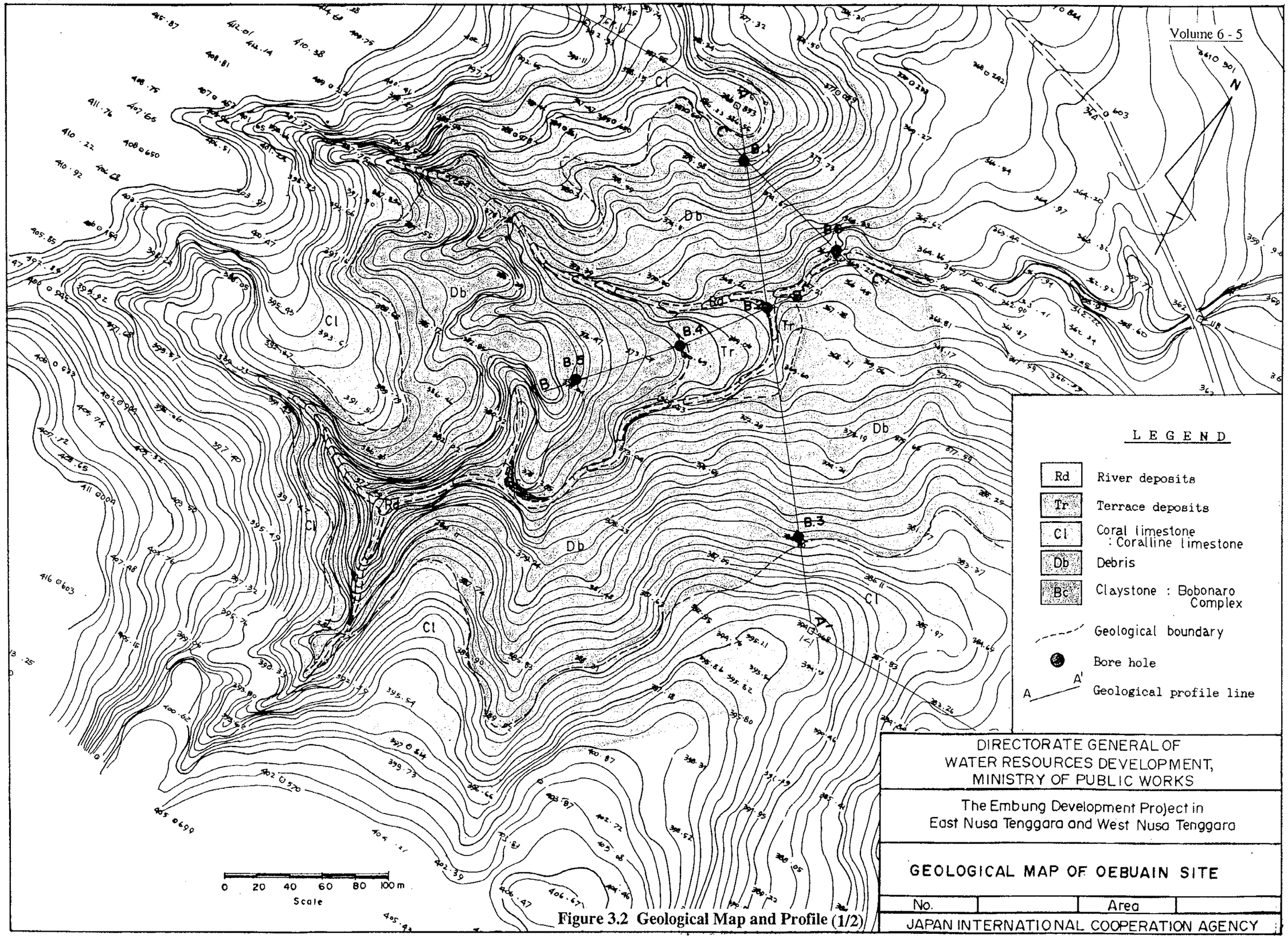


LEGEND

Rd	River deposits
Tr	Terrace deposits
Cl	Coral limestone : Coralline limestone
Db	Debris
Bc	Claystone : Bobonaro Complex
	Geological boundary
	Bore hole
A — A'	Geological profile line

DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

The Embung Development Project in
East Nusa Tenggara and West Nusa Tenggara

GEOLOGICAL MAP OF OEBUAIN SITE

No.		Area	

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2 Geological Map and Profile (1/2)

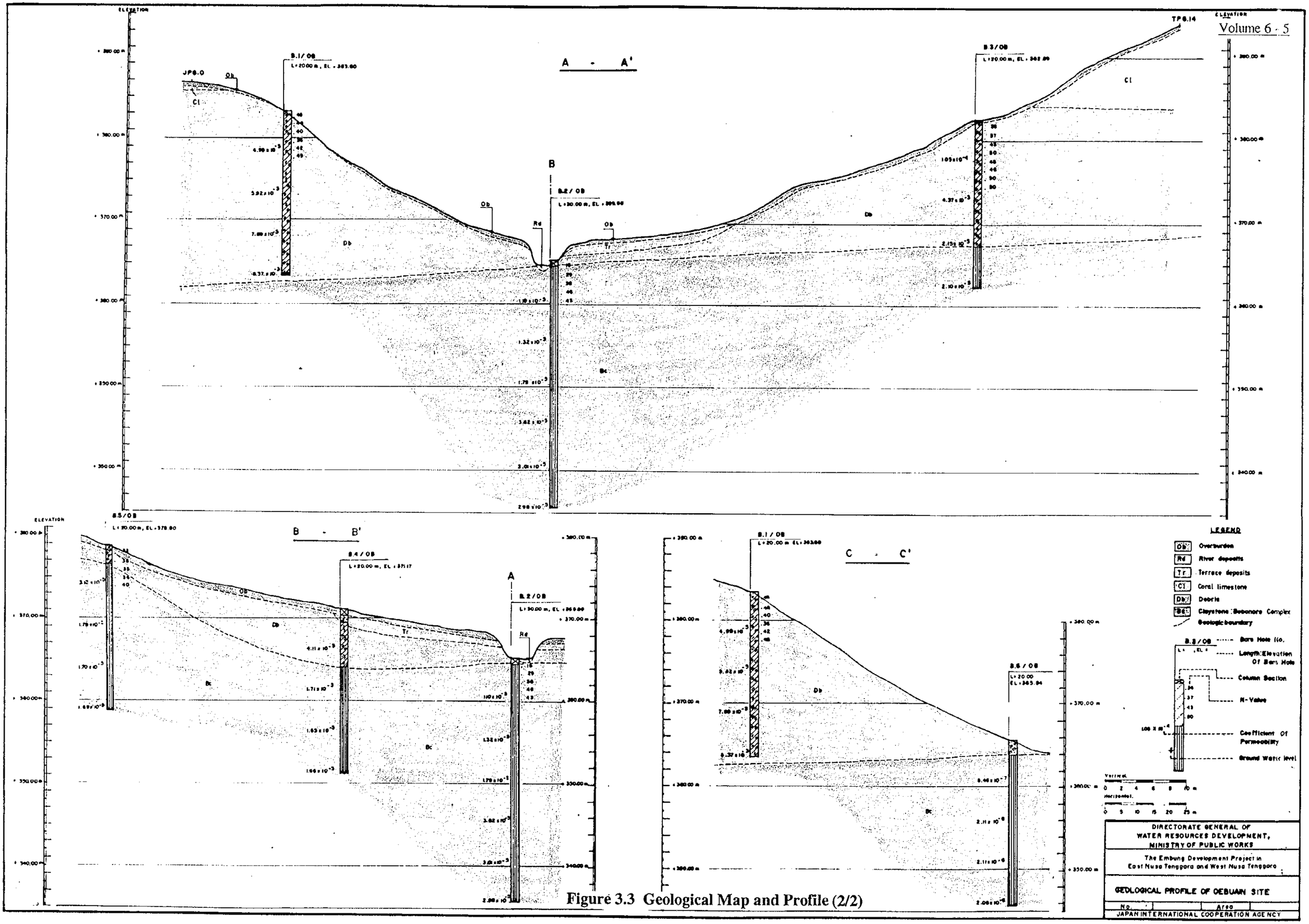


Figure 3.3 Geological Map and Profile (2/2)

