Construction Works for Water Distribution System

Water distribution system	
- Pipe setting works of dia. 400 mm	1.1 km in total
- Pipe setting works of dia. 65 mm & 50 mm	9.5 km in total
- Construction works of the related facilities such as check valves, air valves, blow off and division boxes for inhabitants and livestock	68 Nos. in total
Irrigation facilities	
- Rehabilitation works for existing weir and canal (around 1.6 km)	L.S.
- Construction works of irrigation canal (concrete flume type canal with a base width of 0.5 m)	3.1 km in total
- Construction works for the canal related structures such as irrigation inlet box, cross drains and irrigation division boxes	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 Tasiepah 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 Tasiepah 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 Tasiepah 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.

(4) Water Users' Association

In the beneficiary irrigation area of the proposed Tasiepah Embung, no Water User's Association (P3A) is organized yet. Before completion of construction works of the Tasiepah Embung, it is necessary to establish P3A in each of the two irrigation blocks on the both banks of N. Puluti river taking into consideration the difference of the proposed irrigation water distribution system to each block.

To organize P3A, it is proposed that training of farmers is carried out following the training program established by the Water User Training Program (PTGA) under DGWRD. Training materials and modules prepared under PTGA will be fully utilized.

It is proposed to execute the necessary field activities for establishing P3A and training farmers by non government organizations (NGO) selected by competitive bidding. For this service, budget arrangement shall be done by PRWS of each province.

7. COST ESTIMATE

7.1 Basic Assumption of Cost Estimate

Project cost of the proposed works for development of the Tasiepah 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 Tasiepah Embung is estimated at Rp. 22,688 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 Tasiepah Embung is summarized below.

Summary of the Project Cost for Tasiepah Embung

Unit : Rp. million

Item		Project cost
I.	Direct construction cost	13,587
1.1	Preparatory works	647
1.2	Embung construction	10,860
1.3	Domestic water supply	639
1.4	Operation & maintenance road	162
1.5	Irrigation facilities	1,279
II.	Administration cost	679
III.	Engineering services	2,038
IV.	Physical contingencies	2,446
V.	Contract tax	1,807
VI.	Land acquisition	68
VII.	Price contingency	2,063
	Grand Total	22,688

7.3 Operation and Management 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. 17.0 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 Tasiepah 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 Tasiepah Embung with the effective storage capacity of 1.996 MCM is estimated to be Rp. 22,688 million. The total number of beneficiary water users is 1,645 inhabitants and 1,013 heads of cows with the annual water demand of 0.05082 MCM. The investment amount estimated is Rp. 21,754 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 Tasiepah Embung to supply only domestic and livestock water. Thus, the investment amount is split into Rp. 12,906 million for the domestic and livestock water portion and Rp. 8,848 million for the irrigation portion.

The value of effective storage water to be created by the Tasiepah Embung is estimated to be Rp. 6,466/m^3, while that of supplied water is estimated to be Rp. 253,955/m^3. The estimated investment amount to the respective beneficiary people is Rp. 7.85 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 beneficiary people and livestock is Rp. 5.55 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. 8,848 million, the economic investment cost is estimated to be Rp. 5,366 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. 139.0 million and is Rp. 868,500/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 the Tasiepah 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 Tasiepah Embung Project would still have a significant positive impact on the development of economically depressed area in NTT. Furthermore, the both water values can be reduced by 20% compared with the case that Tasiepah Embung is developed at the minimum scale only for meeting BHN.

(4) Farm budget analysis

With implementation of the Tasiepah 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. 868,500/year from Rp. 206,100/year under the "Without Project" condition to Rp. 1,074,600/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 river water and well water (not useful in the dry season)
Health and sanitation	:	Prevalence of waterborne intestinal diseases
Physical environment		
Geology/land	:	Noele formation / coral limestone / talus deposit
Surface/ground water	:	Surface water of which catchment area of 32 km^2 is 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 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 350 families can be quite free from their daily hard job to carry their domestic water at the average distance of 363 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 Tasiepah 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 1,645 inhabitants of 350 families to get permanent water source, to be quite free from daily hard job to carry their domestic water at the average distance of 363 m, to decrease frequency of water born disease and to increase their farm income through irrigation water supply.

Although the construction of Tasiepah Embung is worthy of urgent implementation for meeting BHN in the Project area, such development approach will be unable to utilize water resource potential to the fullest extent. If the available water resources potential is developed by constructing a dam with the maximum height of 36.0 m, the effective water supply volume can be expected to increase by 5.1 MCM to 7.096 MCM. This increase in available water resource can irrigate paddy field of 590 ha if the water is transferred to the neiboring river basin or supply domestic water to around 100,000 urban people if the water is sent to Kupang. According to preliminary cost estimate, the Project cost additionally required amounts to Rp. 12.8 million. This means that raw water cost can be reduced by 50 % to Rp. 4,800/m^3 compared with that of the proposed development scale of Tasiepah Embung.

From the topographic and engineering viewpoints, however, the proposed site is not suitable for stepwise development. Under the Study, therefore, it is concluded that the development scale of the proposed Tasiepah Embung should be upgraded to the maximum extent as the last resort of water source supporting socio-economic growth of Kupang, the capital of NTT as well as economic development through irrigation development.

9.2 Recommendations

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

Necessary technical matters to be made are composed of detailed investigation and study focusing upon engineering geology, alternative study on dam sites, construction method of dam on permeable foundation, confirmation of water demand, water conveyance, treatment and distribution system, proper watershed management and so on.

Main issues of the administrative matters to be taken up will be the urgent approach to sources for technical and financial assistance to conduct the investigation and study recommended in the above aiming at early implementation of this Project.

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

Feasibility Study on Tasiepah Embung Development Project

Tables

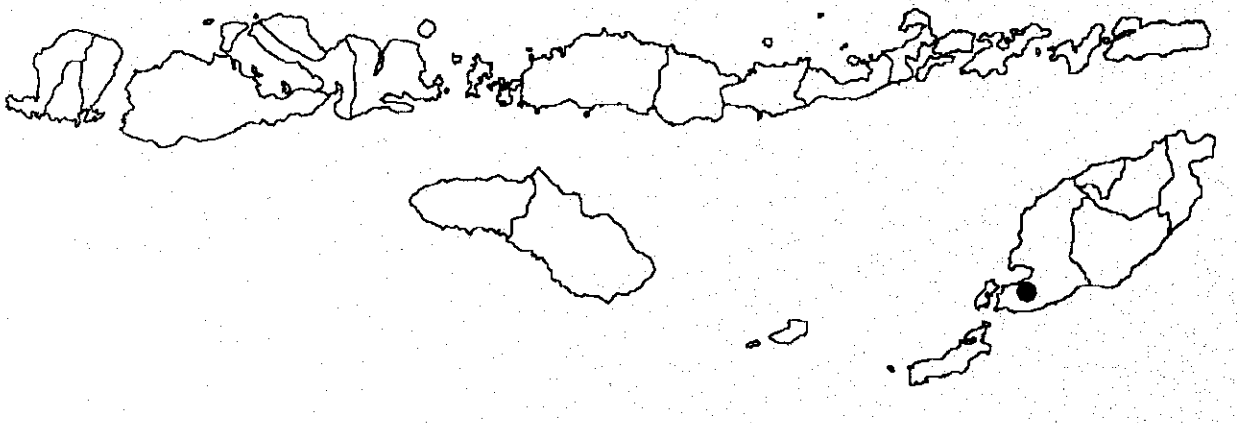


Table 1.1 Monthly Rainfall Record

Station : Penfui 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	
1966	76	158	129	208	39	27	2	0	5	3	54	0	0	0	0	0	0	0	25	0	8	16	144	127	1,020
1967	110	305	252	230	284	38	14	1	0	0	8	0	0	0	0	0	0	0	19	10	5	24	104	52	1,455
1968	44	237	313	162	61	21	31	26	88	3	20	1	3	4	0	1	0	0	0	0	3	20	52	49	1,139
1969	105	146	243	133	17	63	0	0	10	3	22	0	3	1	2	0	0	0	0	4	6	4	113	41	915
1970	42	89	27	93	40	7	0	47	21	9	0	0	0	0	0	0	0	13	5	0	80	72	147	35	724
1971	31	280	248	216	293	88	15	28	12	10	1	0	2	0	0	0	0	1	5	4	56	76	97	42	1,506
1972	9	0	2	7	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	24	94	22	163
1973	56	286	81	11	58	75	7	9	45	0	0	10	1	0	0	10	0	1	0	0	34	85	93	144	1.006
1974	701	48	318	319	228	209	89	15	26	0	54	2	38	1	12	0	33	0	2	3	93	94	15	22	2,318
1975	121	127	146	161	144	21	87	23	0	16	0	11	0	10	0	0	0	0	14	168	59	118	312	145	1,683
1976	364	137	93	205	415	142	29	10	0	0	1	0	6	0	0	0	0	0	0	14	76	3	185	43	1,722
1977	415	37	306	256	188	62	23	11	0	0	0	0	1	0	0	0	0	0	0	0	6	11	142	92	1,550
1978	127	111	208	559	50	51	85	1	38	124	54	2	38	1	12	0	0	0	0	0	7	233	25	237	1.960
1979	248	177	33	140	380	46	6	58	2	47	22	0	0	0	0	0	0	0	0	5	0	157	148	111	1.579
1980	142	467	580	39	31	37	0	93	0	18	0	6	0	0	0	0	0	0	0	19	12	73	135	222	1,874
1981	248	319	211	225	175	6	4	11	4	40	5	24	101	12	0	0	15	27	0	4	125	149	438	237	2,380
1982	71	380	226	226	313	80	1	38	0	7	0	4	14	0	0	0	0	0	0	0	0	77	38	123	1,597
1983	356	92	158	196	215	22	139	57	20	30	0	0	0	0	0	0	0	0	9	49	8	83	16	91	1,540
1984	307	296	209	272	29	230	19	2	12	0	4	1	0	3	0	0	29	0	0	34	20	30	172	243	1,910
1985	18	176	71	112	122	2	23	30	0	0	6	0	15	0	0	0	0	0	0	13	11	120	95	115	928
1986	265	401	130	172	62	71	40	2	0	15	10	39	0	82	0	0	0	0	0	8	3	76	89	164	1,629
1987	156	533	206	180	0	53	24	1	6	32	1	0	12	0	0	0	0	0	0	0	2	118	198	99	1,621
1988	168	245	306	26	147	142	25	0	4	0	0	0	0	0	0	0	9	0	0	5	127	208	155	127	1.695
1989	88	203	96	83	353	103	10	86	42	3	0	36	1	13	0	0	0	0	0	7	20	6	113	122	1,385
1990	281	123	122	220	280	0	7	114	4	3	0	0	0	0	0	11	0	0	0	0	56	9	209	78	1,517
1991	190	303	245	257	43	32	424	9	0	1	0	2	0	0	0	0	0	0	0	0	61	131	47	28	1,773
1992	22	106	232	66	78	153	74	29	0	29	0	0	0	0	0	1	0	12	20	10	30	58	128	0	1,047
1993	135	625	161	108	101	84	14	4	0	2	0	30	0	2	0	0	0	0	3	1	0	20	90	274	1,651
1994	161	81																							
Average	174	224	191	174	148	67	43	25	12	14	9	6	8	5	1	1	3	2	4	13	32	75	128	110	1,469