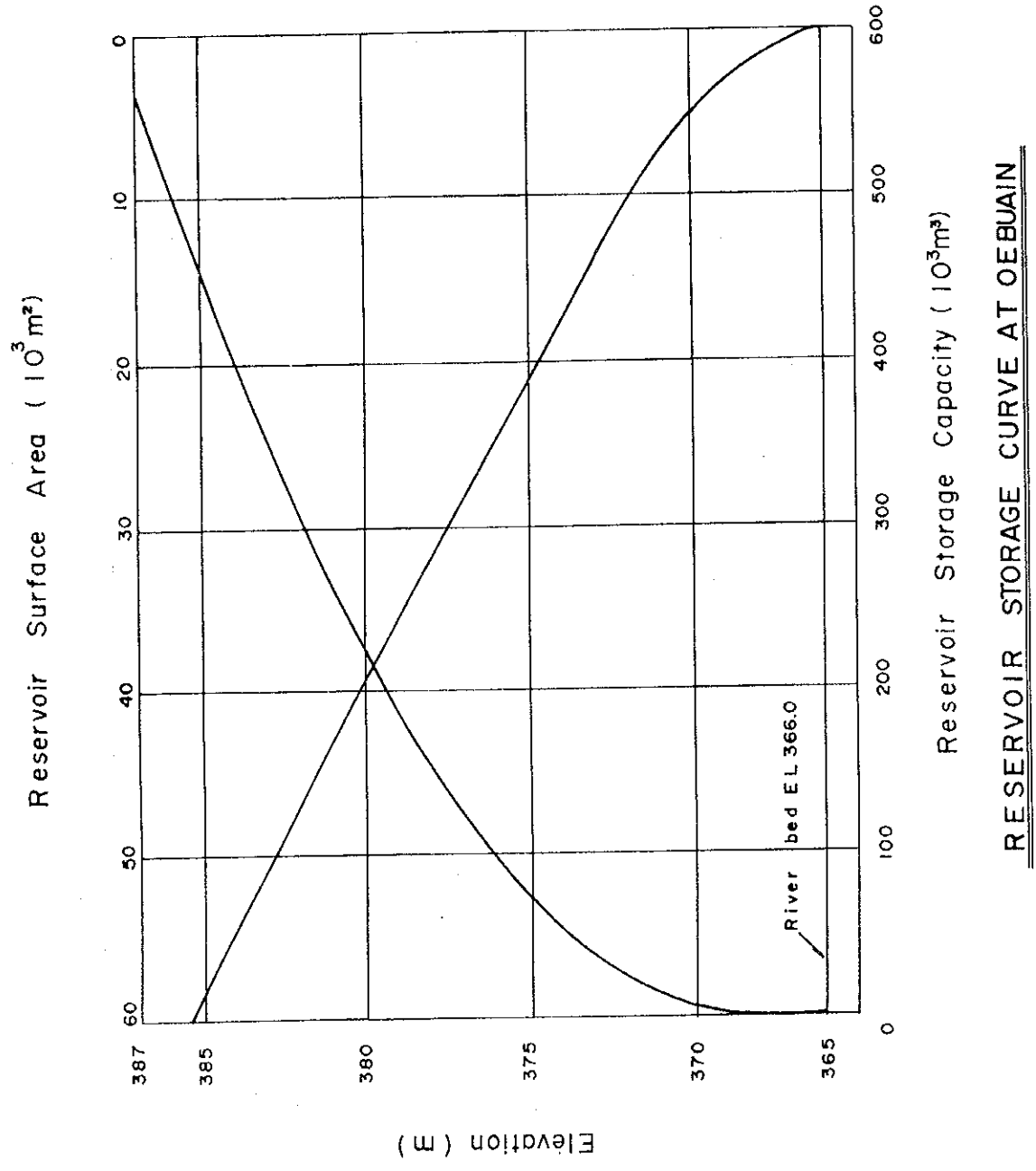


Figure 4.1 Reservoir Storage Curve

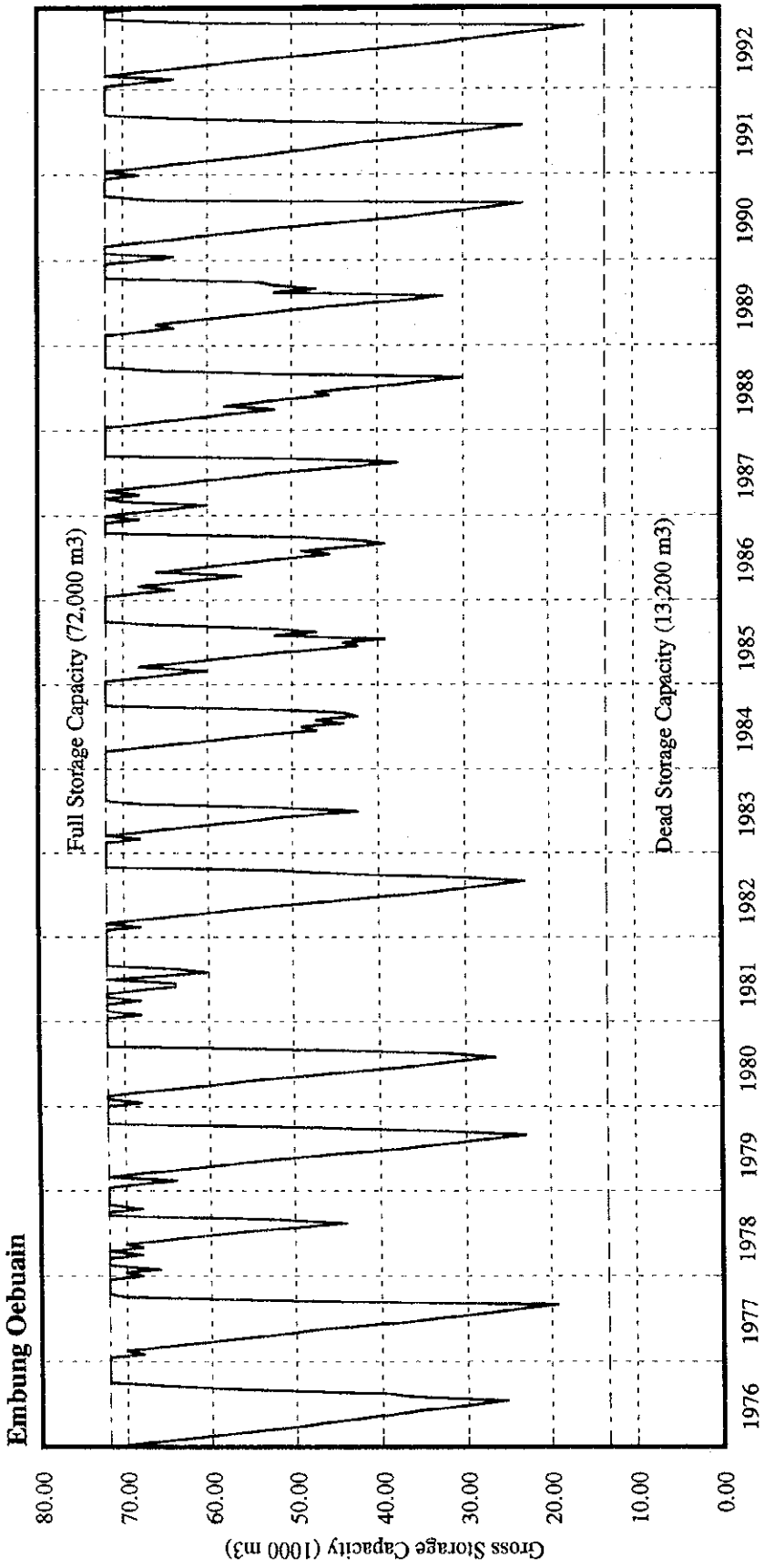


Figure 4.2 Result of Reservoir Operation

	Slope	Safety factor
Upstream	1: 4	1.26
Downstream	1: 3	1.32

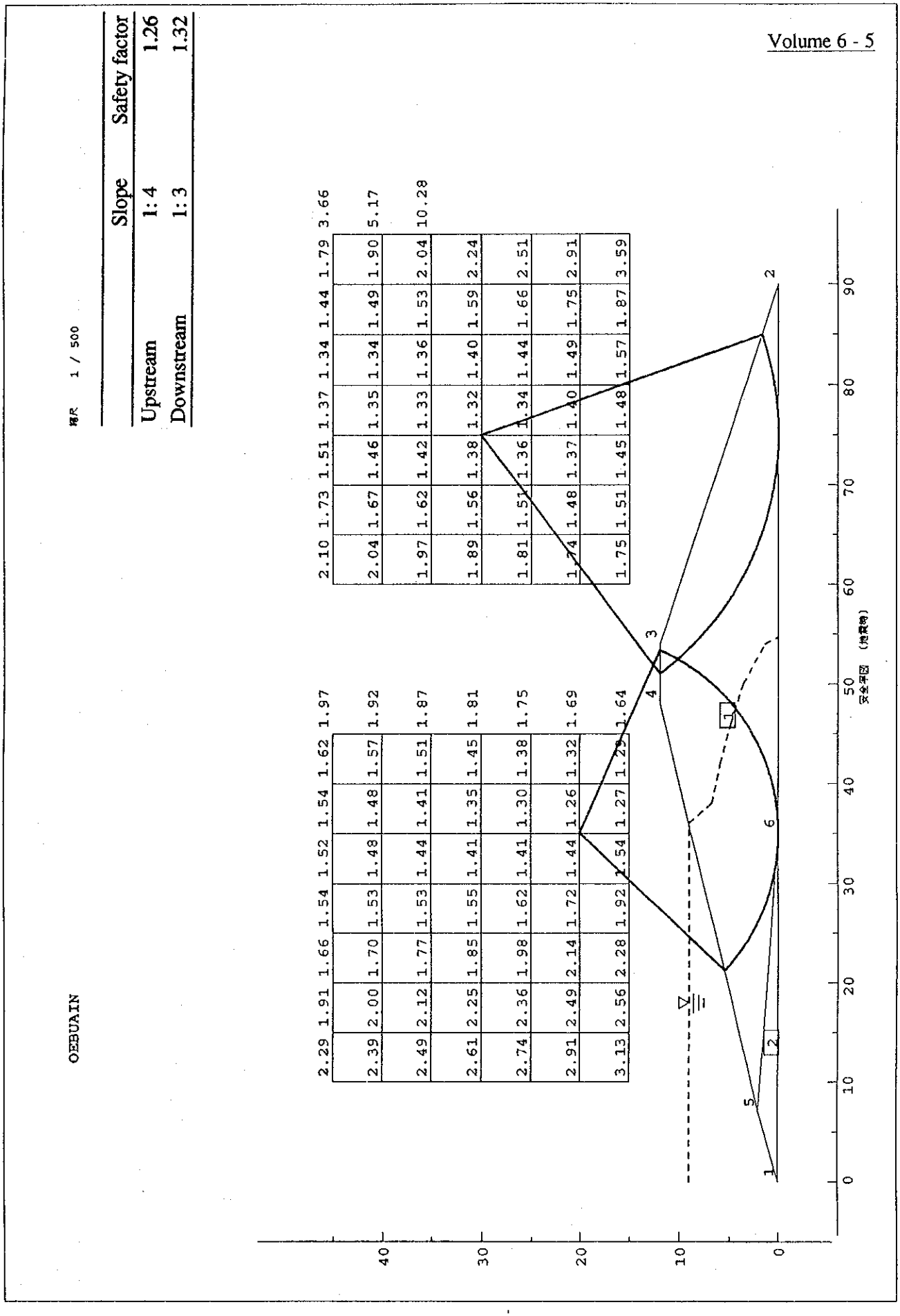


Figure 5.1 Stability Analysis

Oebuain Scheme

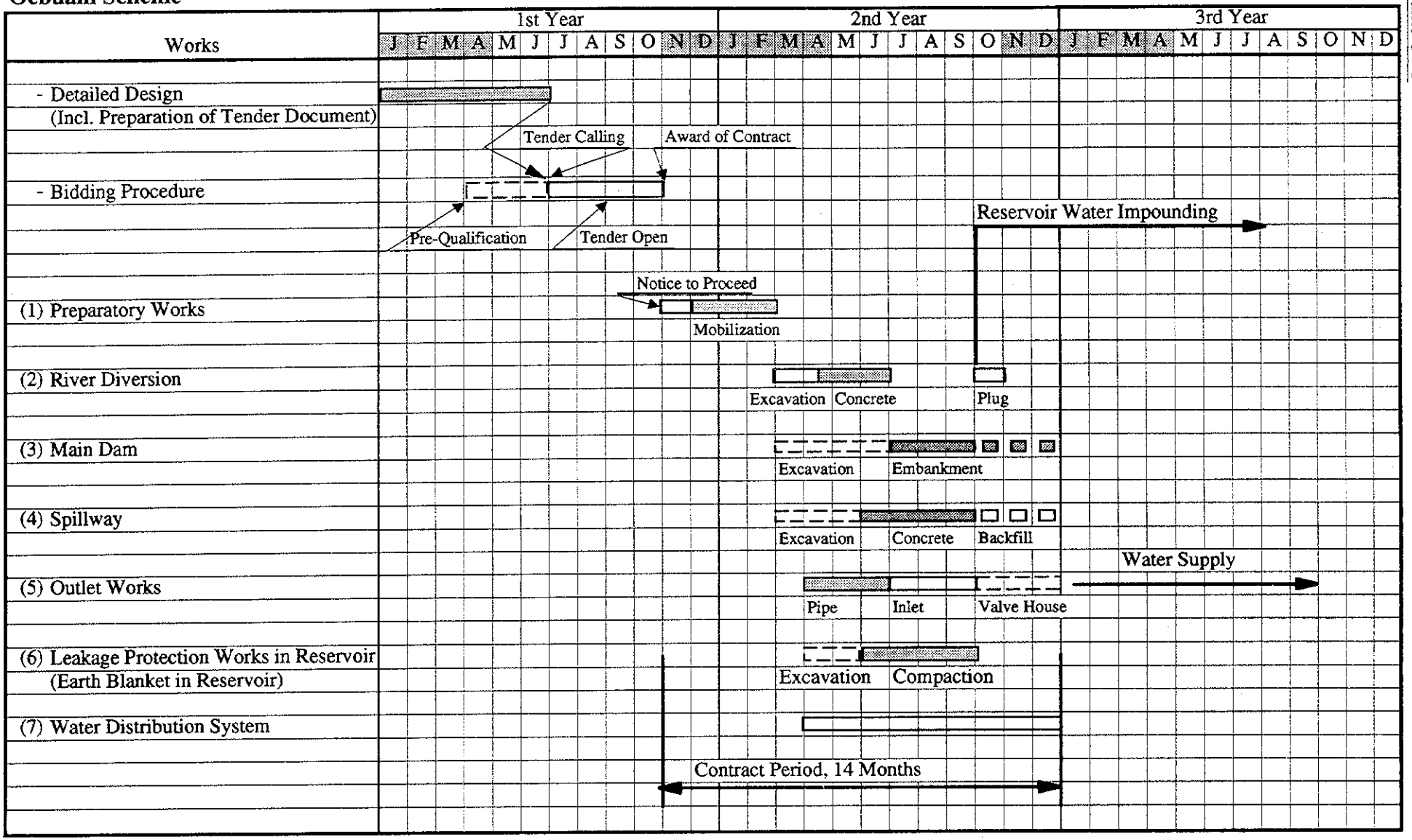
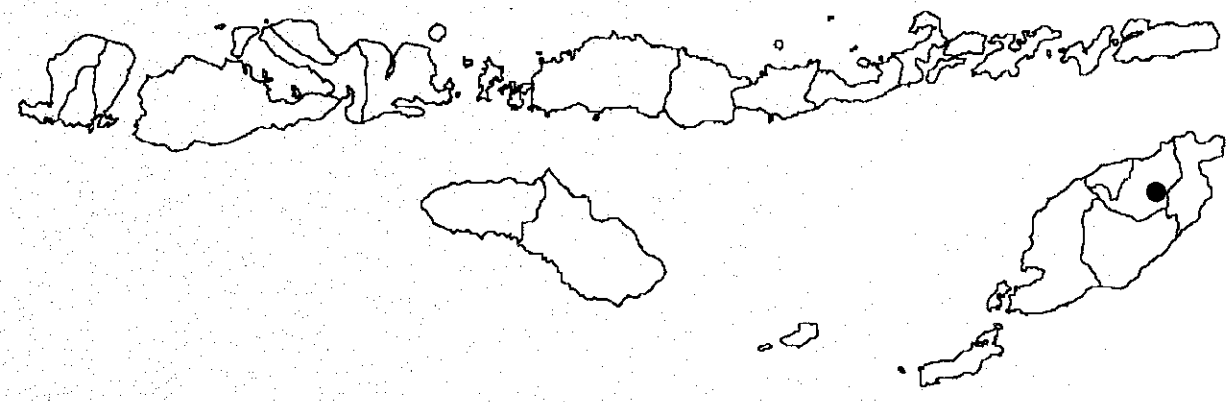


Figure 6.1 Construction Time Schedule

The Study on The Embung Development Project in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on Oebuain Embung Development Project

Attachments



Attachment - 1

Result of Soil Laboratory Test in Oebuain

Bor.No. (Depth)	Formation Classification	Unified Soil Content(%)	Water (g/cm3)	Unit Weight	Specific Gravity
B2(2.0m)	Bobonaro claystone	CL	21.5	1.86	2.7
B2(6.0m)	Bobonaro claystone	CL	18.8	2.04	2.56
B3(6.0m)	Debris	CH	8.2	-	2.62
B5(3.0m)	Bobonaro claystone	CL	21	-	2.58
B5(7.0m)	Bobonaro claystone	CL	23.6	-	2.46
B6(3.0m)	Bobonaro claystone	CL	11.1	-	2.6

Result of Rock Test in Oebuain

Sample	Formation	Unit Weight (g/cm3)	Specific Gravity	Unconfined Compression (kg/cm3)
B1(11.0m)	Bobonaro claystone	2.62	2.67	5.51
B3(9.0m)	Bobonaro claystone	2.54	2.75	196.28

Attachment-2

SUMMARY OF LABORATORY TEST

PROJECT : Embung Oebuain
LOCATION OF PROJECT : Ds. Letmafo, Kec. Insana
DISTRICT : Timor Tengah Utara
PROVINCE : Nusa Tenggara Timur
DATE : Jun-94

			TP.1	TP.2	TP.3	TP.4	TP.5	Average
Depth of Sample		m						
Water Content	(Wn)	%	47.86	54.91	52.00	67.56	59.08	56.28
Unit Weight	(γ w)	g/cm3						
Maximum Dry Density	(γ d max)	g/cm3	1.695	1.550	1.580	1.520	1.495	1.57
Optimum Moisture Content	(Wopt)	%	19.80	23.10	23.20	21.60	26.00	22.74
Specific Gravity	(Gs)	-	2.61	2.49	2.69	2.71	2.75	2.65
Liquid Limit	(LL)	%	57.50	54.35	61.35	67.50	61.25	60.39
Plastic Limit	(PL)	%	18.23	22.15	21.37	19.33	24.35	21.09
Plastic Index	(PI)	%	39.27	32.20	39.98	48.17	36.90	39.30
Shrinkage Limit	-	%	18.62	30.32	27.41	27.71	24.89	25.79
Angle of Internal Friction	(ϕ)	°	26	28	33	27	31	29.00
Cohesion (UU/CU)	(C)	kg/cm2	1.185	0.900	0.960	1.600	1.085	1.15
Permeability	(K)	cm/sec	1.93E-06	3.72E-06	6.12E-06	4.21E-06	4.50E-06	
Passing of # 200 Sieve	-	%	65.79	82.09	79.75	74.60	74.84	
Clasification of Soil			CH	CH	CH	CH	CH	

1. Physical Environmental Impacts

Place I : Catchment area
Place II : Embung and reservoir area planned
Place III : River and riverbed
Place IV : Riverside
Place V : Beneficial area
Place VI : Downstream area other than beneficial area

Embung Site: 1: T101 : Bimoku
2: T102 : Oeltua
3: T103 : Tasiepah
4: T108 : Benkoko
5: T109 : Oebuain
6: RO13: Matasio

Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I	II	III	IV	V	VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I	II	III	IV	V	VI	Embung Site 1	2	3	4	5	6	Mitigatory Measures
LAND	Land use	Actual	I						not available														
		Potential	I						not available														
	Soil erosion	Actual	I						not available														
		Potential	I						not available														
	Soil fertility	Actual	I						not available														
		Potential	I						not available														
	Soil contamination	Actual	I						not available														
		Potential	I						not available														
WATER	River hydrology	Actual			III				available	· Flush floods in short duration are observed during the wet season	· no impact						1	2				
		Actual			III				available	· -ditto-	· It causes scour and erosion of river bed			III							5		
		Potential			III				available	· River run-off is reduced by storage function of the reservoir	· no impact						1	2			5		
		Actual			III				available	· River flow discharge rapidly increase during the wet season	· It causes scour and erosion of riverbed · Sedimentation and erosion of riverbed induce reduction of flow area of the river			III					3				
		Actual			III				available	· -ditto-	· It causes scour and erosion of riverbed			III						4		6	
		Potential			III				available	· River run-off is reduced by storage function of the reservoir	· -ditto-			III					3	4		6	

Place I : Catchment area
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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur	Embung Site	Mitigatory Measures
			I II III IV V VI				I II III IV V VI	1 2 3 4 5 6	
	River morphology	Actual	IV	available	· River section is stable because it composed of lime stone	· no impact		1 2	
		Potential	IV	available	· not applicable	· no impact		1 2	
		Actual	IV	available	· Erosion and collapse of river banks caused by floods and excess grazing are observed	· *Sedimentation in the river reduces* flow area of the river	III	3 5 6	
		Potential	IV	available	· Grazing is slightly controlled by means of the water supply for livestock	Decrease of sedimentation is expected	III	3 5 6	
		Actual	IV	available	· Erosion and slope collapse are not observed owing to the slope protection by dense vegetation along the river	· no impact		4	
		Potential	IV	available	· no applicable	· no impact		4	
	Flooding	Actual	III	IV available	· Overflow from river banks is not observed during floods	· no impact		1	
		Actual	III	IV available	· Intensive flow induces flood occurrence during the wet season.	· no impact		2 4	
		Actual	III	IV available	· Intensive flow induces flood occurrence during the wet season	· Erosion along the river banks is accelerated by floods	III	3 5 6	
		Potential	III	IV available	· Flood discharge is not reduced because the dam has not flood control purpose	· no impact		1 2 3 4 5 6	

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Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Surface water availability	Actual	V	available	· Surface water is utilized in the wet season	· Surface water is utilized for livestock during the wet season	V	1	
		Potential	V	available	· Surface water is stored in the reservoir during the wet season	· Stored water is utilized as a water source for domestic water supply	V	1	
		Actual	V	available	· Surface water is utilized in the wet season	· Surface water is utilized for livestock during the wet season	V	2	
		Actual	V	available	· -ditto-	· Surface water is utilized for livestock during the wet season	V	5	
		Potential	V	available	· Surface water is stored in the reservoir during the wet season	· Stored water is constantly utilized for the uses of domestic water and livestock	V	2 5	
		Actual	V	available	· Surface water is utilized throughout the year	· Stored water is utilized as a water source for domestic water supply throughout the year · Stored water is supplementarily utilized for irrigation purpose during the wet season	V	3	
		Actual	V	available	· Surface water is utilized in the wet season	· Stored water is supplementarily utilized for irrigation purpose during the wet season	V	4	
		Actual	V	available	· -ditto-	· Stored water is supplementarily utilized for irrigation purpose during the wet season	V	6	
		Potential	V	available	· Surface water is stored in the reservoir	· Stored water is utilized as a water source for domestic water supply throughout the year · Stored water is supplementarily utilized for irrigation purpose	V	3 4 6	
	Surface water quality	Actual	III	not available					
		Potential	III	not available					
	Groundwater levels	Actual	V	not available					
		Potential	V	not available					
	Groundwater quality	Actual	V	not available					
		Potential	V	not available					

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur	Embung Site	Mitigatory Measures
			I II III IV V VI				I II III IV V VI	1 2 3 4 5 6	
ATMOSPHERE	Dust, Odor, Noise	Actual	II	available	–	–			
		Potential	II	available	· Air contamination is generated by the construction works in the vicinity area	· Inhabitants and livestock in the vicinity area are affected by air contamination	V	1 2 3 4 5 6	· Proper supervisory works, e.g. education of laborer, construction schedule, safety control shall be performed.

2. Biotic Environmental Impacts

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur	Embung Site	Mitigatory Measures
			I II III IV V VI				I II III IV V VI	1 2 3 4 5 6	
FAUNA	FAUNA	Actual	II	available	· There is not any inhabitant and its migration	· no impact		1 2 3 4 5 6	
		Potential	II	available	· not applicable	· no impact		1 2 3 4 5 6	
FLORA	Forests/trees	Actual	II	available	· There exist savanna and evergreen trees	· Logging by inhabitants is observed	II	1 2 3 4 5 6	
		Potential	II	available	· Logging in the reservoir area caused by dam construction is required	· Limitation of logging area by dam construction accelerate logging activities in the catchment area of the reservoir	I	1 2 3 4 5 6	: Vegetations in the catchment area should be protected by means of artificial remedy

3. Human Environmental Impacts

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
SOCIAL	Human carrying capacity	Actual	V	available	· Human carrying capacity, which is attributed to low farm productivity due to unstable irrigation during the wet season, is still in low level	· Low employment opportunity in the dry season accelerate outflow of labor force from rural area to urban area · Low economic growth is not afford to satisfy the social demand derived from constant population growth	V	3 4	
		Potential	V	available	· Increase of human carrying capacity is expected by means of the provision of sufficient irrigation water supply in the wet/dry seasons	· Control of labor force outflow · Proper economic growth contributes to the social demand derived from constant population growth	V	3 4	
		Actual	V	available	· Human carrying capacity, which is attributed to low farm productivity due to unstable irrigation during the wet season, is still in low level	· Low economic growth is not afford to satisfy the social demand derived from constant population growth	V	6	
		Potential	V	available	· Increase of human carrying capacity is expected by means of the provision of sufficient irrigation water supply in the wet/dry seasons	· Proper economic growth contributes to the social demand derived from constant population growth		6	
	Settlement	Actual	V	available	· Settlement is not recommended to avoid conflict among indigenous social communities	· no impact		1 2 3 4 5 6	
		Potential	V	available	· Settlement is not composed of the project components	· no impact		1 2 3 4 5 6	
	Resettlement	Actual		available	—	—		1 2 3 4 5 6	
		Potential	II	available	· Involuntary resettlement is not applicable because any residence does not exist there	· not applicable		1 2 3 4 5 6	

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Population growth	Actual	V	available	· Population is growing as same rate as nation's average	· Increase of water demand due to population growth causes the shortage of the water supply in coming year	V	1 2 5 6	
		Actual	V	available	· Twice of rapid annual population increase were observed due to implementation of irrigation project in latest 5 years	· Rapid increase of population causes the shortage of domestic water supply	V	3	
		Potential	V	available	· Constant population growth is maintained due to stable domestic water supply and medical and sanitary improvement of living condition	· Sufficient domestic water supply in proportion to the population growth is inevitable to maintain rural living condition in view points of health and sanitation	V	1 2 3 5 6	
		Actual	V	available	· Rapid annual population decreases caused by starvation from drought, and increases by implementation of irrigation project were observed due to in latest 5 years	· Decrease of population was occurred · Deterioration of a sense of social cohesion in their communities	V	4	
		Potential	V	available	· Improvement of living condition is attained through stable farm activities	· Mitigate a decrease of population · Retrieve a sense of social cohesion in their communities	V	4	
	Demographic structure	Actual	V	available	· Poor employment opportunity induces seasonal laborer movement to the urban area	· no impact	V	1	
		Potential	V	available	· not applicable	· no impact	V	1	
		Actual	V	available	· Composition of population ranges in national average by age and sex	· no impact		2 6	
		Potential	V	available	· not applicable	· no impact		2 6	
		Actual	V	available	· Young generation is likely to outflow to urban area	· no impact	V	3 4 5	
		Potential	V	available	· Labor force requirement due to increase of employment opportunity slightly reduces an outflow of young generation to the urban area	· no impact	V	3 4 5	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Social equity	Actual	V	available	· Indigenous practice regarding domestic water utilization, such as water right and distribution methods might incur inconvenience among them	· Restriction of water use might confuse their general concept on water use especially in the dry season	V	1 2 3 4 5 6	
		Potential	V	available	· Social equity regarding water utilization is realized through unification of water distribution system	· Achievement of effective water distribution system is acceptable for inhabitants and it improves social cohesion among them	V	1 2 3 4 5 6	
	Health	Actual	V	available	· Lacking of acknowledge about disease prevention, i.e. excretion in the field is social problem in the health and sanitary points of view	· It causes prevailing oral contagious and rising of waterborne intestinal disease among infant	V	1 2 3 4 5 6	
		Potential	V	available	· Prevention of disease infection is expected by means of stable domestic water supply	· Decrease of contagious disease and infant mortality rate are expected	V	1 2 3 4 5 6	

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur						Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur						Embung Site						Mitigatory Measures
			I	II	III	IV	V	VI				I	II	III	IV	V	VI	1	2	3	4	5	6	
HUMAN USE	Cultivation	Actual					V		available	· Insufficient irrigation water, poor maintenance of irrigation facilities and water distribution management cause low productivity and cultivated area	· Unstable farm management causes low farm income, investment and increase unemployment rate					V				3	4		6	
		Potential					V		available	· High farm productivity and increase of cultivated area are attained by adequate irrigation water supply	· High farm income, investment and employment opportunity are realized by improvement of irrigation system					V				3	4		6	
	Livestock	Actual					V		available	· Surface water is used for livestock during the wet season · Ground water or spring yield are used in the dry season	· Shortage of domestic water is occurred in the dry season · Women are compelled to heavy duties, such as water conveyance					V			2					
		Actual					V		available	· Ground water and spring yield are available during the wet season · Ground water is principally utilized in the dry season	· -ditto-					V					4			
		Actual					V		available	· Spring yield is available	· -ditto-					V							6	
		Potential					V		available	· It is possible to supply stable water for livestock · Effective water distribution system is planned	· Water supply quantity for livestock is kept · Heavy duties of women, e.g. water conveyance, is mitigated					V			2		4		6	
		Actual					V		available	· Majority of water supply for livestock uses surface water throughout the year, the rest uses ground water	· Insufficiency of water supply for livestock is occurred during the dry season due to a shortage of surface flow · Over grazing induces erosion and slope collapse at the riverside				IV	V				3		5		
		Potential					V		available	· Stable water supply is required · Effective water distribution system is required	· Water supply quantity for livestock is kept · Restriction of grazing in the river to control riverside erosion				IV	V				3		5		
	Fisheries	Actual						IV	available	· Fisheries activities are not conducted at downstream of reservoir and at a mouth of river	· no impact							1	2	3	4	5	6	
		Potential						IV	available	· no impact	· no impact							1	2	3	4	5	6	
	Afforestation	Actual	I						available	· Reforestation project is not implemented · Logging is conducted to maintain inhabitants' daily life	· Deterioration of recharge of ground water is observed in the reservoir catchment area · Logging accelerate soil erosion	I						1	2	3	4	5	6	
		Potential	I						available	· Limitation of logging area contributes excess logging in the reservoir catchment area	· Excess logging accelerate soil erosion and results in deterioration of ground water recharge capacity and increase of inflow of sediment into the reservoir	I	II	III	IV			1	2	3	4	5	6	· Increase of recharge capacity of ground water and effect of erosion control are expected by reforestation in the catchment area

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Positive Impact with Project

Negative Impact with Project

Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
	Domestic water supply	Actual	V	available	· Ground water is utilized for the domestic water supply · Private shallow wells are not useful during the dry season because of the decline of water level Public deep wells are useful during the dry season	· Shortage of domestic water supply is observed · Women are compelled to water conveyance	V	1	
		Potential	V	available	· Stable and sufficient domestic water supply shall be attained · Improvement of water system, e.g. distribution tank construction is planned	· Shortage of domestic water supply is reduced at a part of area · Heavy duties of women are mitigated	V	1	
		Actual	V	available	· Ground water or spring yield are available for the domestic water supply · Spring yield is perennially available in the case that well water is dried up in the dry season	· Shortage of domestic water supply is observed · Women are compelled to water conveyance	V	2	
		Actual	V	available	· Ground water or river water are available for the domestic water supply · Water shortage is occurred during the dry season	· -ditto-	V	3 5	
		Actual	V	available	· Ground water (including by pump lifting) and spring yield transmitted by pipeline are available for domestic water supply	· -ditto-	V	4	
		Actual	V	available	· Spring yield and ground water by pump lifting are used for domestic water supply · Shortage of water supply is occurred in a part of service area in the dry season in both water sources	· -ditto-	V	6	
		Potential	V	available	· Reliable water sources and distribution system are to be facilitated · Water distribution plan shall be established to attain stable water distribution	· Shortage of domestic water supply is reduced at a part of area · Heavy duties of women are mitigated	V	2 3 4 5 6	

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
ECONOMIC	Income	Actual	V	available	· Farm income by single cropping in the wet season remains farmers in low income level	· Increase of farm productivity is not expected owing to the deficiency of investment (farm inputs)	V	3 6	
		Actual	V	available	· Increase of disposable income is not expected owing to a low productivity	· Increase of farm productivity is not expected owing to insufficiency of disposable income	V	4	
		Potential	V	available	· Slightly increase of farm income with improvement of farm productivity is expected by means of stable irrigation water supply	· Increase of investment incentive and improvement of living standard are expected with increase of farm income	V	3 4 6	
	Employment	Actual	V	available	· Employment opportunity remains in a low level due to a stagnation of agro-economy	· Outflow of labor force is incurred due to low employment opportunity in the rural area	V	3 4	
		Potential	V	available	· Increase of farm income with improvement of farm productivity is expected by means of stable irrigation water supply	· Outflow of labor force is controlled	V	3 4	
		Actual	V	available	· Employment opportunity remains in a low level because cultivation in the dry season is not enforced	· It causes unemployment	V	6	
		Potential	V	available	· Employment opportunity is created by activation of farming practice with irrigation water supply	· It affects decrease of unemployment	V	6	

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Environmental component	Environmental Issue	Actual or Potential	Places Environmental Issues Occur I II III IV V VI	Evaluation is available or not available	Actual and Potential Aspect	Actual and Potential Impact of Aspect	Places Environmental Impact Occur I II III IV V VI	Embung Site 1 2 3 4 5 6	Mitigatory Measures
CULTURAL	Historic/ archaeological sites	Actual	II	available	· Historic/archaeological remains and cultural assets do not exist	· no impact		1 2 3 4 5 6	
		Potential	II	available	· not applicable	· no impact		1 2 3 4 5 6	
	Lifestyle (quality of life)	Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance	· Physical disorder is observed in women	V	1	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc.	· Release women from physical disorder	V	1	
		Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance for domestic use	· Physical disorder is observed in women · Indifference on education	V	2 5	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc.	· Release women from physical disorder · Interest and spreading in education	V	2 5	
		Actual	V	available	· Women are imposed in heavy duties, e.g. water conveyance for domestic use · Living condition is still in low level	· Physical disorder is observed in women · Living condition is subjected to being distracted by natural disasters	V	3 4 6	
		Potential	V	available	· Alleviation of women's heavy duties by means of stable supply of domestic water, etc. · Living condition is upgraded by increase of farm income and employment opportunities	· Release women from physical disorder · Interest and spreading in education · Inhabitants live in affluent circumstances	V	3 4 6	

Japan International
Cooperation Agency
(JICA)

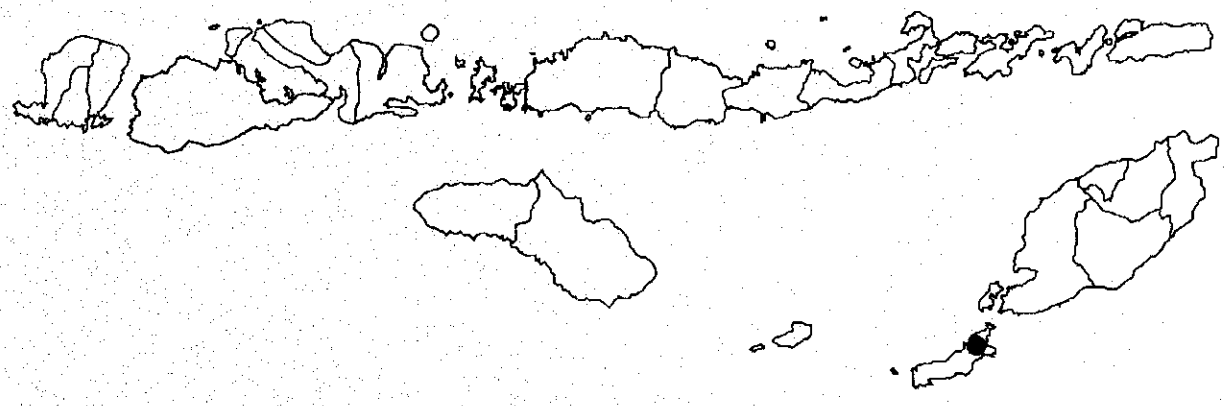
Directorate General of
Water Resources Development,
Ministry of Public Works

The Study
on
The Embung Development Project
(Small Water Impounding Pond Development Project)
in
East Nusa Tenggara and West Nusa Tenggara
in
The Republic of Indonesia

Final Report

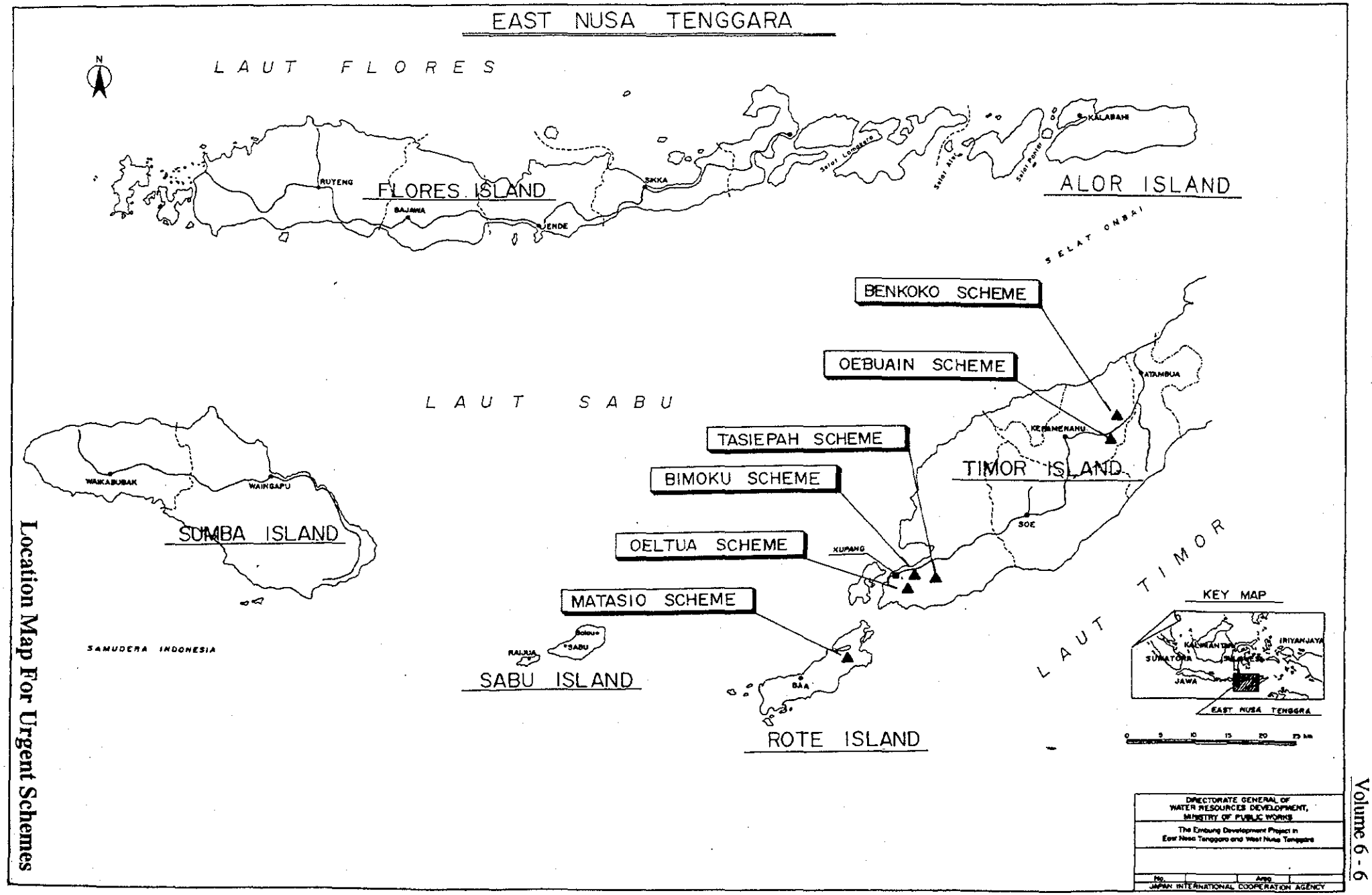
Volume 6-6

Feasibility Study
on
Matasio Embung Development Project

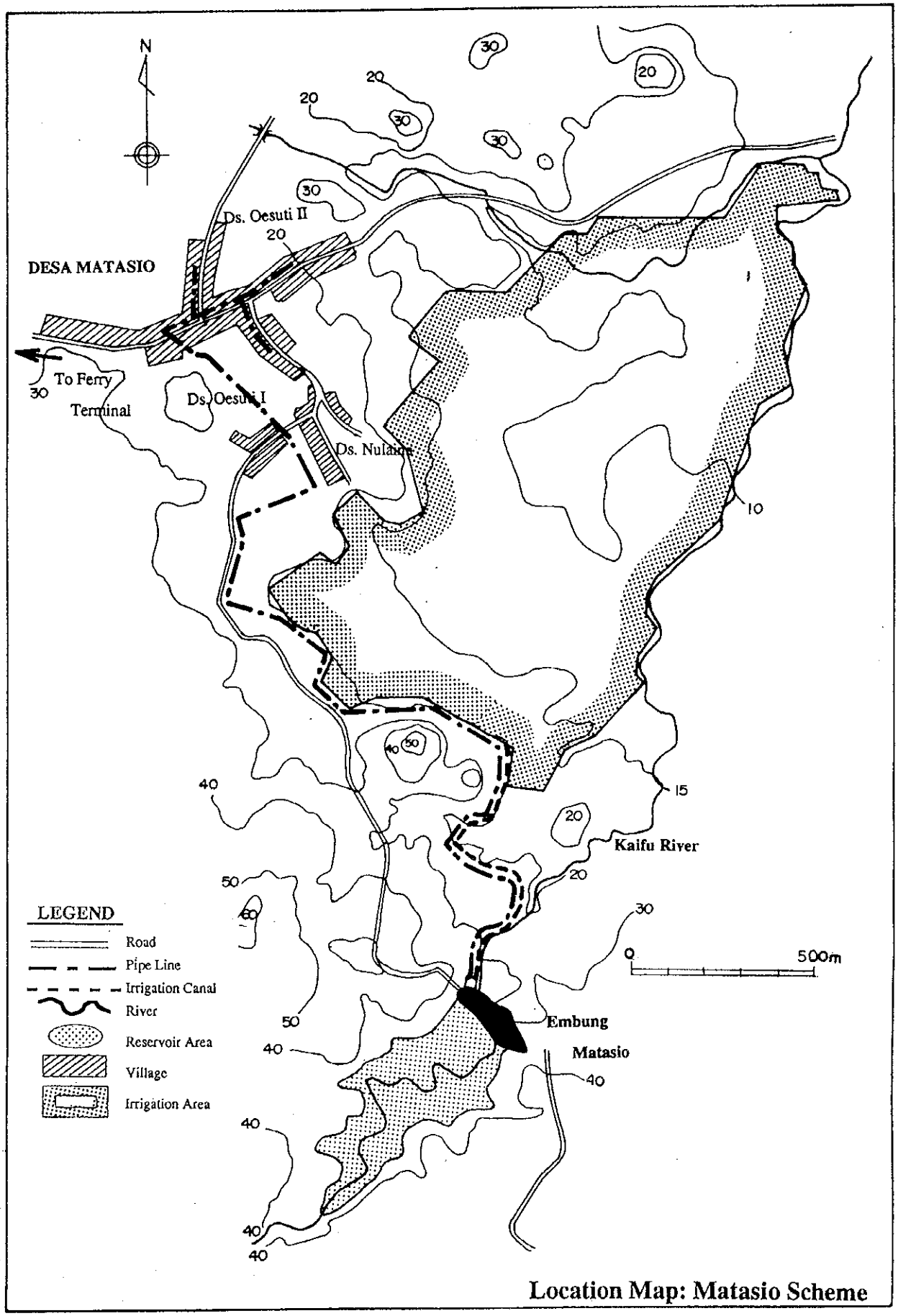


May 1995

Nippon Koei Co., Ltd.