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
Oefafi	Nainiab RW I	234	263	295	50	57	63
	Nainiab RW II	201	226	253	40	46	51
	Tasiepah RW III	153	172	193	32	36	41
	Tasiepah RW IV	231	260	291	47	53	60
	Koat RW V	202	227	254	47	53	59
Babau	Dulurasa	284	320	359	62	70	76
	Total	1,305	1,468	1,645	278	315	350

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							
Oefafi	Nainiab RW I	134	13	16	35	134	156
	Nainiab RW II	109	11	12	28	109	127
	Tasiepah RW III	67	7	104	26	113	93
	Tasiepah RW IV	100	10	155	40	170	138
	Koat RW V	48	8	69	46	199	74
Babau	Dulurasa	122	26	52	106	479	178
	Total	580	75	408	281	1,204	766
1999							
Oefafi	Nainiab RW I	152	14	19	44	184	178
	Nainiab RW II	124	12	15	36	150	146
	Tasiepah RW III	77	7	126	33	156	107
	Tasiepah RW IV	114	11	187	51	234	159
	Koat RW V	56	8	83	58	274	87
Babau	Dulurasa	139	28	63	134	659	205
	Total	662	80	493	356	1,657	882
2004							
Oefafi	Nainiab RW I	173	15	23	56	254	203
	Nainiab RW II	141	13	18	45	187	166
	Tasiepah RW III	87	8	151	42	214	123
	Tasiepah RW IV	129	12	226	64	322	184
	Koat RW V	62	9	104	74	377	101
Babau	Dulurasa	158	30	76	170	906	236
	Total	750	87	598	451	2,260	1,013

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 36	Male 30	Male 47	Male 35	Male 18	Male 32	Male 44	Male 49	Male 62	Male 58	44
2	No. of Family Member		M-1/F-3	F-5	M-3/F-3	M-3/F-2	F-3	F-5	M-2/F-3	M-1/F-4	M-2/F-1	M-3/F-1	M-1/F-3
3	Type of Side Job		Entrepreneur	None	Carpenter	None	None	None	Workman	None	None	None	
4	Own Farmland	ha	1.00	0.24	1.15	2.25	1.50	0.50	1.00	2.50	0.04	0.22	1.04
	(Paddy field)	ha	0.50	0.00	0.50	0.25	0.00	0.00	0.50	0.25	0.00	0.00	0.20
5	Cropped Area	ha	0.98	0.48	1.50	1.45	1.50	0.50	1.00	2.20	0.04	0.38	1.00
	(Paddy)	ha	0.50	0.00	0.50	0.25	0.00	0.00	0.50	2.00	0.00	0.18	0.39
	(Palawija)	ha	0.32	0.48	0.75	1.20	1.50	0.50	0.50	0.20	0.04	0.20	0.57
	(Others)	ha	0.16	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
6	Cow/Buffalo	head	4	0	0	2	4	1	10	0	7	2	3.0
	Horse	head	0	0	0	0	4	0	0	0	0	0	0.4
	Goat/Sheep	head	0	0	0	0	0	3	5	6	0	1	1.5
	Pig	head	9	10	3	6	0	0	0	8	7	8	5.1
	Chicken/Dug	head	3	10	16	13	0	8	0	13	6	4	7.3
7	Gross Income	Rp/yr	2,616,000	110,000	296,000	586,925	587,000	156,300	1,580,000	519,000	500,000	500,000	745,123
	(Crop)	Rp/yr	216,000	0	56,000	36,925	137,000	6,300	650,000	189,000	0	0	129,123
	(Livestock)	Rp/yr	1,150,000	110,000	40,000	550,000	450,000	150,000	450,000	330,000	500,000	500,000	423,000
	(Side job)	Rp/yr	1,250,000	0	200,000	0	0	0	480,000	0	0	0	193,000
8	Expenditure	Rp/yr	2,541,650	656,900	1,239,100	1,266,900	668,600	1,206,150	1,044,000	1,351,100	318,375	767,800	1,126,598
	(Food/Drink)	Rp/yr	1,260,000	402,000	861,600	834,000	534,000	890,400	864,000	942,000	226,000	450,000	726,400
	(Living)	Rp/yr	694,750	232,500	258,900	385,000	131,000	287,750	198,000	187,350	65,150	168,150	260,855
	(Education)	Rp/yr	500,000	20,000	100,000	25,000	0	25,000	57,000	100,000	22,000	50,000	89,900
	(Production)	Rp/yr	86,900	2,400	18,600	22,900	3,600	3,000	130,400	121,750	5,225	99,650	49,443
9	Surplus/Deficit	Rp/yr	74,350	-546,900	-943,100	-679,975	-81,600	-1,049,850	536,000	-832,100	181,625	-267,800	-381,475

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
Oefafi	Nainiab RW I	5,760	2,595	8,355	6,461	2,965	9,426
	Nainiab RW II	4,949	2,125	7,074	5,541	2,421	7,962
	Tasiepah RW III	3,767	1,563	5,330	4,227	1,801	6,028
	Tasiepah RW IV	5,694	2,329	8,023	6,373	2,682	9,055
	Koat RW V	4,971	1,273	6,244	5,563	1,471	7,034
Babau	Dulurasa	7,008	2,991	9,999	7,862	3,454	11,316
	Total	32,149	12,876	45,025	36,027	14,794	50,821

Source : Provincial Statistic Office, NTT

Table 2.2 Estimated Evapotranspiration (Eto)

Site : Tasiepah
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 : Tasieph
Meteorological Station : Penfui Station

Month	Evapotrans-piration (ETo)	Average Rainfall		Annual-base Dependable Rainfall	Effective Rainfall	
					Paddy	Upland crops
	[1] (mm)	[2] (mm)	[3] (%)	[4] (mm)	[5] (mm)	[6] (mm)
January	165	369	25.8%	270	189	138
February	144	368	25.7%	269	189	130
March	165	196	13.7%	143	100	104
April	172	77	5.4%	56	39	46
May	165	22	1.5%	16	11	13
June	145	16	1.1%	12	8	0
July	154	15	1.0%	11	8	0
August	176	2	0.1%	1	1	0
September	189	4	0.3%	3	2	0
October	214	23	1.6%	17	12	14
November	192	107	7.5%	78	55	65
December	168	234	16.3%	171	120	121
Total	2,049	1,433	100.0%	1,049	734	630

Note ;

[1] : Estimated by modified Penman method on Penfui climatological station in this study
[2] : Rainfall data in Penfui station compiled by P3SA (1947-1992)
[3] : Percentage of monthly rainfall to annual rainfall, calculated from column [2]
[4] : 1,049 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 Penfui station (19~~~ to 19~~~)

Table 2.4 Irrigation Water Requirement (1/3)

Site : Tasiepah-Left Side
Crops : Wet Season Paddy

Item		Month	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
		(days)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
			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			1.10	1.10	1.05	1.05	0.95	0.00																	LP	LP	
- WP-2			LP	1.10	1.10	1.05	1.05	0.95	0.00																	LP	
- WP-3			LP	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
(2) Crop consumptive use (Etc)																											
- WP-1		mm	88	94	75	75	76	0																			408
- WP-2		mm		94	79	75	84	81	0																		413
- WP-3		mm			79	79	84	90	82	0																	413
(3) Land preparation (IR)																											
- WP-1		mm																							195	208	403
- WP-2		mm	194																							208	402
- WP-3		mm	194	206																							400
(4) Percolation																											
- WP-1		mm	30	32	28	28	30																				
- WP-2		mm		32	28	28	30	32																			
- WP-3		mm			28	28	30	32	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	91	98	95	94	48	52	20	19	5	6											27	28	58	62	
(7) Field water requirement																											
- WP-1		mm	27	78	8	59	58	0																	137	146	513
- WP-2		mm	103	28	62	9	116	61	0																	146	525
- WP-3		mm	103	108	12	63	66	120	92	0																	563
(8) Diversion requirement		mm	119	109	42	68	123	93	47	0															70	150	821
		m3/ha	1,190	1,090	420	680	1,230	930	470	0															700	1,500	8,210

Source : JICA Study Team estimate based on the meteorological data at the Penfui station