Location Map For Urgent Schemes



Location Map: Matasio Scheme

THE STUDY
ON
THE EMBUNG DEVELOPMENT PROJECT
(SMALL SCALE IMPOUNDING POND DEVELOPMENT PROJECT)
IN
EAST NUSA TENGGARA AND WEST NUSA TENGGARA
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

VOLUME 6-6

FEASIBILITY STUDY
ON
MATASIO EMBUNG DEVELOPMENT PROJECT

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Location of Matasio Embung Development Project

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1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in the eastern part of Rote island across the Rote Strait and around 50 km of southwest of Kupang, the capital of East Nusa Tenggara (NTT) Province. The proposed site of Matasio Embung has coordinates of 123°29'18" east longitude and 10° 37' 60" south latitude.

The Project area extends on the left bank of the Kaifu river. It is bounded on the east by hills and the west by the Korobafo bay. A rolling and undulating hill is distributed along the Kaifu river and, at the proposed Embung site, forms wide valley with flat bottom and steep slope sides. The Project area ranges from 5 to 30 m in elevation. The potential area for irrigated agriculture including the existing irrigation area is flat.

Main residential zone in the Project area is Matasio Village (Desa) in the Sub-district (Kecamatan) of Rote Timur of the District (Kabupaten) of Kupang. This village within the Project area consists of three sub-villages (Dusun); Nulaina, Oesuti I and Oesuti II in Matasio Village.

1.2 Climate and Hydrology

The wet season usually starts from late November and ends early April in the Project area with the average annual rainfall of 1,190 mm. Rainfall pattern is featured by concentrated heavy rains occurring two or three times during the wet season with the maximum 24 hours rainfall record of 120 mm. Mean annual temperature is 27.4°C with the average maximum temperature of 31.0°C and the average minimum temperature of 22.9°C. Mean relative humidity is 72.8%. Average sunshine hours are 4 to 5 hr/day during the wet season and increase to 7 to 8 hr/day in the dry season. Winds are stronger from June to September and weaker from December to March with the average wind velocity of 0.4 km/hr. Tables 1.1 and 1.2 show monthly rainfall record at the Baia Namodale station and climate data at the Penfui station, respectively.

The Kaifu river as a potential water resource is a perennial stream with a catchment area of 5.0 km^2 at the proposed Embung site. There is no gauging station on this river. Usually, the river resume reflects the monthly rainfall pattern. Due mainly to deforestration in the catchment area, sedimentation on the river bed is common along the river stretch.

1.3 Geology

The Project area is underlain by the Tertiary and the Quaternary. The Tertiary is composed of claystone with exotic blocks called the Bobonaro Complex. The Quaternary is formed by coral limestone, alluvial terrace deposits and recent river deposits. With regard to geological formation, the Bobonaro Complex is chaotic and considered to be submarine landslide deposits. The claystone is soft and the exotic blocks are composed of crystalline limestone and calcarious shale. Coral limestone forms Coralline Limestone, being distributed on a ridge of hills. Terrace deposit comprises gravel and sand spreading widely along the river. Recent river deposits are derived from river sediments on the river bed consisting of gravel, sand and clay.

1.4 Soils and Land Use

Soils in the cultivated and cultivable land in the Project area are structured with clay to silty clay, being sticky when wet and very firm when dried. As presence of exchangeable cations is high, soil reaction is slightly alkaline. Response to fertilizer application is high because of poor soil fertility caused by lack of organic matters in the top soil.

At present, a total land of 295 ha is used for agriculture activities comprising wet paddy field of 140 ha, dry upland of 25 ha, estate crop field of 10 ha, and grass land and idle field of 120 ha. Out of the wet paddy field, 20 ha are provided with simple irrigation facilities diverting spring water. In addition, inhabitants in the Project area possess a small piece of home yard growing vegetables and tree crops mainly for their home consumption.

1.5 Demography

The total population in the Project area as of 1993 was 1,305 and the number of households was 116 in total. The breakdown of population and household by sub-village is shown in Table 1.3. The average family size is 4.2 persons. Heterogeneous ethnics are originated from Rote. The majority of inhabitants are Protestant and engaged in agriculture. Their average education attainment is primary school grade.

1.6 Domestic Water Use

There exist six springs and seven wells in the Project area. Users of these water supply sources are not directly suffering from water shortage problem but some conflicts for the dry season because many people and livestock come from the outside of the village to get water at these perennial water sources. The present water use in each sub-village clarified under the Study is summarized as follows:

- In Nulaina Sub-village with 47 families and 205 persons, there is one public water basin at a distance of 200 m on an average from 47 families for using Nulaina spring water. In addition, 22 families are also using three private-owned wells at an average distance of 15 m. Discharge of these wells reduces from October to December. The total number of livestock is equivalent to 32 heads of cow and water for these livestock use is taken from Oekaifo spring;

- In Oesuti I Sub-village with 36 families and 150 persons, 20 families are using two private-owned wells at an average distance of 10 m. Discharge of these wells reduces from October to December. The remaining 16 families without any specific water source are getting water from springs in the neighboring sub-villages. The total number of livestock is equivalent to 135 heads of cow and water for these livestock use is taken from three springs in Oesuti II Sub-village; and,

- In Oesuti II Sub-village with 33 families and 133 persons, there are two public water basins; one at a distance of 200 m on an average from 28 families for using Oesuti spring water and the other at a distance of 1,000 m on an average from five families for using Oebau spring water. The total number of livestock is equivalent to 80 heads of cow and water for these livestock use is taken from the Oebau spring as well as another two springs, Oetinala and Oeloloen.

1.7 Social Infrastructures

The access from Kupang to the Rote island is by ferry. It takes four hours. A paved road of 15 km and an off-road of 3 km connects the ferry terminal with the Project area. All the sub-villages in the Project area have no rural electricity supply. In the Project area, there is no hospital but a health integrated post.

All of 116 families are using spring water for bathing and washing at outside of their houses. Further, they are using public toilets for defecating purposes. Under such circumstances, inhabitants in the Project area are sometimes suffering from various diseases like vomiting and diarrhea, dysentery, roundworm, and so on.

1.8 Agriculture and Livestock

In the Project area, there exists farm land of 295 ha in total of which currently cultivable land occupies 175 ha. The present planted area amounts to 73 ha comprising rainfed paddy of 60 ha, maize of 3 ha and coconut of 10 ha. Rainfed rice cultivation predominates, while irrigated rice cultivation is practiced on the wet paddy field where spring water can be used during the wet season. Maize is the main crop grown on upland under the rainfed condition. The present cropping pattern is single cropping of paddy on the wet paddy field and maize on the dry upland during the wet season. The overall cropping intensity is thus 42% for farm land except grassland due to existence of idle paddy field.

In the Project area, the wet paddy field is prepared by an animal-drawn plough and harrow. The high yielding rice variety of IR 64 is commonly used, while fertilizers are not applied as usual. No serious plant pests are reported under the hot and dry weather condition, and farmers put insecticide if necessary. Harvesting is principally done by family labor force with an additional input of hired labors. Farming practices for growing dry upland crops are very simple and primitive with direct sowing on harrowed field and no fertilizer application. The average yield level at present is 2.25 ton/ha for paddy and 2.0 ton/ha for maize. Annual crop production is 13.5 tons for paddy and 6 tons for maize.

As of 1993, a total of 154 cows/buffaloes, 6 horses, 400 goats/sheep, 300 pigs and 150 chickens/ducks were raised in the Project area. The breakdown of livestock population by sub-village is shown in Table 1.4. The majority of goat/sheep and pigs are marketed to and slaughtered in Kupang.

1.9 Irrigation Facilities

In the Project area, there exists the wet paddy field of 140 ha in net on the left bank of the Kaifu river. This paddy fields is located in the flat area at 1.0 km downstream from the Embung site. Farmers use spring water to irrigate their paddy field of 20 ha out of the available paddy field.

1.10 Agro-economy

In terms of agricultural extension services, one rural extension center (BPP) is established in Matasio Villages directly under the District Agricultural Office (Dinas Pertanian Kabupaten) covering its own working area with field extension workers (PPL). In the Project area, however, most of the farmers have no frequent access to the PPL's extension activity at present due mainly to limited number of transportation means and amount of budget in BPP.

Farmers are organized as memberships of Agricultural Cooperative (KUD). As KUD's branch shop in the Project area is not active at present, farmers buy necessary farm inputs from local markets or merchant shops. Agricultural credits are available in the service network of the Indonesian People's Bank (Bank Rakyat Indonesia), consisting of short-term credits to cover one crop season and a mid-term credit of five years to support farmers' small investment.

Food production in the Project area is used for home consumption of farmers themselves. They sell farm products in local markets in the Project area or middlemen for markets in Kupang when farmers need cash. The results of agro-economy survey carried out under the Study reveal that farmers in the Project area usually have some deficit in their home economy with the average annual income of Rp. 1,564,000 and expenditure of Rp. 1,883,000 as shown in Table 1.5.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs

In the Project area, it is common for 488 inhabitants to carry water from available water sources to their homes at the average distance of 135 m throughout a year. During the dry season when many people and livestock come from the outside of the Project area to get water, conflicts often occur between them and inhabitants of Lasiana and Tarus. Such condition has made public water basins and tanks dirty by excreta resulting in dissemination of infectious diseases among villagers. Further, the limited availability of water resources has prevented farmers' willingness to introduce improved crop production system with irrigation facilities.

The pressing necessity of inhabitants in the Project area is to meet basic human needs (BHN) aiming at improvement of their living conditions paying special attention to avoid the said water conflicts caused by lack of perennial water sources around the Project area. In addition, the inhabitants are eager to get sufficient water for maintaining their livestock which are their sources of nutrition and cash income.

The available land resources suitable for agricultural use amount to 175 ha in the Project area. The wet paddy field occupies 140 ha comprising irrigated paddy field of 20 ha and rainfed paddy field of 120 ha. From the topographic viewpoints, all of rainfed paddy field are irrigable if irrigation water source is created. With the condition that irrigation water can be secured, the existing farm land resources can be expected to be fully utilized by practicing the following cropping pattern.

Proposed Cropping Pattern

Crops	Area (ha)	Nursery	Transplanting/Planting	Harvesting
Wet Season				
- Paddy	75	Dec. 5 - Jan. 5	Jan. 1 - Feb. 1	Apr. 15 - May. 15

2.2 Water Demand

The estimated per capita domestic water consumption in the Project area is about 25 lit/day being far below the regional levels, 123 lit/day for NTT and 144 lit/day for Kabupaten Kupang. The future water demand in the Project area comprises domestic water for inhabitants, livestock water and irrigation water. In the draft Repelita VI (1993/94 to 1998/99), the Provincial Government of NTT has set the goals of meeting BHN by 1998. In terms of domestic and livestock water supply, the target is 60 lit/day/capita for rural people and 40 lit/day/head for cow.

In comparison with the present level of water consumption and taking into consideration limited availability of water resources in the Project area, the target year to reach the above water supply levels is to be set 2003/04, the last year of Repelita VII, under the Study. Also, the above per capita water supply target of 60 lit/day is to include drinking, bathing, defecating, washing, gardening and unaccounted-for water. The future population of inhabitants and livestock in the target year is estimated by the Study referring to the projected population growth rates made by the Provincial Statistic and Livestock Offices.

(1) Domestic water demand

The future population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.3 based on the projection of population growth rate mentioned in the above. The total population projected is 576 in the Project area. The future water demand is calculated by multiplying the target per capita water supply amount by the projected population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 12,614 m^3 and the breakdown by each sub-village is shown in Table 2.1.

(2) Livestock water demand

The future livestock population in the target year of 2003/04 is projected for each sub-village located in the Project area as shown in Table 1.4 based on the projection of livestock population growth rate mentioned in the above. The livestock population projected is 200 cows/water buffaloes, seven horses, 582 sheep/goats, 481 pigs and 285 chickens/ducks as a whole in the Project area.

Regarding daily water consumption of livestock other than cow, unit water requirement assumed in "The Study for Formulation of Irrigation Development Program in the Republic of Indonesia" is employed; 40 lit/head/day for cow/buffalo, 5 lit/head/day for sheep/goat, 6 lit/head/day for pig and 0.6 lit/head/day for poultry. That for horse is assumed to be 40 lit/head/day. The future water demand is calculated by multiplying the target unit water supply requirement by the projected livestock population.

The projected water demand in the Project area for the target year of 2003/04 amounts to 5,201 m^3 and the breakdown by each sub-village is shown in Table 2.1.

(3) Irrigation water demand

Irrigation water demand is estimated for unit irrigation area of 1 ha on the semi-monthly base taking into account crop consumptive use, evapotranspiration, crop coefficient, effective rainfall and irrigation efficiency both for paddy and Palawija crops as well as land preparation water, layer replacement and percolation loss only for paddy. As described in Attachment 1, irrigation water demand in the Project area is calculated by referring to standards quoted in "Irrigation Design Standard, KP-01" by DGWRD.

Tables 2.2 and 2.3 show the calculation results of evapotranspiration and effective rainfall, respectively, and Table 2.4 presents irrigation water requirement. Annual unit diversion requirement of irrigation water for irrigated paddy field of 1 ha amounts to 10,010 m^3 and 7,660 m^3, respectively.

2.3 Development Constraints

Available water resources in Matasio Village are used by inhabitants living in and around the Project area for meeting their BHN during the dry season. These water resources are insufficient to cover increasing water demand. The only one potential water resource is thus the Matasio river with the possibility of developing Embung as water reservoir.

In developing water resource potential of the Kaifu river, it is said that there are not so much serious limitations in terms of topography, geology, hydrology, environment and socio-economy. In the western part of Timor island, 92 small Embungs have already been developed for domestic and livestock water supply, and another 11 Embungs in Sumba and Rote islands for domestic and irrigation water supply. The average height of these Embungs is 7.15 m for the case of domestic water supply and 8.75 m for the case of irrigation water supply. Under such situation, therefore, technical know-how to construct higher Embung has not been accumulated yet in both the public and private sectors in NTT.

2.4 Development Concepts and Approach

In order to correct economic imbalance between NTT and other Provinces in harmony with the national policy, it is prerequisite to give the highest priority over improvement of infrastructures related to BHN and the second priority to betterment of agricultural production

base in rural areas of NTT. Among others, special attention should be paid to how to solve chronic water shortage problem under the dry weather condition being characteristic of NTT.

The objective of the Project is a part of the strategies of the Government to improve BHN, to alleviate poverty of rural areas and to achieve a balanced regional development throughout the country. The objective of water resources development through construction of Embung is to supply domestic and livestock water to rural people for meeting their BHN as well as to utilize the existing farm land resources to the fullest extent by providing with irrigation water.

Through the previous identification study undertaken by the NTT Provincial Irrigation Service (PRIS) in 1992, a possible site to construct higher Embung was found on the Kaifu river nearby Matasio Village. In the course of the Study, therefore, it is firstly to examine water resources development potential at this site called Matasio Embung from the viewpoints of topography, geology, soil engineering and hydrology. If the examination results reveal that there is possibility of creating new permanent water source facility, development strategies of the Matasio Embung are to be worked out including the optimization of development scale and then technical feasibility of Embung development is to be confirmed. In the end, development impacts are to be assessed from social and environmental viewpoints as well as from an economic consideration if necessary.

3. EXAMINATION OF EMBUNG DEVELOPMENT POTENTIAL

3.1 Topographic Condition

The original site of Matasio Embung was identified by the PRIS through its identification study done in 1992. Under the present Study, the original site as shown in Figure 3.1 is reviewed from topographical and geological points of view including mapping and geological investigations. As a result, it is reconfirmed that selection of the original site by PRIS is topographically appropriate. Thus, the original site is taken up as the proposed Embung site for the Study. At the proposed site, the Kaifu river flows through rather deep and wide valley on the gentle slope of hill. The width of valley is around 300 m and the elevation of riverbed is El. 24.0 m. The left bank shapes very gentle slope of about 3° up to around El. 30.0 m and then becomes steep to very steep slope of about 8° up to about El. 40.0 m. The right bank is of very gentle slope of about 3° up to around El. 27.0 m and then becomes steep slope of about 10° up to about El. 47.0 m. Elevation of hills surrounding the proposed reservoir ranges about 35.0 to 57.0 m above sea level.

3.2 Geological Condition

Under the Study, geological investigations including core drilling works are conducted in the proposed Embung site. The results of core drilling, standard penetration test and field permeability test are presented as Attachment 2. Figures 3.2 and 3.3 depict geological map and profile of the proposed Matasio Embung, respectively.

The proposed site of Matasio Embung is underlain by mainly claystone of Bobonaro Complex and partly coral limestone. The claystone is found below El. 32.0 m on the left bank and El. 38.0 m on the right bank, while the coral limestone appears above El. 32.0 m on the left bank. The foundation rock of the proposed site is composed of claystone of Bobonaro Complex. Some of terrace deposits with a thickness of 3 to 5 m and small amount of alluvial deposits are confirmed on the river bed portion.

The result of field permeability test reveals that the coefficient of permeability is 2×10^{-6} and rather constant in the vertical direction. In the design of the foundation treatment, therefore, ordinary care against for seepage or leaking the water from the reservoir through dam foundation or the abutments is taken into consideration. According to the standard penetration test, the average N-value will be expected to be more than 12 for the claystone and at least 14 for the coral limestone. The result of unconfined compression test on recovered core samples of drilling works shows that the unconfined compression strength is only 29 kg/cm^2 and the geological formation of the claystone is not so hard for the dam construction. In this connection, special consideration is required for determination of dam type.

The reservoir area is underlain by mainly the claystone of Bobonaro Complex. No major fault and landslide are recognized in the field. It is prospected that no water leakage through the claystone occurs in the reservoir area because of its compact layer. No special attention is therefore needed to introduce practical countermeasures for water leakage.

3.3 Availability of Embankment Materials

In 1992, PRIS carried out construction material survey to check embankment and concrete aggregate materials in and around the proposed Matasio Embung site. In addition, the second material survey is performed under the Study, comprising field test pitting and laboratory tests. In due consideration of the results of the second material survey and the required quantity of embankment materials, the borrow area is selected in the reservoir area as shown in Figure 3.1. The location of test pits is shown in Figure 3.1 and the results of laboratory tests are presented as Attachment 3.

(1) Embankment materials

In general, earth materials in the reservoir area are composed of relatively fine grained soils. The result of gradation analysis in the borrow area is shown below.

Result of Gradation Analysis

Test Pit No.	Passing sieves (%) No. 4	No. 200	Classification
TP. 1	77	32	CL
TP. 2	92	84	CH
TP. 3	93	81	CH
TP. 4	97	94	CH
TP. 5	100	97	CH

As physical property to oppose piping, mean value of Plastic Index (PI) is 39, being satisfied with the quality level which enables the materials to prevent the piping phenomena.

The result of compaction test of the materials in the borrow area are as follows:

- Maximum dry density (γd max.) ranges from 1.43 to 1.75 ton/m^3 and 1.60 ton/m^3 on an average, which are slightly high in comparison with 1.50 as an average of CH generally;

- Optimum moisture content (OMC) ranges from 16.1 to 29.5% and 22.0% on an average;

- The discrepancy between OMC and the natural moisture content (NMC) is approximately 18%, wetter side from OMC. Considering the sampling time of early May 1994, NMC is more favorable in respect of the moisture control which is required in the embankment works because other borrow materials are slightly drier than those OMC. Accordingly, the moisture control needs to be considered at the borrow area during the construction period; and,

- According to the shear strength test carried out by using unconsolidated-undrained tri-axial compaction test (U-U test) apparatus under the OMC condition, the average values of internal friction angle and cohesion are 26° and 0.73 kg/cm^2, respectively. The test method is however based on U-U test which is applied to get a design value for the case of just after completion of a dam.

For a design value under the full supply level (F.S.L.) and earthquake conditions, the shearing strength at consolidated-undrained test under the effective stress condition is provisionally estimated at 24° for friction angle and 0.11 kg/cm^2 for cohesion by using the standard values of soil classified as "CH" of ASTM Unified Soil Classification.

(2) Sand and gravel materials

Sand and gravel materials to be used for the filter of the dam embankment, i.e., horizontal drainage mattress and the embedded filter below riprap protection, are coral sand to be quarried from seashore located between Olafulihaa and Leli. The sand and gravel materials for concrete aggregates will be procured at the site from the supplier.

3.4 Availability of Water Resources

(1) Catchment yield

As for the Kaifu river, there has been no record of discharge. Accordingly, runoff at the proposed Embung site is estimated by use of the rainfall record near the proposed site. Baia Namodale rainfall station which is located in the east of the Matasio Embung catchment has rainfall record of nearly consecutive 10 years and is considered to represent catchment rainfall. A runoff coefficient of 0.30 is adopted considering the characteristics of the catchment area and previous hydrological analysis in the Timor Island. Using this runoff coefficient and rainfall record of the Baia Namodale station, river flow of the Kaifu river at the proposed Embung site is estimated.

The following conditions are considered for estimation of the half monthly discharge:

- Catchment area of the proposed Embung site is 5.0 km^2; and,
- Less than 20 mm of half monthly rainfall is ignored for estimation.

This estimation is made based on the rainfall record from 1931 to 1940. The estimated half monthly discharge is given in Table 3.1 and summarized below:

Mean Monthly Discharge

Unit: 1,000 m^3

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
431	356	429	30	74	17	8	7	0	0	74	284	1,710

(2) Floods

The flood analysis is made to determine the design discharge of the structures, such as spillway, diversion tunnel, and so on. Taking availability of the flood record and size of the catchment area into account, the rational formula is adopted to estimate the flood discharge in the Study. The formula is;

$$Q = 0.2778 \, f \, r \, A$$

where, Q : Peak discharge (m^3/s)
f : Runoff coefficient
r : Average rainfall intensity within time of concentration (mm/hr)
A : Catchment area (km)

1) Design rainfall

Design rainfall is estimated by the Log Pearson Type III method, which is widely used in NTT. In this study, 9 years rainfall data of the Lobalain station from 1981 to 1992 are analyzed by the method. The result of probability analysis is summarized below.

Design Rainfall

Unit : mm

Return Period	Design Rainfall
1 in 2 year	115
1 in 5 year	136
1 in 10 year	149
1 in 20 year	160
1 in 50 year	175
1 in 100 year	185
1 in 200 year	195

2) Design flood

The following formula is the Ruziha's formula to estimate the flood travel time:

$T = L/V$
$V = 72(H/L)^{0.6}$

where, T : Flood travel time (hr)
L : Horizontally projected length of river course (km)
H : Difference of elevation (m)
V : Velocity of flood (km/hr)

The rainfall intensity within concentration time of the flood is estimated by an empirical formula prepared by Dr. Mononobe as follows:

$r = (R_{24}/24) \times (24/T)^{2/3}$

where; r : Maximum average rainfall intensity within concentration time (mm/hr)
R_{24} : Daily rainfall (mm)
T : Time of concentration (hr)

The runoff coefficient is estimated at 0.8 considering the condition of the catchment area.

Based on the above condition, the peak floods in various return period are estimated. The result is shown in Table 3.2 and summarizes below.

Probable Flood

Unit : m^3/s

Return Period	Probable Flood
1 in 2 year	20
1 in 5 year	24
1 in 10 year	26
1 in 20 year	28
1 in 50 year	31
1 in 100 year	33
1 in 200 year	34

(3) Sediment load

There is no available data on sediment load on the Kaifu river. The Technical Report I (Embung Study Program) in the Sumbawa Water Resources Development Planning Study Extension Phase in 1982 indicates that the sedimentation rate is 0.5 mm/year/km^2. Taking data availability and characteristics of the catchment area into account, the same value is adopted in this Study.

(4) Water Quality

On June 6, 1994, water samplings were carried out at the proposed Embung site and upstream and downstream of the site for the clarification of the water quality. The result of the test is shown in Table 3.3.

4. EMBUNG DEVELOPMENT PLAN

4.1 Optimization of Development Scale

(1) Cases for comparison

In order to determine the optimum development scale of Matasio Embung, the following two cases are compared:

- Case-1 : To develop Embung with the minimum height of 10.0 m to store water necessary for meeting domestic and livestock water demand. In this case, irrigation water can be also supplied to the existing rainfed paddy field of 40 ha during only the wet season; and

- Case-2 : To develop Embung with the maximum height of 11.0 m within the limitation of available run off to store water necessary for meeting domestic and livestock water demand as well as for irrigating the existing rainfed paddy field of 75 ha during only the wet season.

(2) Methodology

The simulation equation is as follows:

$$W_2 = W_1 + I - L - S_P - O_D - O_L - O_I$$

where , I : inflow to reservoir at the half monthly period (m^3)
L : water losses from the reservoir caused by evaporation during the half monthly period (m^3)
S_P : flow of water over the spillway during the half monthly period (m^3)
O_D : outflow needed for domestic water during the half monthly period (m^3)
O_L : outflow needed for livestock water during the half monthly period (m^3)
O_I : outflow needed for irrigation water during the half monthly period (m^3)
W_1 : volume of water in the reservoir at the beginning of the half monthly period (m^3)
W_2 : volume of water in the reservoir at the end of the half monthly period (m^3)

1) Inflow

Since there is no gauging station on the Kaifu river, discharge is generated from rainfall of the Baia Namodale station.

2) Reservoir storage curve

Reservoir storage curve with surface area is shown in Figure 4.1 in relation to the elevation at the proposed Embung site.

3) Losses

Evaporation from inundation area can be estimated as "1.1 x ETo" indicating "open water evaporation", which is employed in the Design Criteria KP-1.

4) Spill out discharge from reservoir

Spill out discharge is considered if there is any excess storage which exceeds the maximum storage capacity of dam. The probability that the spill out comes in the wet season is set at about 80%.

5) Water demand

The annual water demand for the domestic water and livestock are outlined below.

Annual Domestic and Livestock Water Demand

Description	Unit	Numbers	Demand (m^3/year)
Beneficiaries	Nos.	576	12,614
Livestock (equivalent to cow)	Nos.	356	5,201

The 100% dependability of the above demand shall be secured by the proposed Matasio Embung.

As for the irrigation water demand, maximum irrigable areas for the both wet and dry seasons are outlined below.

Annual Irrigation Water Demand

Description	Area (ha)	Demand (1,000 m^3/season)
Maximum area in the wet season	140	1,401
Maximum area in the dry season	140	1,072

To meet 80% dependability of irrigation water, reservoir capacity will be determined.

The priority of water use is to be given to domestic water, livestock water, irrigation water for the wet season and irrigation water for the dry season in order.

6) Water level of reservoir

Minimum water level is estimated at El. 27.3 m considering sedimentation volume for 25 years and 0.5 m allowance. Maximum water level for the simulation is equal to the crest elevation of spillway. Probable maximum high water level according to topography is set at El. 36.0 m.

(3) Optimum development scale

From the hydrological viewpoint, the maximum height is unable to go beyond 11.0 m. For the purpose of improving inhabitants' living condition and also strengthening their production basis, therefore, the Case-2 is selected for the Study as the optimum development scale of Matasio Embung with the height of 11.0 m and effective storage capacity of 0.445 million cubic meters (MCM). The result of reservoir operation of the Case - 2 is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

By developing the proposed Matasio Embung at the optimum scale, the beneficiary area of domestic and livestock water supply from the Matasio Embung covers Nulaina, Oesuti I and Oesuti II Sub-villages with 576 inhabitants and 356 heads of cows in total. The beneficiary irrigation area is 75 ha, but it is limited to supplemental irrigation water supply to the wet season paddy. The beneficiary area of Matasio Embung is shown in Dwg. - 601.

4.3 Embung Development Plan

Following the results of the geological and material surveys as well as the optimization study, the proposed development plan of Matasio Embung is determined. In terms of dam type, homogeneous earthfill type is applied in due consideration of the foundation strength and the availability of embankment materials.

The main components of Matasio Embung are the main dam, spillway, river diversion conduit and water supply facility as shown Dwg. - 602. In order to provide the reservoir with the total storage capacity of 0.53 MCM , F.S.L. is set at El. 32.0 m. Taking overflow depth of spillway and freeboard into account, the dam hight of Matasio Embung becomes 11.0 m above the river bed. In order to release the flood discharge during the construction period, a river diversion conduit with two lanes of concrete pipes of 1.2 m in diameter is provided below the dam body. The spillway is designed on the left bank of the main dam to release the flood discharge of 33 m^3/sec from the catchment area of 5.0 km^2. For the purpose of supplying domestic, livestock and irrigation water to the beneficiary area, such related facilities are provided as an intake structure in the reservoir, water supply pipe with a diameter of 300 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Matasio Embung are summarized below.

(1)	Reservoir	
	- Catchment area	5.0 km^2
	- F.S.L.	El. 32.0 m
	- Minimum operating level	El. 27.3 m
	- Effective storage capacity	445,000 m^3
	- Dead storage capacity	85,000 m^3
	- Gross storage capacity	530,000 m^3
	- Sediment deposition level	El. 26.8 m
(2)	Main dam	
	- Type	Homogeneous earthfill
	- Height	11 m above river bed
	- Crest elevation	El. 35.0 m
	- Crest length	297 m
	- Crest width	6.0 m
	- Upstream slope	1:4.0
	- Downstream slope	1:3.0
	- Total embankment volume	110,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	33 m^3/sec
	- Type	Non gated overflow
	- Crest elevation of overflow weir	El. 32.0 m
	- Width of overflow weir	9.1 m
	- Discharge capacity	33 m^3/sec
	- Length	120 m

(4)	River diversion	
	- Design flood (1/5 year)	7.0 m^3/sec
	- Type	Pipe culvert
	- Diameter	1200 mm x 2 nos.
	- Length	190 m (Pipe 100 m, Open 90 m)
(5)	Water supply system	
	- Inlet structure	1.0 x 1.0 m with trashracks
	- Pipe diameter	300 mm

5. PRELIMINARY DESIGN OF FACILITIES

5.1 Preliminary Design of Embung

(1) Freeboard

The freeboard of the main dam is designed taking into consideration the rise of the reservoir water surface due to extraordinary flood discharge and wave uprush on the slope.

The following formula is applied for the design of the dam in the Matasio Embung;

$Hf = 0.05h + 1.0$ (m)

where, Hf : freeboard
h : height from river bed to the designed flood level.

(2) Stability of dam slopes

1) Design criteria

The design criteria adopted for evaluating the stability of the dam body comprises:

- Stability of a dam embankment as a whole and safety against surface sliding of the embankment slopes; and,
- Hydraulic stability of embankment materials and safety and serviceability against leakage.

The reservoir condition to be considered here is at F.S.L. of 32.0 m under seismic condition. The dam slopes for upstream and downstream are determined using the stability calculation.

The required minimum safety factor for the stability of the embankment is 1.2 for all cases. Seismic coefficient of 0.15 is applied for the stability calculation taking into consideration design seismic coefficient applied for dam and irrigation projects.

2) Design value

Considering the result of laboratory tests, the design values of the embankment materials for the stability calculation are as shown in Table 5.1.

3) Slope stability against sliding

A slip circle method is used for the stability analysis. The basic concept of the method is to check if the resisting moment of the force along a presumed slip circle line exceeds the driving moment caused by gravity and seismic forces. The ratio of those two moment gives the safety factor for sliding.

The result of the numerical calculations is summarized in Figure 5.1.

(3) Horizontal filter drain and toe rock drain

In order to reduce the seepage line within the dam body under full reservoir water condition, horizontal filter drain (drainage mattress) and toe rock drain are provided below body and at toe portion of the main dam as shown in Dwg. - 602.

(4) River diversion during construction

During the dam embankment period, river flow including floods has to be diverted to avoid inundation of the Embung site. This can be effectively and economically made by providing a random-filled cofferdam and utilizing the concrete pipe culvert with diameter of 1.2 m x 2 Nos. as a diversion facility as shown in Dwg. - 604. Since the volume of flood inflows from 5.0-km^2 catchment will be quite small as compared to the storage created by constructing low cofferdams, a 2 m high cofferdam with a crest level of El. 26.0 m would suffice to contain the dry season flood inflow of 7.0 m^3/sec having a return period of five years.