Table 2.4 Irrigation Water Requirement (2/3)

Site : Tasiepah-Right Side
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
	(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	LP	1.10	1.10	1.05	1.05	0.95	0.00																	
- 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			79	79	84	90	82																		413
- WP-2	mm				79	88	90	90	82																	429
- WP-3	mm					88	94	90	90	76																439
(3) Land preparation (IR)																										
- WP-1	mm	194	206																							400
- WP-2	mm		206	179																						385
- WP-3	mm			179	179																					358
(4) Percolation																										
- WP-1	mm			28	28	30	32	30																		
- WP-2	mm				28	30	32	30	30																	
- WP-3	mm					30	32	30	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	91	98	95	94	48	52	20	19	5	6											27	28	58	62	
(7) Field water requirement																										
- WP-1	mm	103	108	12	63	66	120	92	0																	563
- WP-2	mm		108	84	13	120	70	150	93	0																638
- WP-3	mm			84	85	70	124	100	151	101	0															716
(8) Diversion requirement	mm	53	111	92	83	131	160	176	125	52	0															983
	m3/ha	530	1,110	920	830	1,310	1,600	1,760	1,250	520	0															9,830

Source : JICA Study Team estimate based on the meteorological data at the Penfui station

Table 2.4 Irrigation Water Requirement (3/3)

Site : Tasiepah Left Side & Rite Side
Crops : Dry Season Palawija (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
		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. Left Side (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	60	85	73	60	17												
- DB-2	mm									40	64	73	73	61	18											
- DB-3	mm										43	54	73	74	65	20										
(3) Effective rainfall (ER)	mm	67	71	65	65	50	54	23	23	6	7	0	0	0	0	0	0	0	0	7	7	32	33	59	62	
(4) Field water requirement																										
- DB-1	mm								20	54	78	73	60	17												302
- DB-2	mm									34	57	73	73	61	18											315
- DB-3	mm										36	54	73	74	65	20										322
(5) Diversion requirement	mm							0	13	59	114	133	136	102	56	13	0		0							626
	m3/ha							0	130	590	1,140	1,330	1,360	1,020	560	130	0		0							6,260
III. Right Side(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	50	54	23	23	6	7	0	0	0	0	0	0	0	0	7	7	32	33	59	62	
(4) Field water requirement																										
- DB-1	mm										36	54	73	74	65	20										322
- DB-2	mm											36	54	74	79	70	21									335
- DB-3	mm												36	56	79	85	75	22								353
(5) Diversion requirement	mm									0	24	61	109	136	149	116	64	14	0							673
	m3/ha									0	240	610	1,090	1,360	1,490	1,160	640	140	0							6,730

Source : JICA Study Team estimate based on the meteorological data at the Penfui station

Table 3.1 Estimated Half Monthly Discharge at Proposed Embung Site

Embung Tasiepah

Unit : 1000 m3

	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	
1966	727	1,517	1,242	1,998	379	261	0	0	0	0	520	0	0	0	0	0	0	0	244	0	0	0	1,390	1,218	9,496
1967	1,061	2,937	2,426	2,214	2,736	365	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	229	998	504	13,470
1968	423	2,284	3,017	1,560	591	199	298	253	844	0	0	0	0	0	0	0	0	0	0	0	0	0	503	474	10,446
1969	1,006	1,409	2,343	1,281	0	603	0	0	0	0	216	0	0	0	0	0	0	0	0	0	0	0	1,087	391	8,336
1970	402	856	260	892	383	0	0	454	201	0	0	0	0	0	0	0	0	0	0	0	767	690	1,418	333	6,656
1971	296	2,695	2,390	2,079	2,817	848	0	273	0	0	0	0	0	0	0	0	0	0	0	0	538	736	932	407	14,011
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	228	902	211	1,341
1973	541	2,752	775	0	557	725	0	0	434	0	0	0	0	0	0	0	0	0	0	0	327	816	899	1,382	9,208
1974	6,754	466	3,058	3,075	2,193	2,008	853	0	248	0	515	0	361	0	0	0	320	0	0	0	896	905	0	210	21,862
1975	1,165	1,223	1,406	1,550	1,390	204	838	221	0	0	0	0	0	0	0	0	0	0	0	1,618	565	1,136	3,005	1,396	15,717
1976	3,502	1,317	898	1,970	3,992	1,368	279	0	0	0	0	0	0	0	0	0	0	0	0	0	732	0	1,777	417	16,252
1977	3,995	351	2,945	2,465	1,809	599	221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,370	887	14,642
1978	1,220	1,072	2,001	5,379	477	493	815	0	368	1,193	515	0	361	0	0	0	0	0	0	0	0	2,243	240	2,285	18,662
1979	2,383	1,700	316	1,349	3,656	442	0	559	0	453	214	0	0	0	0	0	0	0	0	0	0	1,514	1,425	1,069	15,080
1980	1,367	4,492	5,589	374	296	351	0	898	0	0	0	0	0	0	0	0	0	0	0	0	0	706	1,300	2,136	17,509
1981	2,388	3,067	2,027	2,163	1,688	0	0	0	0	388	0	231	973	0	0	0	0	263	0	0	1,199	1,434	4,214	2,286	22,321
1982	679	3,663	2,173	2,172	3,010	771	0	369	0	0	0	0	0	0	0	0	0	0	0	0	0	740	368	1,187	15,132
1983	3,424	881	1,523	1,890	2,070	207	1,342	549	0	285	0	0	0	0	0	0	0	0	0	472	0	797	0	872	14,312
1984	2,953	2,846	2,009	2,623	276	2,212	0	0	0	0	0	0	0	0	0	0	280	0	0	327	0	290	1,653	2,340	17,809
1985	0	1,698	687	1,080	1,171	0	225	293	0	0	0	0	0	0	0	0	0	0	0	0	0	1,158	910	1,106	8,328
1986	2,554	3,860	1,248	1,654	599	683	382	0	0	0	0	379	0	792	0	0	0	0	0	0	0	727	860	1,581	15,319
1987	1,506	5,128	1,984	1,736	0	513	228	0	0	310	0	0	0	0	0	0	0	0	0	0	0	1,139	1,903	955	15,402
1988	1,622	2,355	2,947	252	1,419	1,371	241	0	0	0	0	0	0	0	0	0	0	0	0	0	1,224	1,998	1,497	1,220	16,146
1989	844	1,959	927	797	3,397	990	0	831	404	0	0	347	0	0	0	0	0	0	0	0	196	0	1,090	1,172	12,954
1990	2,701	1,184	1,179	2,122	2,700	0	0	1,098	0	0	0	0	0	0	0	0	0	0	0	0	536	0	2,012	750	14,282
1991	1,829	2,917	2,361	2,474	414	311	4,083	0	0	0	0	0	0	0	0	0	0	0	0	0	587	1,258	453	270	16,957
1992	211	1,021	2,232	638	747	1,476	715	279	0	282	0	0	0	0	0	0	0	0	0	0	284	560	1,228	0	9,673
1993	1,300	6,015	1,551	1,040	971	806	0	0	0	0	0	287	0	0	0	0	0	0	0	0	0	0	868	2,634	15,472
Average	1,673	2,202	1,840	1,672	1,419	636	376	217	89	104	71	44	61	28	0	0	21	9	9	86	280	689	1,225	1,060	13,814

Table 3.2 Estimate of Probable Flood Discherge

Tasiepah Scheme

Characteristics of the catchment area								
Catchment Area	(km2)	32.10						
Eelevation at Dam Site (1)	(m)	87						
Maximum elevation in the catchment area (2)	(m)	350						
Height (3)=(2)-(1)	(h)	263						
Length of Catchment Area (l)	(m)	12,500						
Flow velocity	W2 (km/hr)	7.10						
Time of concentration	T2 (hrs)	1.76						
Estimate of the Design Flood Discherge								
Return Period	(years)	2	5	10	20	50	100	200
Rainfall	(mm/day)	103	160	205	253	327	390	459
Rainfall intensity within the time of concentration	(mm)	16	25	31	39	50	60	71
Designed Flood	(m3/s)	113	175	225	278	359	428	504
Specific Discharge	(m3/s/km2)	4	5	7	9	11	13	16

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

Tasiepah 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	27.50	27.50	27.00	28.00	Normal water temperature
2 Dissolved solid matter	mg/liter	357.00	229.00	474.00	453.00	1000
3 Electric Conductivety	umhos/cm	475.00	304.00	643.00	616.00	-
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	0.00	0.00	0.00	0.00	1
6 Fluoride	mg/liter	0.90	1.20	1.30	0.80	1.5
7 Cadmium	mg/liter	0.00	0.00	0.00	0.00	0.005
8 Chloride	mg/liter	60.30	59.00	57.00	60.00	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	0.00	0.00	10
12 Nitric, N	mg/liter		0.00	0.00	0.00	1
13 Dissolved Oxygen	mg/liter	7.82	7.83	7.71	7.30	*
14 pH	-	7.80	7.80	7.80	7.60	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	18.50	78.00	72.50	78.50	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	130	240	240	240	2,000
2 Total Coliform	per 100 ml	170	350	350	540	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

Tasiepah Scheme

Item		Unit	Design Value
Natural Water Content	(NWC)	%	31.6
Bulk Density	(γ d max)	g/cm3	1.932
Maximum Dry Density	(γ t)	g/cm3	1.43
Saturated Density	(σ sat)	g/cm3	2.090
Optimum Moisture Content	(Wopt)	%	28.8
Specific Gravity	(Gs)	-	2.62
Liquid Limit	(LL)	%	70.9
Plastic Limit	(PL)	%	28.8
Plastic Index	(PI)	%	36.1
Shrinkage Limit	-	%	24.9
Angle of Internal Friction	(ϕ)	°	30.0
Cohesion (UU/CU)	(C)	kg/cm2	0.2
Permeability	(K)	cm/sec	2.50E-06
Classification of Soil	-	-	CL