(5) Spillway

The spillway is located on the left abutment of the Embung, which is composed of side channel type overflow weir, throughway, chuteway and downstream channel. The overflow weir is designed to cope with the inflow design flood with a flood surcharge space provided above F.S.L. The inflow design flood is determined at 100-year probable flood having a peak discharge of 33 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, overflow depth at 1.4 m and width of 9.1 m are decided so as to minimize the costs of spillway and the main dam.

A non-gated ogee crest would be set at El. 32.0 m to coincide with F.S.L. A bridge would be provided over the throughway of the spillway.

The profile and sections of spillway are shown in Dwg. - 603.

(6) Water supply system

In order to meet BHN and irrigation to the downstream water users, the water supply system is provided to release the water of 100.56 lit/sec throughout the year, which consists of intake structure, pipe line and valve house. The intake structure is located in the reservoir area just above the sediment deposition level of El 26.8 m. Fixed trashracks are provided on the intake structure. Cast iron pipe with diameter of 300 mm is connected from the intake structure to the downstream through the main dam. The detail of water supply inlet is given in Dwg. - 604

The value house would be constructed near the downstream toe of the dam. The guard valve and control devices would be installed in the valve house. The detail of the valve house is shown in Dwg. - 605.

5.2 Preliminary Design of Water Distribution Facilities

(1) Basic concept

The following basic concepts are applied for executing the preliminary design of water distribution facilities for inhabitants and livestock in the beneficiary area :

- Distribution facilities to the beneficiary area are selected taking into consideration the effective storage capacity of the Embung, topographic condition of the Project area, village boundary and the existing water supply facilities;

- Water demand for inhabitants and livestock are fully referred to the preliminary design of pipeline and the arrangement of division boxes in the beneficiary area;

- The system of pipelines with pressure flow is used for the water distribution system from the Embung to the beneficiary area. Pipes are arranged along the

existing roads as much as possible from the viewpoint of easiness of the operation and maintenance of the pipe lines. Pipes are set at around 50 cm below the ground surface;

- Division boxes for inhabitants, of which capacity is estimated at 6,000 lit/100 persons, are arranged based on the water demand, the water conveyance distance by inhabitants from the proposed division boxes to their houses and the topographic condition at sites division box sites;

- Division boxes for livestock, of which capacity is estimated at 900 lit per 22 heads of cow /buffalo, are arranged based on the water demand and taking into consideration the locations not affecting the division boxes for inhabitants;

- Related structures of pipelines such as check valves, air valves and blow offs are planed to be set taking into considerations the locations of pipelines and their topographic conditions; and,

- The High Density PVC pipe is used for the water supply taking the safety against the unexpected high pressure to the pipe, the steep and undulating topographic condition in the area and the easiness to get the materials in Indonesia into account.

(2) Beneficiary area and design discharge for pipelines

Beneficiary area of the domestic water and livestock water supply from the Oeltua Embung covers three villages located at around 2.5 km downstream of the proposed Embung site. The total beneficiary inhabitants to be supplied with domestic water is estimated at 576 persons based on the population projection. Further, the projected livestock population in the beneficiary area is estimated as shown below with unit water demand.

Projected Livestock Population in the beneficiary area of Matasio Embung

Livestock	Numbers (heads)	Water demand (lit/head/day)
Cattle/Buffalo	207	40
Sheep/Goat	582	5
Pig	481	6
Poultry	285	0.6

Design discharge of pipelines is estimated at 0.56 lit/sec adding the design discharge of domestic water supply estimated at 0.40 lit/sec taking the above population and the domestic water demand of 60 lit/sec/day and livestock water supply estimated at 0.16 lit/sec taking the above numbers and water demands.

(3) Preliminary design

In due considerations of the above basic concept and the design discharge, the locations of pipelines and related facilities are planed to be set as shown in Dwg. - 601. Design of pipelines is executed by using the Hazen Williams formula. Typical designs for related facilities such as check valves, air valves, blow offs and division boxes for domestic water supply and livestock water supply are shown in Dwg. - 606. Required water distribution facilities for domestic and livestock water supply are summarized below :

Water Distribution Facilities Required for the Matasio Scheme

Facilities	Quantities
Pipe Line	
- Dia. 75 mm	3.7 km
- Dia. 65 mm	0.3 km
Related Facilities	
- Check valve	5 Nos.
- Air valve	1 Nos.
- Blow off	1 Nos.
- Division box for domestic water	6 Nos.
- Division box for livestock	10 Nos.

5.3 Preliminary Design of Irrigation Facilities

(1) Basic concept

The following basic concepts are applied for the preliminary design of irrigation facilities in line with the development strategy :

- Irrigation is carried out by using the remaining impounded water after satisfying of domestic and livestock water requirements fully in the beneficiary area;
- Irrigation water is supplied firstly to the existing cropped field, irrigated or rainfed, in the beneficiary area;
- Irrigation area is defined taking into consideration availability of irrigable area and the effective storage capacity of the Embung;
- Irrigation canal from the outlet of Embung to the head of existing cropped field is constructed in the form of open channel as much as possible from the economic viewpoint;
- Irrigation system in the existing cropped field is developed by farmers themselves as the irrigation system commands around 50 ha only. No consideration is taken into in terms of new land reclamation;
- Proper design of canal alignment for gravity irrigation is conducted paying special attention to avoid adverse effect on environment; and,
- Drainage improvement is not be required for the existing cropped field since the beneficiary area is situated on well drained land.

(2) Irrigation area

There exists paddy fields of 140 ha in net at around 1.0 km downstream from the proposed Embung site expanding on the left side of the Kaifu river. This paddy field is mainly rainfed and partly irrigated by using spring water. Based on the optimization study and water resources allocation plan, the future irrigation area is to be 75 ha in net for the wet season paddy.

(3) Irrigation plan

The outlet works of the Embung are planned to be used for dual purposes of supplying irrigation and domestic water. The water taken from the reservoir is led to the valve house through the cast iron pipe provided inside the diversion tunnel driven through the right

abutment of the dam. The water is then diverted to irrigation and domestic water supply channels at the valve house with check valve and flow meter.

Irrigation water diverted at the valve house is discharged to the irrigation inlet box to make the open flow from the pipe pressure flow. Irrigation water is led to the head of existing paddy field through an open channel with a distance of around 1.0 km. Irrigation water is distributed to the paddy field by the irrigation diversion box to be provided at the head of paddy field.

General layout is shown in Dwg. - 601 including the layout of irrigation canals and pipe lines for domestic water supply.

(4) Design discharge and initial water level

Design discharge for canal and related structures are decided based on the irrigation water requirement and proposed cropping pattern. Peak semi-monthly base diversion requirement for the unit area of 1.0 ha is defined as a design discharge after multiplying the irrigation area. Peak diversion requirement occurs in the second half month of October for Palawija crops and its design discharge is estimated at 100 lit/sec for the net irrigation area of 75 ha.

Initial water level of the open channel is decided taking into consideration of the topographic elevation at the irrigation inlet box situated at the valve house. As a result, the initial water levels is El. 26.0 m at the head point of open channel.

(5) Irrigation facilities

The proposed canal layout and design of irrigation facilities are made based on the 1/5,000 topographic map prepared under the Study and in accordance with the following conditions:

- Canal alignment is to be straight and short as much as possible;
- The alignment is to be planned to pass outside of villages and give no damages to public facilities;
- The types of canal related structures are to be minimized as much as possible; and,
- The structures are to be simplified as much as possible.

Irrigation canal to lead the water to the head of existing paddy field from the Embung is construction using concrete flumes with a base width of 0.5 m taking into account the rather small design discharge of the canal, steep topographic condition, construction method and available construction materials in the Project area. Canal related structures required are irrigation inlet box to make open flow from the pressure flow of pipe line, aqueduct to cross the proposed spillway of Embung, cross drain and irrigation division box. Required irrigation facilities are summarized below and preliminary design for each facility is shown in Dwg. - 607.

Irrigation Facilities Requirement

Facilities	Quantities
- Valve house (included in the facilities of Embung)	1 No.
- Irrigation inlet box	1 No.
- Concrete flume type canal with a base width of 0.5 m	Approx.1.0 km
- Aqueduct	1 No.
- Cross drain	3 Nos.
- Irrigation division box	1 No.

6. EMBUNG CONSTRUCTION PLAN

6.1 Construction Schedule

(1) Basic condition

All the construction works will be carried out by a local contractor selected by local competitive bidding. Some construction equipment will be purchased through international competitive bidding, if necessary.

The construction plan is based on the mode of construction and the target schedule of construction works as well as taking into consideration the construction conditions such as availability of construction labor, material and equipment as well as weather and the topographic conditions of the construction site. Generally, the mechanized construction method is assumed to be adopted although other construction methods may be practiced.

It is assumed that 200 working days per year are available for conducting the earthfill embankment works, 270 days per year for the filter drain and toe rock embankment works and 300 days per year for concreting works in view of the daily rainfall distribution in the Project area. For each working day, one 8-hour shift is applied.

(2) Construction schedule

The overall construction schedule is determined as shown in Figure 6.1 taking into account the necessary time of detailed design, bidding procedure including the time of tender evaluation and award of the contract. The major points of construction schedule are described below.

1) Mobilization and preparation works

Immediately after the receipt of the "Notice to Proceed", the contractor would commence the mobilization of the construction equipment and key staffs to the Project site from the beginning of November in the first year. Following the above, preparatory works would be commenced at the Project site.

2) Setting out and excavation works

During the mobilization, setting out of all the structures would be commenced by the contractor at the Project site. Construction of temporary access roads such as access to the borrow area and access to major structural sites shall be started by using equipment available at the Project site. The excavation works for the river diversion culvert, and leakage protection walls would be commenced at the beginning of March in the second year.

3) Concrete works embankment works

After completion of the concrete placing into the river diversion culvert, embankment works for the main dam shall be commenced and completed before the wet season in the second year. Concrete works for the spillway shall also be concentrated and completed before October in the second year.

4) Commencement of reservoir water impounding

Commencement of the reservoir water impounding will be done at the beginning of October in the second year after completion of the main dam embankment and spillway construction. Considering the rainfall in November and December in the second year, the Bimoku reservoir would be quite full and the water could be supplied from the reservoir to the water users from January in the third year.

5) Water distribution system

Construction works for the water distribution system will be executed in parallel with the construction works of the Embung by using mainly manpower since those work quantities are not so much. The construction works shall be completed by the end of December in the second year before supplying the impounded water to the beneficiary area.

6.2 Construction Plan of Embung

(1) Preparatory works

The preparatory works consist of preparation of temporary buildings, construction plant and repair shop, arrangement of power and water supply systems as well as communication system, construction of access and haul roads, and so on. All of these works will be conducted during four months from November in the first year to February in the second year.

1) Temporary buildings and yards

The temporary buildings required for the construction works would include office, quarters, workshop, warehouse and storage yards. These temporary buildings will be built by the contractor.

The temporary buildings will require a total floor area of 1,200 m^2 for an anticipated staff strength of 15 persons and labor force of 80 persons. The land required for the temporary buildings and construction facilities is estimated at 2,500 m^2. The temporary buildings and yards may be located near the construction site.

2) Water and power supply

The water required for the construction works and the daily use of the construction camp is planned to be taken from the rivers or springs near the Embung site or the wells drilled in the contractor's yard.

The electric power for the construction camp is planned to be supplied by the constructor's diesel generators with installed capacity of 200 kW to meet the requirements as shown below.

Power Requirement

Place / works	Power Requirement (kW)
Office and quarters	30
Construction plant	50
Repair shop	60
Dam site	20
Water supply	20
Others	20
Total	200

(2) River diversion works

The river flow will be released through the river diversion conduit during the dry season in the second year. The river diversion culvert would be provided along the right bank of the Kaifu river. In order to avoid the leakage or seepage water from the reservoir along the river diversion conduit across the dam body, the river diversion conduit is planned to be

installed in the excavated rock foundation so as to contact the concrete surface smoothly to the homogeneous earth materials as seen in Dwg. - 604.

Considering very short construction period as four months from the beginning of March to the end of June in the second year, two lanes of concrete pipe culverts with diameter of 1.2 m are used, and therefore the concrete placing will be made without inside-forms nor reinforcement bars in the conduit.

After completion of the main dam embankment around the end of September in the second year, the river diversion conduit shall be plugged by the concrete using concrete pump with a capacity of 20 m^3/hr for the whole length from the reservoir-side to the downstream outlet.

(3) Main dam works

Following the foundation excavation and completion of the river diversion conduit, the dam embankment will be commenced at the beginning of July in the second year. Considering a embankment volume of 110,000 m^3 and remaining dry season period of three months until the end of September in the second year, the daily embankment volume is to be 1,500 m^3 which is quarried from the reservoir.

Excavation of the embankment materials at the borrow area will be done with D-7 class (21 ton) bulldozers and the excavated materials will be loaded with 1.2-m^3 wheel loader and be hauled to the dam site by 11-ton dump trucks. The embankment materials will be spread at the dam site will be spread with 21-ton bulldozer and compacted with 10-ton class tire roller in layers of 20 cm thickness before compassion.

The filter embankment is planned as a horizontal drainage mattress with a thickness of 1.0 m, which is scheduled to be placed immediately after completion of the river diversion culvert, at the beginning of June in the second year. Before placing the drainage mattress, the main dam foundation should be graded and trimmed smoothly. The filter material will be spread by 21-ton bulldozer and be compacted by 21-ton bulldozer or 10-ton tire roller. This filter material will be hauled with 11-ton dump trucks from the seashore located between Olafulikaa and Leli.

Riprap placement is scheduled to be made simultaneously as the homogeneous earth embankment of the main dam. The riprap volume is estimated to be 6,000 m^3 and the rock material will be procured from the supplier at the Embung site. The rock material will be placed by 0.6 m^3-backhoe and large voids should be filled with smaller rock fragments. The riprap protection should be finished manually to the design slope and thickness.

(4) Spillway construction

Excavation of the spillway will be scheduled to be performed about three months from March to May in the second year. As the total volume of common and weathered rocks is estimated to be 37,000 m^3, 21-ton bulldozer and 1.2-m^3 backhoe will be used for flat portion and steep slope chuteway portion of spillway, respectively. Most of the excavated materials may be used as the main dam embankment materials so that the excavated materials will be stocked in the designated area. For loading the excavated materials to 11-ton dump trucks, 1.2 m^3 wheel loaders is used.

After completion of the spillway excavation, preparation for foundation of chuteway will be commenced. For concrete placing into side-walls and shuteway slope portion, 20-ton class truck crane with concrete bucket (1.0 m^3) and concrete pump with a capacity of 20 m^3/hr will be used. Before starting the reservoir water impounding at the beginning of October in the second year, major concrete works of the spillway should be completed in order to release the flood discharge in the following wet season.

(5) Water supply system

Inlet structure of the water supply system is constructed above the sediment load disposition level of El. 26.8 m. Connecting the inlet structure, a cast iron pipe with diameter of 300 mm is installed up to the downstream end of the main dam. Construction of the river diversion conduit and water supply pipe should be completed before commencement of the main dam embankment at the beginning of July in the second year.

The valve house of the water supply system will be constructed before the reservoir water reaches to F.S.L. around the end of December in the second year.

(6) Construction materials

Quantities of the major construction materials required for constructing the Matasio Embung are summarized below.

Construction Material Requirement

Item	Quantity	
Earthfill materials		
Main dam	110,000	m^3
Filter materials		
Horizontal drain	11,000	m^3
Riprap portion	1,800	m^3
Rock materials		
Riprap protection	4,800	m^3
Toe rockfill	2,200	m^3
Concrete		
Cement	660	tons
Reinforcement bars	43	tons
Aggregates	1,700	m^3

(7) Construction equipment

The minimum number of major construction equipment and plants to be used for the Matasio Embung construction works are summarized in Table 6.1.

6.3 Construction Plan of Water Distribution and Irrigation Facilities

Construction works required for the water distribution system and irrigation facilities are summarized below:

Construction Works for Water Distribution System

Water distribution system	
- Pipe setting works of dia. 50 mm	4.5 km in total
- Construction works of the related facilities such as check valves, air valves, blow off and division boxes for inhabitants and livestock	23 Nos. in total
Irrigation facilities	
- Construction works of irrigation canal (concrete flume type canal with a base width of 0.5 m)	1.0 km in total
- Construction works for the canal related structures such as irrigation inlet box, aqueduct, cross drains and irrigation division box	6 Nos. in total

The facilities to be constructed for distributing domestic, livestock, and irrigation water are rather small in work quantities and scattering in the beneficiary area in comparison with the construction works. Therefore, almost of all the facility construction works will be executed by manual except for earth works for irrigation canal such as clearing, stripping, excavation, and embankment works. These earth works will be conducted by using heavy construction equipment including bulldozer, excavator, compactor, and so on. The construction works of water distribution facilities and irrigation canal will be carried out in parallel with the Embung construction works.