Table 6.1 Summary of Construction Equipment

Tasiepah 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 : TASIEPAH

Item	Amount (Rp. million)
I. Direct Construction Cost	
1.1 Preparatory Works	647
1.2 Embung Construction	
1) Main dam	2,578
2) Spillway	4,505
3) Intake, outlet & diversion channel	745
4) Leakage protection works	2,045
5) Miscellaneous	987
Sub-total of 1.2	10,860
1.3 Domestic Water Supply	
1) Pipe line	419
2) Division boxes	162
3) Miscellaneous	58
Sub-total of 1.3	639
1.4 Embung Operation and Maitenace Road	162
1.5 Irrigation Facilities	1,279
Sub-toal of I.	13,587
II. Administration Cost	679
III. Engineering Services	2,038
Sub-total of I, II & III	16,304
IV. Physical Contingency	2,446
Sub-total of I, II, II, & IV	18,750
V. Contract Tax	1,807
VI. Land Aquisition Cost	68
Sub-total I, II, III, IV, V & VI	20,625
VII. Price Contingency	2,063
GRAND TOTAL	22,688

Table 7.2 Direct Construction Cost (1/3)

Scheme : TASIEPAH

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
I. Embung				
1. Main Dam				
1.1 Earth/stone works				
1) Clearing	m2	400	15,200	6,080
2) Excavation	m3	5,500	19,000	104,500
3) Embankment	m3	8,000	267,000	2,136,000
4) Rip-rap protection	m3	15,000	6,500	97,500
1.2 Other miscellaneous works				234,408
Sub-total of 1.				2,578,488
2. Spillway				
2.1 Earth works				
1) Clearing	m2	400	4,600	1,840
2) Excavation	m3	5,500	63,000	346,500
3) Backfill	m3	5,200	2,200	11,440
2.2 Concrete works				
1) Concrete - A	m3	250,000	1,300	325,000
2) Concrete - B	m3	170,000	11,900	2,023,000
3) Reinforcement bar	ton	1,500,000	265	397,500
4) Form	m2	15,000	66,000	990,000
2.3 Other miscellaneous works	L.S			409,528
Sub-total of 2.				4,504,808
3. Intake, Outlet & Diversion Channel				
3.1 Earth works				
1) Clearing	m2	400		0
2) Excavation	m3	5,500	15,000	82,500
3) Backfill	m3	15,000		0
3.2 Concrete works				
1) Concrete - A	m3	250,000		0
2) Concrete - B	m3	170,000	3,500	595,000
3) Reinforcement bar	ton	1,500,000		0
4) Form	m2	15,000		0
3.3 Other miscellaneous works	L.S			67,750
Sub-total of 3.				745,250
4. Leakage Protection Works				
4.1 Earth works				
1) Clearing	m2	400	12,000	4,800
2) Earth blanket works	m3	8,000		0
4.2 Concrete lining works	m2	170,000	12,000	2,040,000
Sub-total of 4.				2,044,800
5. Miscellaneous & Others				987,335
Total of I.				10,860,681

Table 7.2 Direct Construction Cost (2/3)

Scheme : TASIEPAH

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
II. Domestic Water Supply				
1. Pipe line				
1.1 Earth works				
1) Clearing	m2	400	21,200	8,480
2) Excavation	m3	5,000	9,930	49,650
3) Backfill	m3	5,200	9,200	47,840
1.2 Pipe line setting works				
1) Dia 40 mm	m	5,300		0
2) Dia 50 mm	m	7,400	6,160	45,584
3) Dia 65 mm	m	9,200	3,280	30,176
5) Dia 75 mm	m	13,300		0
6) Dia. 400 mm	m	218,000	1,050	228,900
1.3 Pipe line related structures				
1) Check valve	nos.	624,000	6	3,744
2) Air valve	nos.	506,000	5	2,530
3) Drainage valve	nos.	1,036,000	2	2,072
Sub-total of 1.				418,976
2. Division Boxes				
1) Division box for inhabitants	nos.	6,990,000	17	118,830
2) Division box for livestock	nos.	1,130,000	38	42,940
Sub-total of 2.				161,770
3. Miscellaneous & Others	L.S			58,075
Total of II.				638,821
III. Embung Operation and Maintenance Road				
1. Road Works				
1.1 Earth works				
1) Clearing	m2	400	49,900	19,960
2) Excavation	m3	5,000		0
3) Embankment	m3	6,300	3,500	22,050
4) Pavement (lime stone)	m3	15,000	6,700	100,500
2. Related structures				
2.1 Cross drain	nos.	4,700,000	1	4,700
3. Miscellaneous and others	L.S			14,721
Total of III				161,931

Table 7.2 Direct Construction Cost (3/3)

Scheme : TASIEPAH

Item	Unit	Unit Price Rp.	Quantity	Total 1000 Rp.
IV. Irrigation Facilities				
1. Canal works				
1.1 Earth works				
1) Clearing	m2	400	25,000	10,000
2) Excavation	m3	5,000	4,500	22,500
3) Embankment	m3	6,300	3,800	23,940
1.2 Concrete works				
1) Concrete - A	m3	250,000	960	240,000
2) Concrete - B	m3	170,000	140	23,800
3) Reinforcement bar	ton	1,500,000	28	42,000
4) Form	m2	15,000	7,400	111,000
2. Related structures				
2.1 Irrigation inlet box	nos.	1,600,000	2	3,200
2.2 Aqueduct	nos.	2,750,000	0	0
2.3 Cross drain	nos.	4,700,000	2	9,400
2.4 Irrigation division box	nos.	600,000	3	1,800
3. Rehabilitation of existing canal				
3.1 Weir rehabilitation	L.S		1	325,000
3.2 Canal rehabilitation	L.S		1	350,000
4. Miscellaneous & Others	L.S			116,264
Total - IV				1,278,904
GRAND TOTAL				12,940,336

Table 8.1 Price Structures for Paddy in NTT
(June 1994 price level)

	Item	Import Parity			Export Parity		
		Operation	US$/ton	Rp./kg	Operation	US$/ton	Rp./kg
1	Export price of Thai 5% broken, FOB Bangkok 1)		283			283	
2	Quality adjusment 2)	x 0.9	255		x 0.9	255	
3	Shipping and insurance cost	+	35		+	0	
4	Import price, bagged milled rice, CIF Surabaya	=	290		=	255	
5	Convert to Rupiah	x 2,117		613.3	x 2,090		539.2
6	Port handling, storage and losses 3)	+		25.0	-		25.0
7	Handling and transportation cost to Kupang	+		50.0	-		50.0
8	Ex-wholesaler	=		688.3	=		464.2
9	Conversion to price of dried paddy 4)	x 0.65		447.4	x 0.65		301.7
10	Milling charge 5)	-		12.0	-		12.0
11	Handling and transportation cost to farm gate 6)	-		30.0	-		30.0
12	Economic farm gate price of dried paddy	=		405.4	=		259.7
		≠		(405)	≠		(260)
	Average farm gate price of Import-Export parity			333 Rp./kg			

Note: 1) Based on "Quarterly Review of Commodity Markets, IBRD Third Quarter 1993" with 1990 constant prices infrated to 1994 prices using factor of 1.1085 based on MUV index.
2) 90% of world price.
3) Includes port costs, transport to warehouse, spraying and fumigation, unloading, warehouse rents, losses at unloading and at the warehouse.
4) Standard coversion rate at DOLOG
5) Net of value of by-products at includes milling/storage losses.
6) Includes 1% losses.

Table 8.2 Price Structures for Palawija Crops in NTT (June 1994 price level)

	Item	Operation	US$/ton	Rp./kg
Maize				
1	Export price, FOB US Gulf port 1)		116	
2	Freight and insurance	+	35	
3	Import price, maize, CIF Surabaya	=	151	
4	Convert to Rupiah	x 2,117		319.7
5	Port handling and storage	+		29.2
6	Internal transportation cost (Surabaya-Kupang)	+		50.0
7	Ex-wholesaler (Kupang)	=		398.9
8	Handling and transportation cost to project site	-		30.0
9	Local transport and handling losses	-		5.0
10	Economic farm gate price of maize	=		363.9
		≠		(364)
Mungbean				
1	Import price, CIF Jakarta 2)		427	
2	Convert to Rupiah	x 2,117		904.0
3	Port handling and storage	+		40.7
4	Transport to wholesaler (Jakarta)	+		5.0
5	Ex-wholesaler (Kupang)	=		949.7
6	Internal transportation cost (Jakarta-Kupang)	-		50.0
7	Handling and transportation cost to project site	-		30.0
8	Local transport and handling losses	-		5.0
9	Economic farm gate price of mungbean	=		914.7
		≠		(915)

Note: 1) Based on "Quarterly Review of Commodity Markets, IBRD Third Quarter1993"
2) Estimated on the basis of CIF Jakarta prices for last 5 years.