6.4 Institutional Arrangement for Project Implementation

(1) Organization for implementation

After the reorganization enforced in August 1994, the Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works (PU) is responsible for managing overall water resources development and conservation in the whole country. At the provincial level, the Provincial Water Resources Services (PRWS) of the Provincial Public Works Service (DPUP) under the direct control of the Governor is the principal organization which is responsible for planning, design, and implementation aspects regarding water resources development, operation and maintenance of water source, irrigation and flood control facilities, and watershed management. The Regional Office of PU (Kanwil PU) is established in each Province bearing the responsibility of maintaining coordination between PU and DPUP, and providing support and assistance to the DPUP as well as planning and implementing projects of a national nature.

In NTT, there are four provincial service offices; Water Resources (Pengairan), Road/Bridge (Bina Marga), Water Supply/Building (Cipta Karya) and Technical Quality Management (Tata Laksana Teknik). In terms of domestic water supply to urban and rural areas in NTT, PRWS is responsible for creating and supplying raw water and Cipta Karya has to treat and distribute clean water to end-users in urban areas.

The organizational structure of PRWS consists of a general administrative unit and four technical sections for design, construction, and operation and maintenance (O&M), and project benefit promotion. Under the chief of DPUP, there are nine functional project offices established for the specific purposes. Of these, Embung development is handled by the both Timor Water Resource Construction and Conservation Project Office (Proyek PKSA Timor) and Flores-Sumba Water Resources Construction and Conservation Project Office (Proyek PKSA Flores-Sumba) in case of the Central Government's financing projects and the Provincial Embung Development Project Office (Embung APBD) in case of the Provincial Government's financing projects. After completion of Embungs, O&M works are transferred to the O&M Section according to the direction from the Minister for Home Affairs to the Governor in response to the request by the Minister for PU. The present organization chart of PRWS and two PKSAs are shown in the Volume 4.

In implementing Matasio Embung Project as one component of the package development program, it is proposed that PRWS is in charge of overall arrangement and the PKSA Timor Project Office is responsible for all of the actual management works. Under the Project Office, one special section or sub-project office needs to be established to represent the following functions:

- Design and construction supervision of all the Project works including water distribution system; and
- Accounting and management of construction works.

(2) Expatriate assistance

In NTT, accumulation of technical know-hows to construct a larger Embung are still insufficient resulting in that the implementation of Matasio Embung requires experienced professional manpower, especially management of supervision on the construction works. For the successful prosecution of the Project, therefore, it is proposed to introduce appropriate expatriate assistance.

A vital part of the functions of expatriate assistance will be the training of the local professional and sub-professional staff on effective management to supervise the earth and construction works and further to provide substantial experience and techniques to the PKSA Timor Project Office.

(3) Organization for O&M

After completion of the proposed Matasio Embung, the O&M Section of PRWS is responsible for operating and maintaining Embung as well as water intake and distribution facilities. Among various O&M works to be done by this Section, the reservoir operation is the main function and needs to be conducted on the basis of operation rule to be established. In order to operate and maintain the Project facilities effectively according to the said rule, it is prerequisite to upgrade the capability of O&M staff and the level of O&M equipment.

As for maintenance works of water distribution facilities, it is proposed for PRWS to organize the beneficiary people aiming at their participation in routine works such as cleaning of water division boxes, clearing of animal excreta around water division boxes, repairing of fence along the reservoir and so on.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for development of the Matasio Embung is estimated on the basis of assumptions as follows:

- All the civil works of the Project will be executed on the contract basis. Contractor(s) will be selected through the competitive bidding;
- Project cost includes the physical contingency of 15% of the construction costs in view of the preliminary nature of the estimate. The price contingency of 10% is also included in the cost estimate taking into account the recent price escalation of construction materials in Indonesia;
- The associated costs to be financed by the Government, such as the cost for strengthening the extension services, facilities of the Water Users' Association and improvement of the social infrastructures except for those included in the proposed Project works, are not included in the cost estimate;
- The direct construction cost is estimated based on the calculated work quantities of the Project works and unit prices of the works. The unit prices of the works are estimated based on the current prices in NTT area as of June 1994 and the data collected from the on-going projects in NTT. The basic prices for construction works include delivery cost of construction materials to the Project site;
- The contract tax, which is a value added tax imposed by the Government at a rate of 10% against the total contract cost, is included in the estimate of the Project cost;
- Engineering service cost for the consultants in conducting detailed design and construction supervision is estimated based on such assumption as 15% of direct construction cost;
- Administration cost consists of staff salary for construction management, vehicle running cost and other related cost only for the Project implementation. Administration cost is estimated at around 5% of the direct construction cost with reference to recent other project costs in NTT;
- Land acquisition cost including the purchase of the Embung site, reservoir area, borrow area and land for pipe line and other permanent structure is estimated at 0.5% of the direct construction cost taking into considerations the present condition of the Project area based on the survey results under the Study; and,
- The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) since all construction materials are available in Indonesia and the payment for construction will be executed with Indonesian Rupiah.

7.2 Construction Cost

The Project cost, as an initial investment by the Project, is composed of; direct construction cost, administration cost, engineering service cost, physical contingency, contract tax, land acquisition cost and price contingency. The total Project cost for constructing the Matasio Embung is estimated at Rp. 5,267 million as shown in Table 7.1. Detail of direct construction cost estimated based on the calculated work quantities of the proposed Project works and unit prices of the works for this scheme is shown in Table 7.2 together with work quantities of the main work items and unit prices.

The total Project cost for constructing the Matasio Embung is summarized below.

Summary of the Project Cost for Matasio Embung

Unit : Rp. million

Item		Project cost
I.	Direct construction cost	3,154
1.1	Preparatory works	150
1.2	Embung construction	2,565
1.3	Domestic water supply	147
1.4	Operation & maintenance road	82
1.5	Irrigation facilities	210
II.	Administration cost	158
III.	Engineering services	473
IV.	Physical contingencies	568
V.	Contract tax	420
VI.	Land acquisition	16
VII.	Price contingency	479
	Grand Total	5,267

7.3 Operation and Maintenance Cost

The O&M costs consist of salaries for O&M staff, cost for maintaining the Project facilities, materials and labor cost for repairing works, and running cost of Project facilities. The annual O&M costs are assumed at Rp. 26.34 million, which is equivalent to 0.5% of the Project cost.

8. PROJECT JUSTIFICATION

8.1 Satisfaction of BHN

In general, it is impossible to quantify benefits attributable to improvement of the existing water supply system for the domestic and livestock use in rural areas of NTT. The water supply benefits anticipated in the beneficiary area of Matasio Embung comprise two main portions: reduced time fetching water from distant sources and reduced health problems or morbidity. It is also hard to evaluate the values of gains prospected in newly available working time and those of decreased incidence of water borne diseases in quantitative manner.

Under the Study, thus, the benefits to be born from satisfaction of BHN by creating a new water source facility are to be indicated as the value of water and the investment amount to each beneficiary inhabitant. The investment amount is given by deducting the administration and land acquisition costs from the Project cost, because these could not be defined as the direct construction cost due to the mode of payment. The value of effective storage water is obtained by dividing the investment amount by the effective storage capacity, while that of supplied water is given by dividing the investment amount by the annual supply amount of domestic and livestock water.

The total Project cost for constructing the Matasio Embung with the effective storage capacity of 0.445 MCM is estimated to be Rp. 5,267 million. The total number of beneficiary water users is 576 inhabitants and 356 heads of cows with the annual water demand of 0.01781 MCM. The investment amount estimated is Rp. 5,050 million. This amount can be allocated to two portions; domestic and livestock water portion and irrigation water portion based on the required cost for developing the Matasio Embung to supply only domestic and livestock water. Thus, the investment amount is split into Rp. 3,897 million for the domestic and livestock water portion and Rp. 1,153 million for the irrigation portion.

The value of effective storage water to be created by the Matasio Embung is estimated to be Rp. 8,757/m^3, while that of supplied water is estimated to be Rp. 218,800/m^3. The estimated investment amount to the respective beneficiary people is Rp. 6.76 million. As the prospected unit water consumption rate of cow is equivalent to that of 0.67 inhabitant, the estimated investment amount to the respective people and livestock is Rp. 4.78 million. Furthermore, the existing water sources can be fully used for livestock raised outside of the Project area. As 488 inhabitants and 247 heads of cow, being equivalent to 975 heads of cow, in the Project area currently depend on the existing water sources, it can be expected that such effective utilization of water sources enables another 975 heads of cow to get water throughout a year. If this indirect beneficiary livestock is taken into account, the estimated investment amount to the respective people and livestock reduces to Rp. 2.65 million.

8.2 Economic Consideration

(1) Economic cost

The financial costs are to be converted into the economic costs by applying the economic conversion factor (ECF) taken up in the Second Provincial Irrigation Project by the World Bank. The ECFs applied are 0.71 for civil works and tertiary irrigation system development, 1.00 for O&M equipment, 0.90 for engineering service and supporting works, 0.80 for O&M costs. All the transfer payments are not included into the economic cost. As the financial investment amount allocated to the irrigation water portion is Rp. 1,153 million, the economic investment cost is estimated to be Rp. 698 million following the above procedure.

(2) Economic benefit

The irrigation benefits of the Project are principally derived from increased crop production attributable to stable irrigation water supply, full utilization of available farm land resources and optimum farm input supply. Tables 8.1 to 8.5 show price structure of paddy,

Palawija crops and fertilizers, economic crop budget and net production value. The annual net incremental benefit estimated amounts to Rp. 36.0 million and is Rp. 479,000/ha. In the proposed reservoir area, there is no loss of productive and foregone benefits due to inundation of the reservoir area after completion of Matasio Embung. The benefits will accure from the initial year after completion of the Project. Taking the present agricultural situation and farmers capability into account, build-up period is assumed to be five years.

(3) *Economic evaluation*

The economic internal rate of return (EIRR) is examined as shown in Tables 8.6 and 8.7 based on costs and benefits as at July 1994. Although the result of economic analysis shows that EIRR is less than 1%, the proposed Benkoko Embung Project would still have a significant positive impact on the development of economically depressed area in NTT. Furthermore, the both values of effective storage water and supplied water can be reduced by 10% compared with the case that Matasio Embung is developed at the minimum scale only for meeting BHN.

(4) Farm budget analysis

With implementation of the Matasio Embung Project, the net on-farm income of farmers holding a unit farm size of 1.0 ha can be expected to increase by Rp. 426,200/year from Rp. 266,800/year under the "Without Project" condition to Rp. 693,000/year under the "With Project" condition. Such improvement of their farm budget would give much incentive for farmers to invest in further development and increase their payment capacity which enables them to pay some portion of irrigation water charge.

8.3 Environment Impact Assessment

(1) Environmental features of the Project area

Principal human and physical environment feature in the Project area are summarized below.

Human and Physical Environmental Features

Items		Descriptions
Human environment		
Social	:	Insufficiency of reliable water sources and facilities for domestic use
Human use	:	Use of spring water and well water (not useful in the dry season)
Health and sanitation	:	Prevalence of waterborne diseases
Physical environment		
Geology/land	:	Bobonaro formation / talus deposit
Surface/ground water	:	Surface water is stably observed in the dry season
Endemic fauna and flora	:	none
Others	:	none

(2) Environmental impact assessment

In the Project area, environmental issues assessed as negative environmental problems are only human activities of using trees in the catchment area. Trees in both the reservoir and catchment areas have been utilized by inhabitants for their economic activities producing water-carriers and other baskets, firewood, timber, alcoholic beverage, sap of sugar, and so on. Decrease of vegetation caused by logging has severely incurred a deterioration of water conservation and acceleration of soil erosion in the catchment area.

The countermeasures to eliminate this environmental impact is to establish an effective watershed management rule and conduct a campaign for participation of inhabitants in forest conservation activities. Additional incentives are required to encourage inhabitants to diversify their economic activities on on-forest basis.

(3) Primary information of environmental assessment

To support undertaking of environmental analysis presentation for the proposed Project on the Indonesian rule, primary information on environmental assessment is compiled in Attachment 4.

8.4 Contribution to Women in Development

With provision of permanent water source facilities, women and children of 138 families can be quite free from their daily hard job to carry their domestic water at the average distance of 135 m. As a result, women will be able to utilize the saved time for improving their activities in relation to not only agriculture and livestock but also small business. Since housewives in the Project area manage their family budgets, increasing family income would encourage women in investing surplus in improvement and diversification of their economic activities.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The Matasio Embung development plan has been formulated as one of the six urgent water resource development schemes in NTT aiming to meet BHN for upgrading the living standard and to support the economic activities in the Project area. The present Study is made to confirm technical feasibility and socio-economic impact of the Project in conformity with this concept.

The Project consists of such structural components as main dam, water leakage protection measure and domestic, livestock and irrigation water distribution system. All of these components have to be implemented without any missing components for the purpose of achieving the development concept.

As the results of the Study, it is clarified that each of the Project components are technically possible and the Project is socially and socio-economically desirable for enabling 576 inhabitants of 138 families to get permanent water source, to be quite free from daily hard job to carry their domestic water at the average distance of 135 m, to decrease frequency of water born disease and to increase their farm income through irrigation water supply.

It is therefore concluded that the construction of Matasio Embung is worthy of urgent implementation.

9.2 Recommendations

As the conclusion of the Study is aforementioned, it is recommended that necessary steps for the implementation of the Matasio Embung Project are to be taken. Such steps will be composed of administrative issues and technical matters.

Main issues of the administrative matters to be taken up will be the determination of executing agency, the procurement of necessary fund in foreign currency and the preparation of budget in domestic currency as a counterparts fund.

Necessary technical matters to be made are composed of introduction of advanced technology and management know-hows in terms of smooth construction of higher Embung on permeable foundation for shorter period. As the development of Matasio Embung aims to supply raw water for domestic and livestock use, it is recommended to take necessary action for appropriate watershed management including afforestation and for no entry of inhabitants and livestock to the reservoir area so as to keep water quality.

The Study on The Embung Development Project
in East Nusa Tenggara and West Nusa Tenggara

Feasibility Study on
Matasio Embung Development Project

Tables

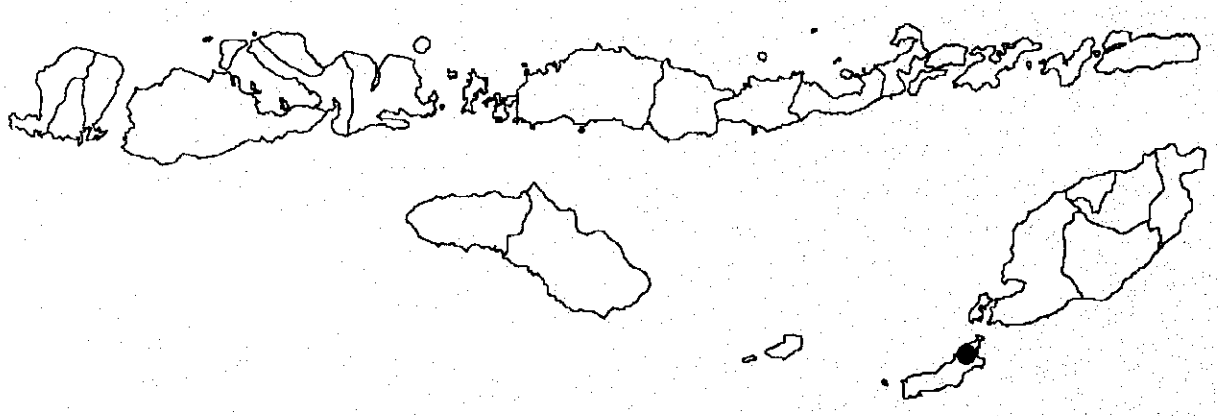

Table 1.1 Monthly Rainfall Record

Station : Baia Namodale Unit : mm

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug		Sep.		Oct.		Nov.		Dec.		Annual
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
1931	245	245	17	17	160	160	15	15	0	0	10	10	0	0	0	0	0	0	0	0	23	23	62	62	1,062
1932	129	129	59	59	60	60	3	3	1	1	28	28	0	0	0	0	0	0	0	0	15	15	101	101	789
1933	47	47	136	136	206	206	14	14	4	4	28	28	0	0	23	23	0	0	7	7	34	34	244	244	1,482
1934	98	98	157	157	175	175	37	37	5	5	0	0	8	8	0	0	0	0	9	9	55	55	44	44	1,171
1935	199	199	102	102	217	217	7	7	0	0	0	0	0	0	0	0	0	0	4	4	23	23	64	64	1,227
1936	162	162	166	166	64	64	3	3	12	12	11	11	0	0	0	0	0	0	0	0	17	17	118	118	1,103
1937	76	76	123	123	201	201	16	16	0	0	6	6	0	0	0	0	0	0	0	0	9	9	67	67	993
1938	156	156	115	115	18	18	6	6	11	11	18	18	27	27	0	0	0	0	0	0	39	39	102	102	979
1939	224	224	239	239	185	185	6	6	247	247	0	0	17	17	0	0	0	0	5	5	50	50	61	61	2,061
1940	106	106	90	90	164	164	62	62	2	2	0	0	2	2	0	0	0	0	0	0	24	24	85	85	1,065
Average	144	144	120	120	145	145	17	17	28	28	10	10	5	5	2	2	0	0	2	2	29	29	95	95	1,193

Source : Data Klimatologi di Nusa Tenggara Timur. Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.2 Climate Data