Table 8.3 Price Structures for Fertilizer in NTT (June 1994 price level)

Item	Operation	US$/ton	Rp./kg
Urea			
Export price FOB Europe, bagged 1)		160	
Transport premium	+	15	
FOB Palembang	=	175	
Conversion to Rupiah	x 2,117		370.5
Cost of shipping to Surabaya	+		8.0
Port handling charges	+		19.3
Handling and transportation cost to project area	+		65.0
Economic cost of bagged urea at farm gate	=		462.8
	≠		(463)
TSP			
Export price, FOB US Gulf, bulk 1)		139	
Shipping and insurance cost to Surabaya	+	65	
Import price CIF Surabaya	=	204	
Conversion to Rupiah	x 2,117		431.9
Port handling charges	+		19.3
Bagging cost	+		15.0
Handling and transportation cost to project area	+		65.0
Economic cost of bagged TSP at farm gate	=		531.2
	≠		(531)
Potassium Chloride (KCl)			
Export price, FOB, Vancouver, bulk 1)		119	
Shipping and insurance cost to Surabaya	+	65	
Import price CIF Surabaya	=	184	
Conversion to Rupiah	x 2,117		389.5
Port handling charges	+		19.3
Bagging cost	+		15.0
Handling and transportation cost to project area	+		65.0
Economic cost of bagged TSP at farm gate	=		488.8
	≠		(489)

Note: 1) Based on "Quarterly Review of Commodity Markets, IBRD Third Quarter1993" with 1990 constant prices infrated to 1994 prices using factor of 1.1085 based on MUV index.

Table 8.4 Economic Crop Budget per Ha
(June 1994 price level)

Tasiepah Scheme

Item		Unit	Unit Value	Without Project				With Project			
				Paddy (Irrigated)		Maize (Rainfed)		Paddy (Irrigated)		Mungbean (Irrig.)	
			(Rp.)	Q'ty	Amount	Q'ty	Amount	Q'ty	Amount	Q'ty	Amount
Gross Production Value											
Paddy		kg	333	1,750	582,750	0	0	4,000	1,332,000	0	0
Maize		kg	364	0	0	1,800	655,200	0	0	0	0
Mungbean		kg	915	0	0	0	0	0	0	1,100	1,006,500
Production Cost											
Seed											
Paddy	Certified	kg	537	0	0	0	0	25	13,425	0	0
	Own	kg	333	60	19,980	0	0	0	0	0	0
Maize	Certified	kg	533	0	0	0	0	0	0	0	0
	Own	kg	364	0	0	25	9,100	0	0	0	0
Mungbean	Certified	kg	1,383	0	0	0	0	0	0	30	41,490
	Own	kg	893	0	0	0	0	0	0	0	0
Fertilizer											
Urea		kg	463	80	37,040	30	13,890	200	92,600	50	23,150
TSP		kg	531	40	21,240	0	0	80	42,480	100	53,100
KCl		kg	489	0	0	0	0	40	19,560	50	24,450
Agro-chemicals		liter	10,000	0.5	5,000	0.5	5,000	2.0	20,000	2.0	20,000
Rodenticide		kg	5,500	0.0	0	0.0	0	0.5	2,750	1.0	5,500
Labor											
Family		md	1,500	80	120,000	75	112,500	165	247,500	82	123,000
Hired		md	2,000	10	20,000	0	0	10	20,000	0	0
Draft Animal		ad	5,000	40	200,000	40	200,000	40	200,000	40	200,000
Tractor		ha	200,000	0	0	0	0	0	0	0	0
Miscellaneous (10% Of above)					42,326		34,049		65,832		49,069
Total production cost					465,586		374,539		724,147		539,759
Net Production Value					117,164		280,661		607,854		466,741

Table 8.5 Calculation of Economic Net Production Value (June 1994 price level)

Item	Tasiepah Embung	Benkoko Embung	Matasio Embung
A Harvested Area (ha)			
1. With Project			
a. Paddy	160	35	75
b. Mungbean	160	35	0
c. Red Onion	0	70	0
2. Without Project			
a. Paddy	73	35	60
b. Maize	87	0	3
B Unit Net Production Value (Rp./ha)			
1. With Project			
a. Paddy	607,854	607,854	693,053
b. Mungbean	466,741	375,241	0
c. Red Onion	0	1,670,950	0
2. Without Project			
a. Paddy	117,164	18,555	248,310
b. Maize	280,661	0	369,961
C Net Production Value (Rp.1,000)			
1. With Project			
a. Paddy	97,257	21,275	51,979
b. Mungbean	74,679	13,133	0
c. Red Onion	0	116,967	0
Sub-total for C1	171,935	151,375	51,979
2. Without Project			
a. Paddy	8,553	649	14,899
b. Maize	24,418	0	1,110
Sub-total for C2	32,970	649	16,008
D Incremental Amount (Rp. 1,000)	138,965	150,725	35,970

Table 8.6 Summary of Economic Costs and Benefits for Economic Evaluation (June 1994 price level)

(Unit : Rp. million)

Item	Tasiepah Embung	Benkoko Embung	Matasio Embung	Total
1. Cost Allocation (Financial Cost)				
1.1 Investment Cost	22,688	9,526	5,267	37,481
(a) Domestic and Livestock Water Supply	12,906	4,255	3,897	21,058
(b) Irrigation Water Supply	8,848	4,879	1,153	14,880
1.2 Administrative Cost born from Counter Budget	934	392	217	1,543
2. Economic Investment Cost for Irrigation				
1.1 Direct construction cost				
(a) Embung	3,013	2,110	361	5,484
(b) Irrigation Water Distribution System	908	53	149	1,110
Sub-total	3,921	2,163	510	6,594
1.2 Engineering services	745	411	97	1,253
1.3 Physical contingency	700	386	91	1,177
Total investment cost	5,366	2,960	698	9,024
1.5 Annual disbursement				
1st Year	285	158	44	487
2nd Year	1,591	2,802	654	5,047
3rd Year	3,490	0	0	3,490
4th Year	0	0	0	0
5th Year	0	0	0	0
3. Annual O&M cost				
3.1 Embung, intake and pipe (0.5% 0f 1.1)	20	11	3	33
4. Economic irrigation benefit				
4.1 Annual net production value (see Table 8-5)				
(a) With project net benefit	171.9	151.4	52.0	375.3
(b) Without project net benefit	33.0	0.6	16.0	49.6
4.2 Incremental net benefit (= a - b)	138.9	150.8	36.0	325.7
5. Negtive benefit	0	0	0	0

Table 8.7 Economic Costs and Benefits Flow (Tasiepah Embung Development Project)

EIRR = #DIV/0! %

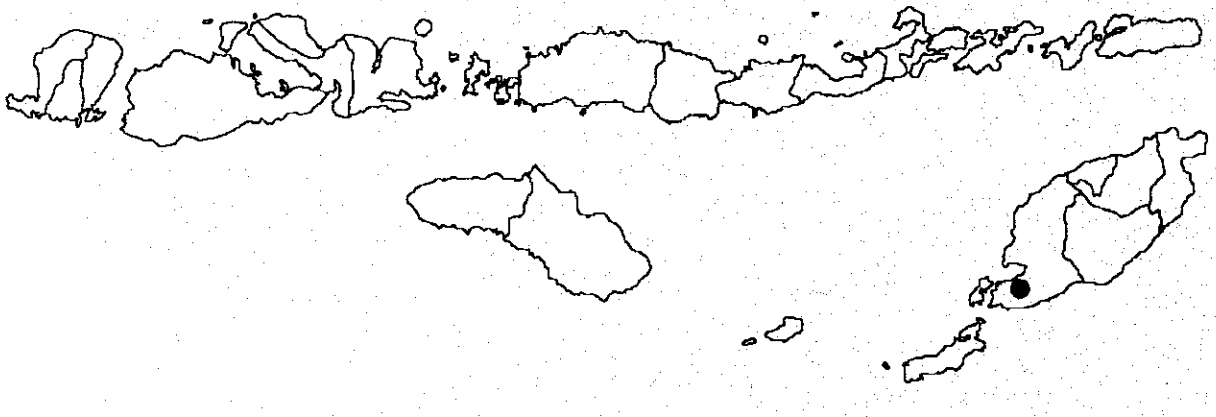
Year	Cost				Benefit			Increment
	Capital	Replace	O&M	Total	Irrigation	Negative	Total	
1.	285	0	0	285	0	0	0	-285
2.	1,591	0	0	1,591	0	0	0	-1,591
3.	3,490	0	0	3,490	0	0	0	-3,490
4.	0	0	20	20	83	0	83	63
5.	0	0	20	20	97	0	97	77
6.	0	0	20	20	111	0	111	91
7.	0	0	20	20	125	0	125	105
8.	0	0	20	20	139	0	139	119
9.	0	0	20	20	139	0	139	119
10.	0	0	20	20	139	0	139	119
11.	0	0	20	20	139	0	139	119
12.	0	0	20	20	139	0	139	119
13.	0	0	20	20	139	0	139	119
14.	0	0	20	20	139	0	139	119
15.	0	0	20	20	139	0	139	119
16.	0	0	20	20	139	0	139	119
17.	0	0	20	20	139	0	139	119
18.	0	0	20	20	139	0	139	119
19.	0	0	20	20	139	0	139	119
20.	0	0	20	20	139	0	139	119
21.	0	0	20	20	139	0	139	119
22.	0	0	20	20	139	0	139	119
23.	0	0	20	20	139	0	139	119
24.	0	0	20	20	139	0	139	119
25.	0	0	20	20	139	0	139	119

Note: June1994 price level

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

Feasibility Study on Tasiepah Embung Development Project

Figures



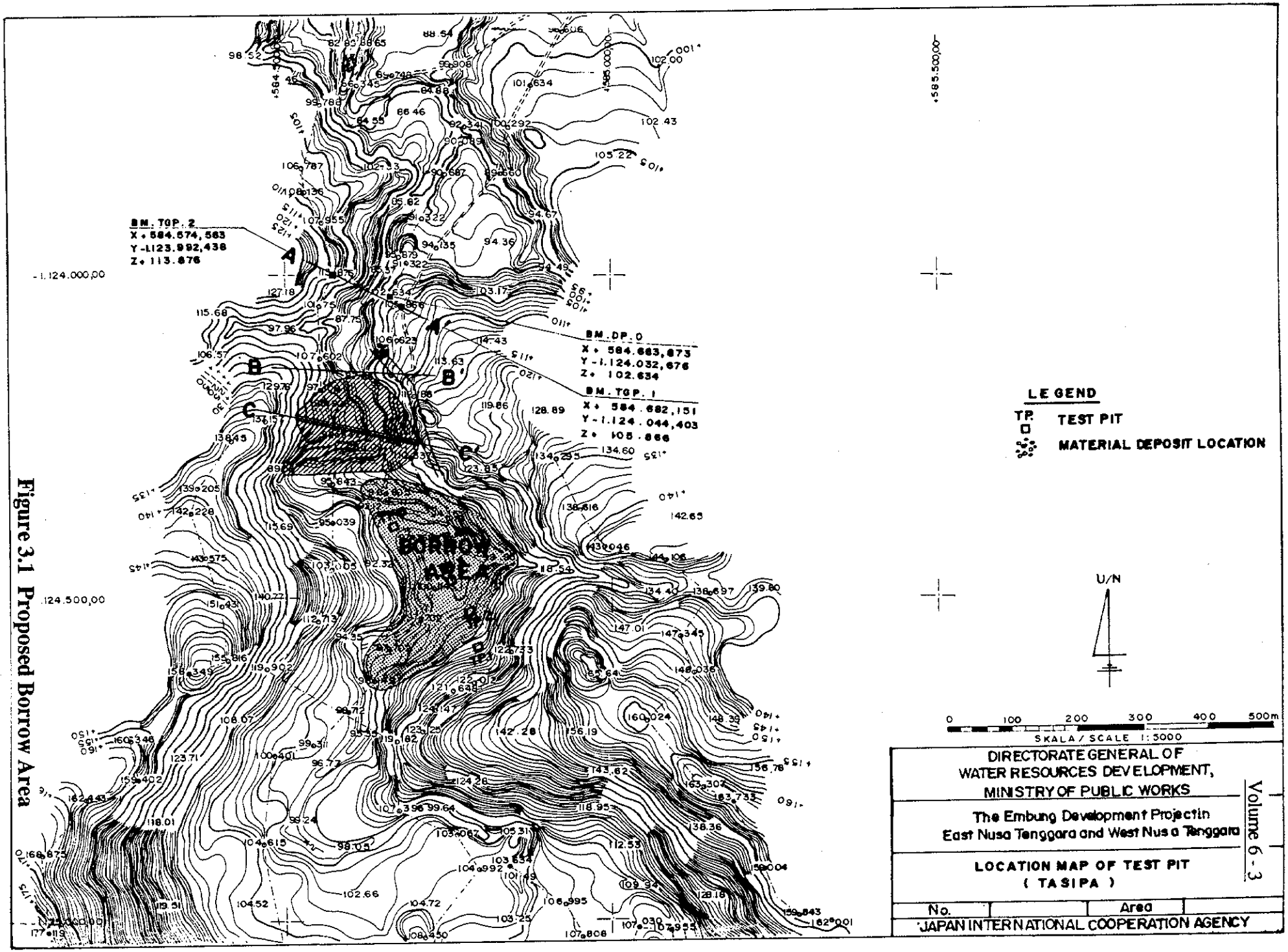
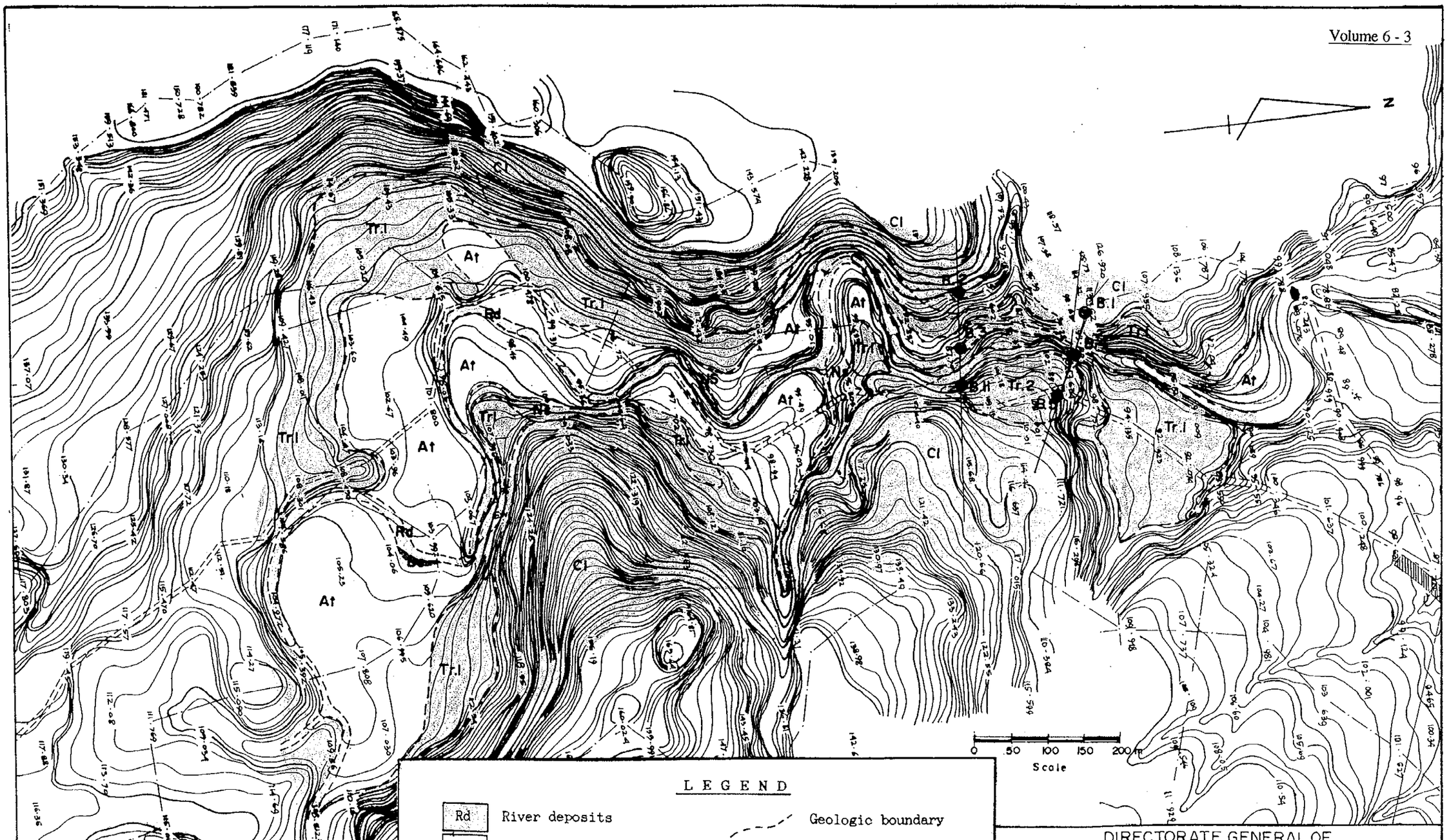


Figure 3.1 Proposed Borrow Area



LEGEND

Rd	River deposits		Geologic boundary
At	Alluvial terrace deposits		Dip and strike of bed
Tr1	Terrace deposits (Low)		Bore Hole
Tr2	Terrace deposits (High)	A — A'	Geologic profile line
Cl	Coral limestone : Coralline limestone		
Ns	Siltstone: Noele Formation		
B	Claystone : Bobonaro Formation		

DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

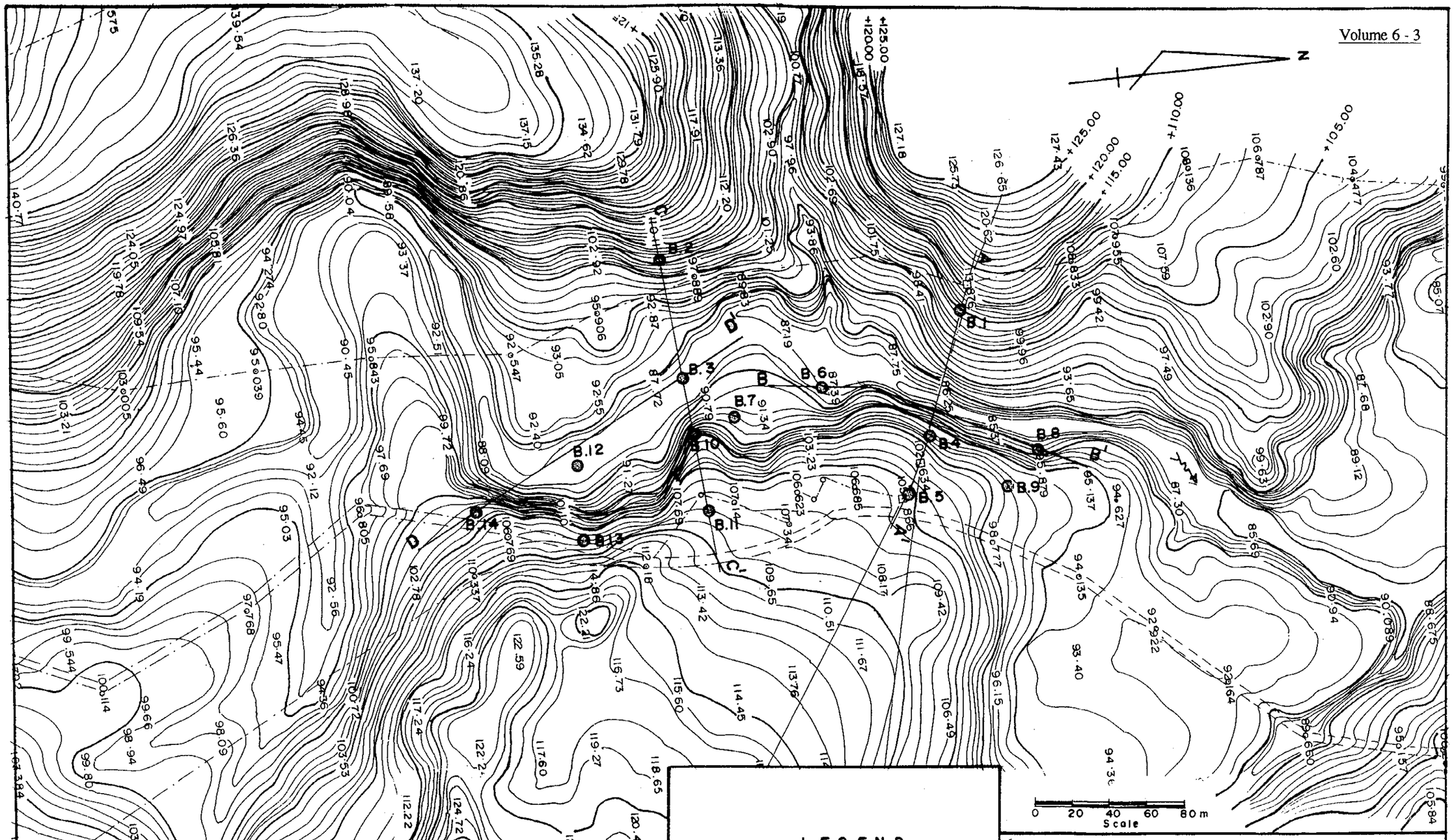
The Embung Development Project in
East Nusa Tenggara and West Nusa Tenggara