Station: Penfui **Latitude : 10.1833S**
Island : Timor **Longitude : 123.6667E**
Kabupaten : Kupang **Elevation : 115 m**

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Average
Temperature (mean)	26.9	26.6	27.1	27.9	27.8	26.8	26.4	26.9	27.8	28.6	28.8	27.7	1966-1992	27.4
Temperature (max)	29.9	29.4	30.4	31.1	30.6	31.2	30.1	29.8	33.1	32.5	32.6	31.4	1966-1992	31.0
Temperature (min)	22.9	22.9	23.8	24.2	22.7	23.0	22.8	22.7	21.0	22.7	23.4	23.2	1966-1992	22.9
Relative Humidity (mean)	84.7	86.2	84.1	74.9	69.6	67.6	65.2	63.5	62.4	64.0	70.8	80.4	1966-1992	72.8
Relative Humidity (max)	100.0	100.0	100.0	6.0	95.0	95.0	96.0	88.0	84.0	94.0	96.0	100.0	1966-1992	87.8
Relative Humidity (min)	57.0	69.0	61.0	56.0	47.0	46.0	45.0	43.0	40.0	40.0	42.0	58.0	1966-1992	50.3
Sunshine Hours (hr/day)	6.5	6.3	7.3	9.3	9.7	9.5	9.4	10.2	10.0	10.4	8.8	6.8	1966-1992	8.7
Wind Velocity (km/day)	8.2	8.2	6.9	8.9	11.6	12.0	13.2	12.3	11.2	9.9	8.0	6.5	1966-1992	9.7

Source : Data Klimatologi di Nusa Tenggara Timur, Tahun - 1992, Bagian Proyek Hidrologi, Kantor Wilayah Propinsi NTT

Table 1.3 Present and Projected Demographic Condition

Village	Sub-village	Population			Household		
		1994	1999	2004	1994	1999	2004
Matasio	Nulaina	205	223	242	47	51	56
	Oesuti I	150	163	177	36	39	43
	Oesuti II	133	145	157	33	36	39
	Total	488	531	576	116	126	138

Source : Provincial Statistic Office, NTT

Table 1.4 Present and Projected Livestock Population

Year and Village	Sub-villaga	Cow & Buffalo	Horse	Sheep & Goat	Pig	Chicken & Duck	Equiv't Total
1994							
Matasio	Nulaina	13	0	53	83	36	32
	Oesuti I	87	4	215	105	105	135
	Oesuti II	54	2	132	112	33	90
	Total	154	6	400	300	174	257
1999							
Matasio	Nulaina	15	0	64	105	50	40
	Oesuti I	100	4	260	133	112	158
	Oesuti II	62	2	159	142	46	106
	Total	177	6	483	380	208	304
2004							
Matasio	Nulaina	17	0	77	133	68	46
	Oesuti I	113	5	313	168	154	185
	Oesuti II	70	2	192	180	63	124
	Total	200	7	582	481	285	355

Source : Provincial Livestock Office, NTT and JICA Study Team

Table 1. 5 Summary of Farm Economic Survey

	Item	Unit	Respond't No. 1	Respond't No. 2	Respond't No. 3	Respond't No. 4	Respond't No. 5	Respond't No. 6	Respond't No. 7	Respond't No. 8	Respond't No. 9	Respond't No. 10	Average
1	Sex and Age		Male 54	Male 46	Male 64	Male 21	Male 30	Male 56	Male 32	Male 50	Male 34	Male 55	44
2	No. of Family Member		F-2	M-1/F-2	M-1/F-1	0	F-2	M-2/F-4	M-2/F-2	M-3/F-1	M-1/F-1	M-2/F-3	M-1/F-2
3	Type of Side Job		None	Civil Servant	Businessman	Civil Servant	None	Pension	None	Workman	Workman	None	
4	Own Farmland	ha	2.20	3.00	1.50	3.25	2.50	1.10	3.70	1.12	5.30	0.50	2.42
	(Paddy field)	ha	1.00	2.00	1.00	2.50	2.00	0.50	2.00	0.50	4.00	0.50	1.60
5	Cropped Area	ha	0.70	3.00	1.50	3.20	2.50	1.10	2.14	0.75	5.00	0.50	2.04
	(Paddy)	ha	0.50	2.00	1.00	2.50	2.00	0.50	2.00	0.50	4.00	0.50	1.55
	(Palawija)	ha	0.20	1.00	0.50	0.70	0.50	0.60	0.14	0.25	1.00	0.00	0.49
	(Others)	ha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Cow/Buffalo	head	0	0	0	0	0	0	0	0	6	0	0.6
	Horse	head	0	0	0	0	0	0	0	0	0	0	0.0
	Goat/Sheep	head	0	3	30	0	0	0	0	0	5	0	3.8
	Pig	head	5	11	11	6	5	6	2	10	5	5	6.6
	Chicken/Dug	head	0	32	50	10	0	27	20	75	30	12	25.6
7	Gross Income	Rp/yr	324,700	2,805,000	1,090,000	1,120,000	305,000	1,924,000	317,000	885,000	3,150,000	305,000	1,222,570
	(Crop)	Rp/yr	144,700	700,000	350,000	420,000	105,000	74,000	315,000	245,000	1,750,000	105,000	420,870
	(Livestock)	Rp/yr	180,000	305,000	500,000	500,000	200,000	50,000	2,000	400,000	1,300,000	200,000	363,700
	(Side job)	Rp/yr	0	1,800,000	240,000	200,000	0	1,800,000	0	240,000	100,000	0	438,000
8	Expenditure	Rp/yr	1,089,300	3,336,950	1,462,750	1,362,200	457,100	2,195,600	1,044,000	861,100	2,198,000	1,054,200	1,521,120
	(Food/Drink)	Rp/yr	666,000	1,794,000	828,000	624,000	72,000	912,000	534,000	438,000	1,044,000	636,000	754,800
	(Living)	Rp/yr	297,500	930,950	348,000	207,000	90,200	735,000	253,000	225,100	605,000	253,100	394,485
	(Education)	Rp/yr	0	100,000	0	200,000	0	360,000	60,000	42,000	60,000	10,000	83,200
	(Production)	Rp/yr	125,800	512,000	286,750	331,200	294,900	188,600	347,000	156,000	489,000	155,100	288,635
9	Surplus/Deficit	Rp/yr	-764,600	-531,950	-372,750	-242,200	-152,100	-271,600	-727,000	23,900	952,000	-749,200	-298,550

Source : JICA's Agro-economy Survey

Table 2.1 Projected Domestic and Livestock water Demand

Unit : m3

Village	Sub-village	1999			2004		
		Domestic	Livestock	Total	Domestic	Livestock	Total
Matasio	Nulaina	4,884	577	5,461	5,300	695	5,995
	Oesuti I	3,570	2,309	5,879	3,876	2,696	6,572
	Oesuti II	3,176	1,546	4,722	3,438	1,810	5,248
	Total	11,630	4,432	16,062	12,614	5,201	17,815

Source : JICA Study Team

Table 2.2 Estimated Evapotranspiration (Eto)

Site : Matasio
Meteorological Station : Penfui Station

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	C	27.40	26.60	27.10	27.90	27.80	26.80	26.40	26.90	27.80	28.50	28.80	27.70
RH mean	%	84.70	86.20	84.10	75.10	69.60	67.60	65.30	63.60	62.50	63.80	70.30	80.20
U	km/day	8.20	8.20	6.90	8.90	11.60	12.00	13.20	12.30	11.20	9.90	8.00	6.50
ea	mbar	36.33	34.65	35.70	37.38	37.17	35.07	34.23	35.28	37.17	38.72	39.41	36.96
RH/100		0.85	0.86	0.84	0.75	0.70	0.68	0.65	0.64	0.63	0.64	0.70	0.80
ed	mbar	30.77	29.87	30.02	28.07	25.87	23.71	22.35	22.44	23.23	24.70	27.71	29.64
(ea-ed)	mbar	5.56	4.78	5.68	9.31	11.30	11.36	11.88	12.84	13.94	14.02	11.70	7.32
f(u)		0.29	0.29	0.29	0.29	0.30	0.30	0.31	0.30	0.30	0.30	0.29	0.29
(1-W)		0.24	0.25	0.24	0.23	0.23	0.24	0.25	0.24	0.23	0.23	0.23	0.23
(1-W)f(u)(ea-ed)	mm/day	0.38	0.34	0.39	0.63	0.79	0.83	0.90	0.94	0.98	0.95	0.77	0.49
Ra	mm/day	16.40	16.30	15.50	14.20	12.80	12.00	12.40	13.50	14.80	15.90	16.20	16.20
n	hr/day	6.50	6.30	7.30	9.30	9.70	9.50	9.40	10.20	10.00	10.40	8.80	6.80
N	hr/day	12.60	12.40	12.10	11.80	11.60	11.50	11.60	11.80	12.00	12.30	12.60	12.70
(0.25+0.50n/N)		0.51	0.50	0.55	0.64	0.67	0.66	0.66	0.68	0.67	0.67	0.60	0.52
Rs	mm/day	8.33	8.22	8.55	9.15	8.55	7.96	8.12	9.21	9.87	10.70	9.71	8.39
Rns	mm/day	6.66	6.57	6.84	7.32	6.84	6.37	6.50	7.37	7.89	8.56	7.77	6.71
f(T)		16.18	16.02	16.10	16.26	16.26	16.06	15.98	16.06	16.26	16.38	16.46	16.22
f(ed)		0.09	0.10	0.09	0.10	0.11	0.12	0.13	0.13	0.12	0.12	0.10	0.10
f(n/N)		0.56	0.56	0.64	0.81	0.85	0.84	0.83	0.88	0.85	0.86	0.73	0.58
Rnl=f(T)f(ed)f(n/N)	mm/day	0.84	0.85	0.98	1.35	1.55	1.65	1.70	1.80	1.71	1.65	1.25	0.91
Rn =Rns-Rnl		5.83	5.72	5.86	5.97	5.29	4.71	4.80	5.57	6.18	6.90	6.52	5.80
W		0.76	0.76	0.76	0.77	0.77	0.76	0.75	0.76	0.77	0.77	0.77	0.77
W Rn		4.45	4.32	4.46	4.58	4.06	3.57	3.61	4.22	4.74	5.33	5.04	4.44
c		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Eto	mm/day	5.32	5.13	5.33	5.74	5.33	4.84	4.96	5.68	6.29	6.91	6.39	5.43

Source : JICA Study Team estimation by Modified Penman Method based on the meteorological data at Penfui station (19~~~ to 19~~~)

Table 2.3 Effective Rainfall (ER)

Site : Matasio
Meteorological Station : Baia Namodale (Rote)

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Palawija
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	165	287	23.2%	212	149	138
February	144	279	22.6%	206	144	130
March	165	210	17.0%	155	109	111
April	172	54	4.4%	40	28	32
May	165	27	2.2%	20	14	15
June	145	35	2.8%	26	18	21
July	154	12	1.0%	9	6	0
August	176	4	0.3%	3	2	0
September	189	3	0.2%	2	2	0
October	214	13	1.1%	10	7	0
November	192	93	7.5%	69	48	57
December	168	220	17.8%	163	114	116
Total	2,049	1,237	100.0%	915	641	620

Note ;

[1] : Estimated by modified Penman method based on the Baia Namodale meteorological station in this study
[2] : Rainfall data in Baia Namodale station compiled by P3SA (1907-1985)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 915 mm (Calculated 80 % dependable annual rainfall) x [3]
[5] : [4] x 0.70
[6] : Derived by USDA SCS Method introduced by Design Criteria KP-01, where effective storage is assumed 75 mm

Source : JICA Study Team estimation based on the rainfall data at the Baia Namodale meteorological station (1907 - 1985)

Table 2.4 Irrigation Water Requirement (1/2)

Site : Matasio
Crops : Wet Season Paddy

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
	Month (days)	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	5.32	5.32	5.13	5.13	5.33	5.33	5.74	5.74	5.33	5.33	4.84	4.84	4.96	4.96	5.68	5.68	6.29	6.29	6.91	6.91	6.39	6.39	5.43	5.43	
	mm	80	85	72	72	80	85	86	86	80	85	73	73	74	79	85	91	94	94	104	111	96	96	81	87	2,049
II. Wet Season Paddy																										
(1) Proposed cropping pattern / Crop coefficient																										
- WP-1		LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-2		LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
- WP-3			LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																
(2) Crop consumptive use (Etc)																										
- WP-1	mm		94	79	75	84	81	0																		413
- WP-2	mm			79	79	84	90	82	0																	413
- WP-3	mm				79	88	90	90	82	0																429
(3) Land preparation (IR)																										
- WP-1	mm	194																							208	402
- WP-2	mm	194	206																							400
- WP-3	mm		206	178																						384
(4) Percolation																										
- WP-1	mm		32	28	28	30	32																			
- WP-2	mm			28	28	30	32	30																		
- WP-3	mm				28	30	32	30	30																	
(5) Water layer replacement (RW)																										
- WP-1	mm			50		50																				
- WP-2	mm				50		50																			
- WP-3	mm					50		50																		
(6) Effective rainfall (ER)	mm	72	77	72	72	53	56	14	14	7	7											24	24	55	59	
(7) Field water requirement																										
- WP-1	mm	122	49	85	31	111	57	0																	149	604
- WP-2	mm	122	129	35	85	61	116	98	0																	645
- WP-3	mm		129	106	35	115	66	156	98	0																705
(8) Diversion requirement	mm	125	157	116	78	147	122	130	50																76	1,002
	m3/ha	1,250	1,570	1,160	780	1,470	1,220	1,300	500																760	10.010

Source : JICA Study Team estimate based on the Meteorological data at the Penfui and Baia Namodale stations

Table 2.4 Irrigation Water Requirement (2/2)

Site : Matasio
Crops : Dry Season Palawija (Maize, Beans)

Item		Jan. 1	Jan. 2	Feb. 1	Feb. 2	Mar. 1	Mar. 2	Apr. 1	Apr. 2	May 1	May 2	Jun. 1	Jun. 2	Jul 1	Jul 2	Aug. 1	Aug. 2	Sep. 1	Sep. 2	Oct. 1	Oct. 2	Nov. 1	Nov. 2	Dec. 1	Dec. 2	Annual
	Month (days)	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	
I. Evapotranspiration (Eto)	mm/day	5.32	5.32	5.13	5.13	5.33	5.33	5.74	5.74	5.33	5.33	4.84	4.84	4.96	4.96	5.68	5.68	6.29	6.29	6.91	6.91	6.39	6.39	5.43	5.43	
	mm	80	85	72	72	80	85	86	86	80	85	73	73	74	79	85	91	94	94	104	111	96	96	81	87	2,049
II. Maize																										
(1) Proposed cropping pattern / Crop coefficient(Kc)																										
- DM-1										0.50	0.59	0.96	1.05	1.02	0.95	0.60										
- DM-2												0.50	0.59	0.96	1.05	1.02	0.95	0.60								
- DM-3													0.50	0.59	0.96	1.05	1.02	0.95	0.60							
(2) Crop consumptive use(Etc)																										
- DM-1	mm									43	43	70	78	81	81	55										
- DM-2	mm										36	43	71	83	87	86	57									
- DM-3	mm											36	44	76	89	93	90	57								
(3) Effective rainfall (ER)	mm	67	71	65	65	54	57	11	16	7	8	11	10	0	0	0	0	0	0	0	0	28	29	56	60	
(4) Field water requirement																										
- DM-1	mm									35	32	60	78	81	81	55										421
- DM-2	mm										25	33	71	83	87	86	57									443
- DM-3	mm											26	44	76	89	93	90	57								475
(5) Diversion requirement	mm									23	38	79	129	160	172	156	97	38								892
	m3/ha									230	380	790	1,290	1,600	1,720	1,560	970	380								8,920
III. Beans																										
(1) Proposed cropping pattern / Crop coefficient(Kc)																										
- DB-1										0.50	0.75	1.00	1.00	0.82	0.23											
- DB-2												0.50	0.75	1.00	1.00	0.82	0.23									
- DB-3													0.50	0.75	1.00	1.00	0.82	0.23								
(2) Crop consumptive use(Etc)																										
- DB-1	mm									43	54	73	74	65	20											
- DB-2	mm										36	54	74	79	70	21										
- DB-3	mm											36	56	79	85	75	22									
(3) Effective rainfall (ER)	mm	67	71	65	65	54	57	11	16	7	8	11	10	0	0	0	0	0	0	0	0	28	29	56	60	
(4) Field water requirement																										
- DB-1	mm									35	43	63	74	65	20											300
- DB-2	mm										25	44	74	79	70	21										314
- DB-3	mm											26	56	79	85	75	22									343
(5) Diversion requirement	mm									23	46	89	136	149	116	64	14									638
	m3/ha									230	460	890	1,360	1,490	1,160	640	140									6,370
IV. Palawija Average(Maize 50%, Beans 50%)																										
(1) Diversion requirement	mm									0	23	42	84	133	155	144	110	56	19	0						765
	m3/ha									0	230	420	840	1,330	1,550	1,440	1,100	560	190	0						7,660

Source : JICA Study Team estimate based on the Meteorological data at the Penfui and Baia Namodale stations