GEOLOGIÇAL MAP OF TASIPA SITE

No.		Area	

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2 Geological Map and Profile (1/3)



DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT,
MINISTRY OF PUBLIC WORKS

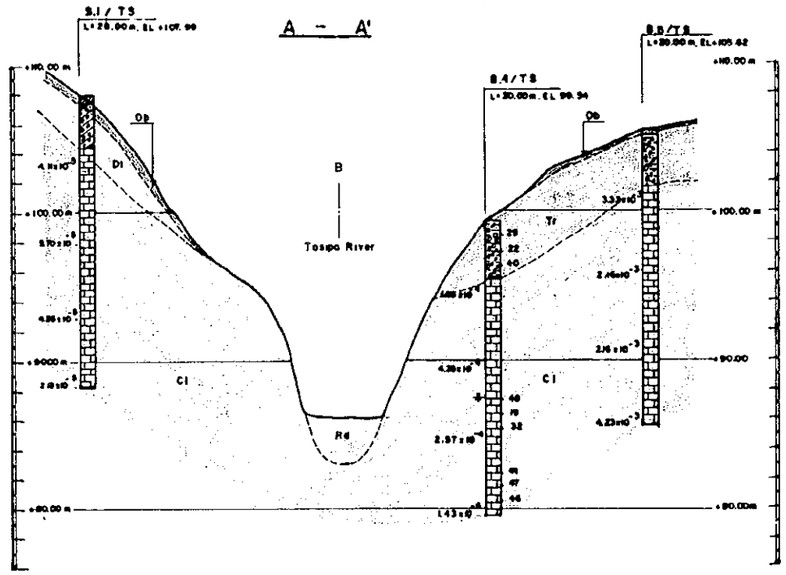
The Embung Development Project in
East Nusa Tenggara and West Nusa Tenggara

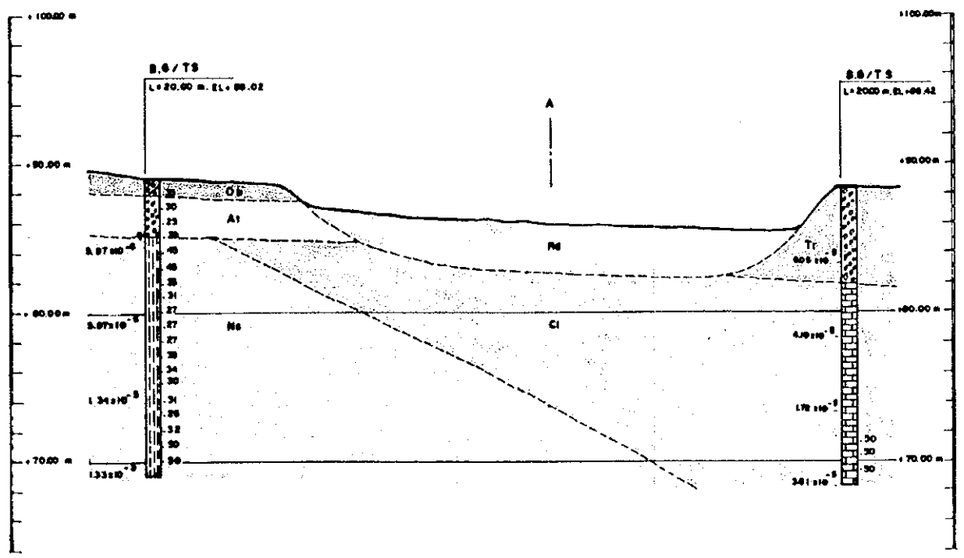
LOCATION MAP OF BORE HOLE
(TASIPA)

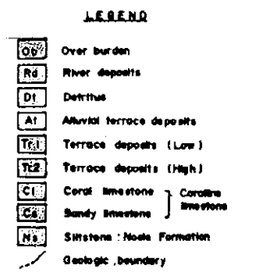
No.		Area	

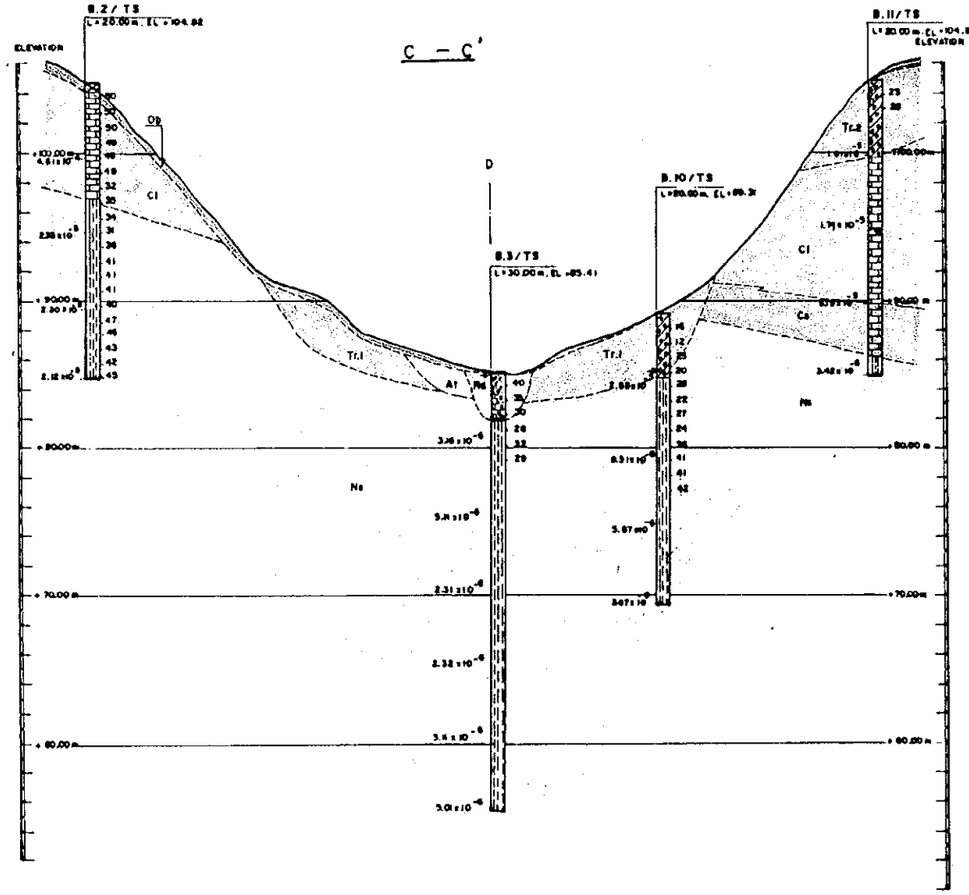
JAPAN INTERNATIONAL COOPERATION AGENCY

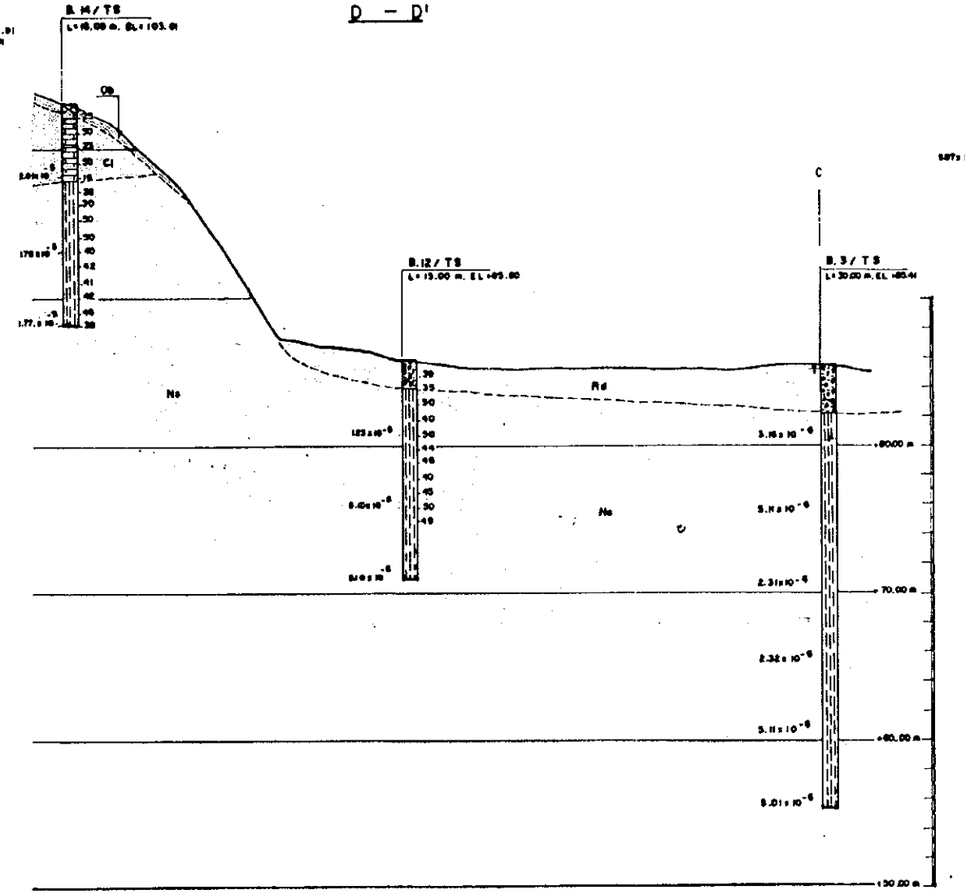
Figure 3.3 Geological Map and Profile (2/3)

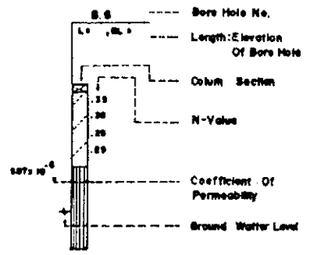


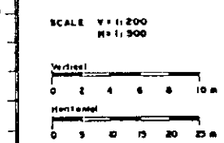












DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT, MINISTRY OF PUBLIC WORKS

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

GEOLOGICAL PROFILE OF TASIPA SITE

No. | Area

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.4 Geological Map and Profile (3/3)

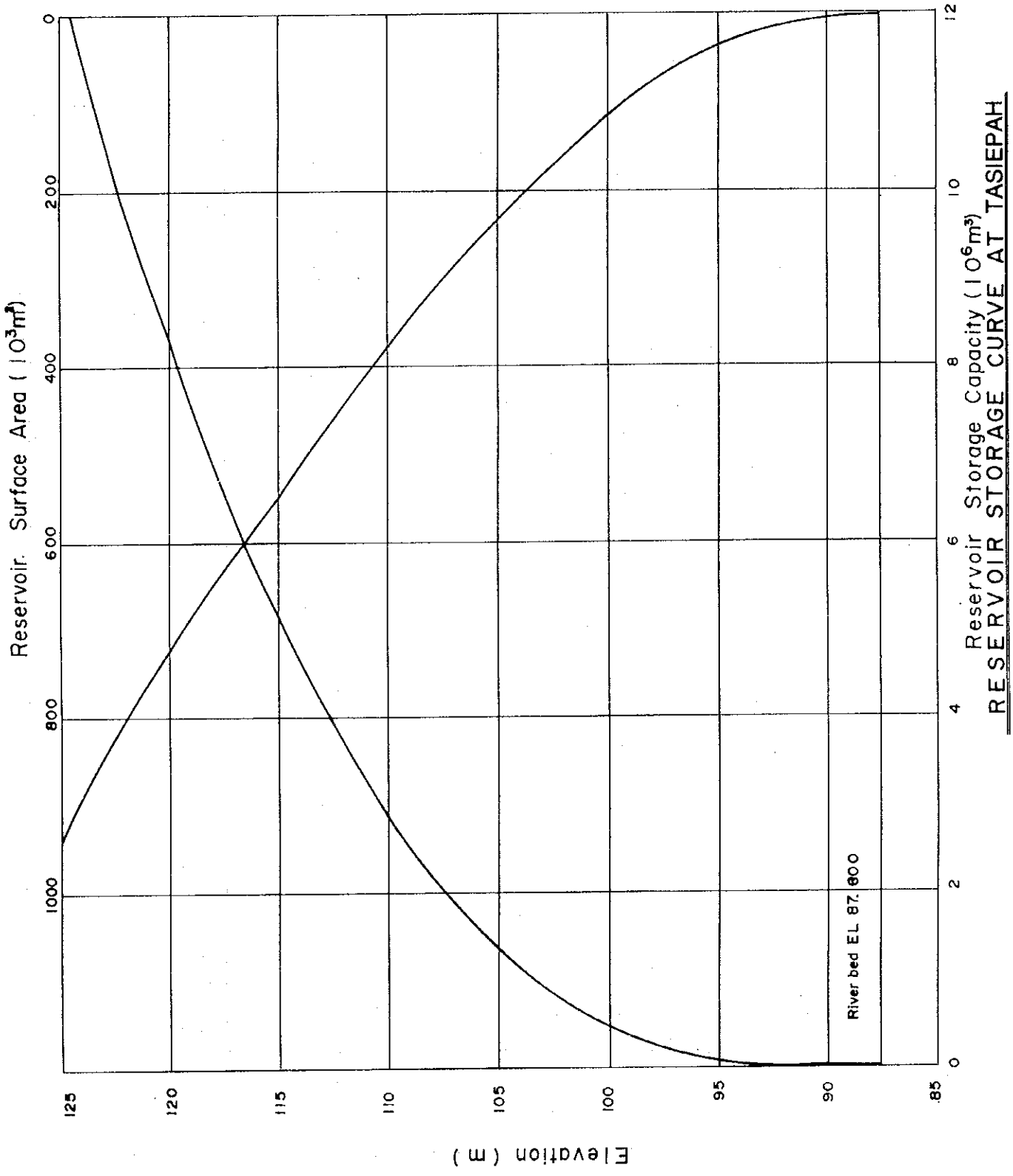


Figure 4.1 Reservoir Storage Curve

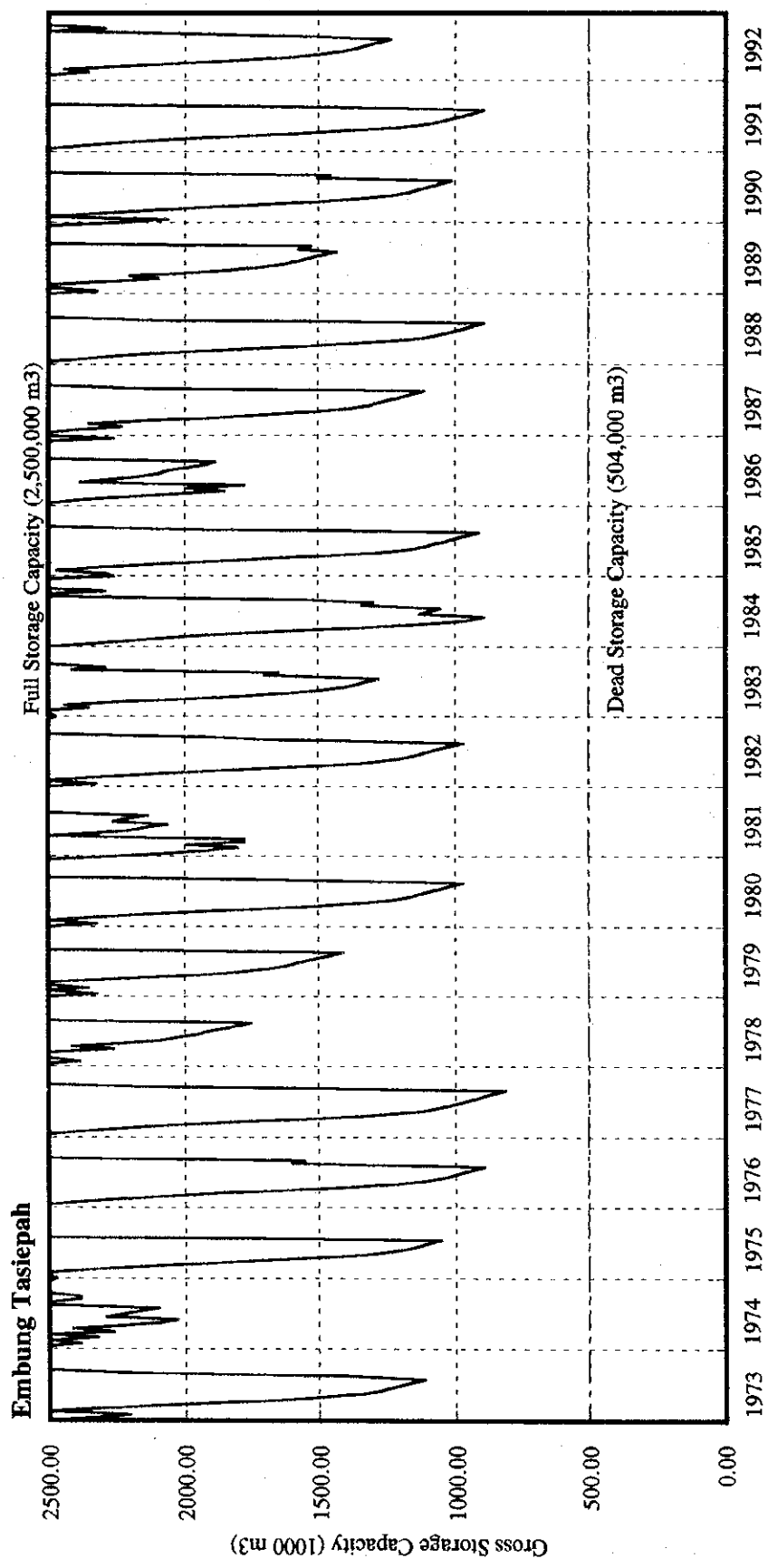


Figure 4.2 Result of Reservoir Operation

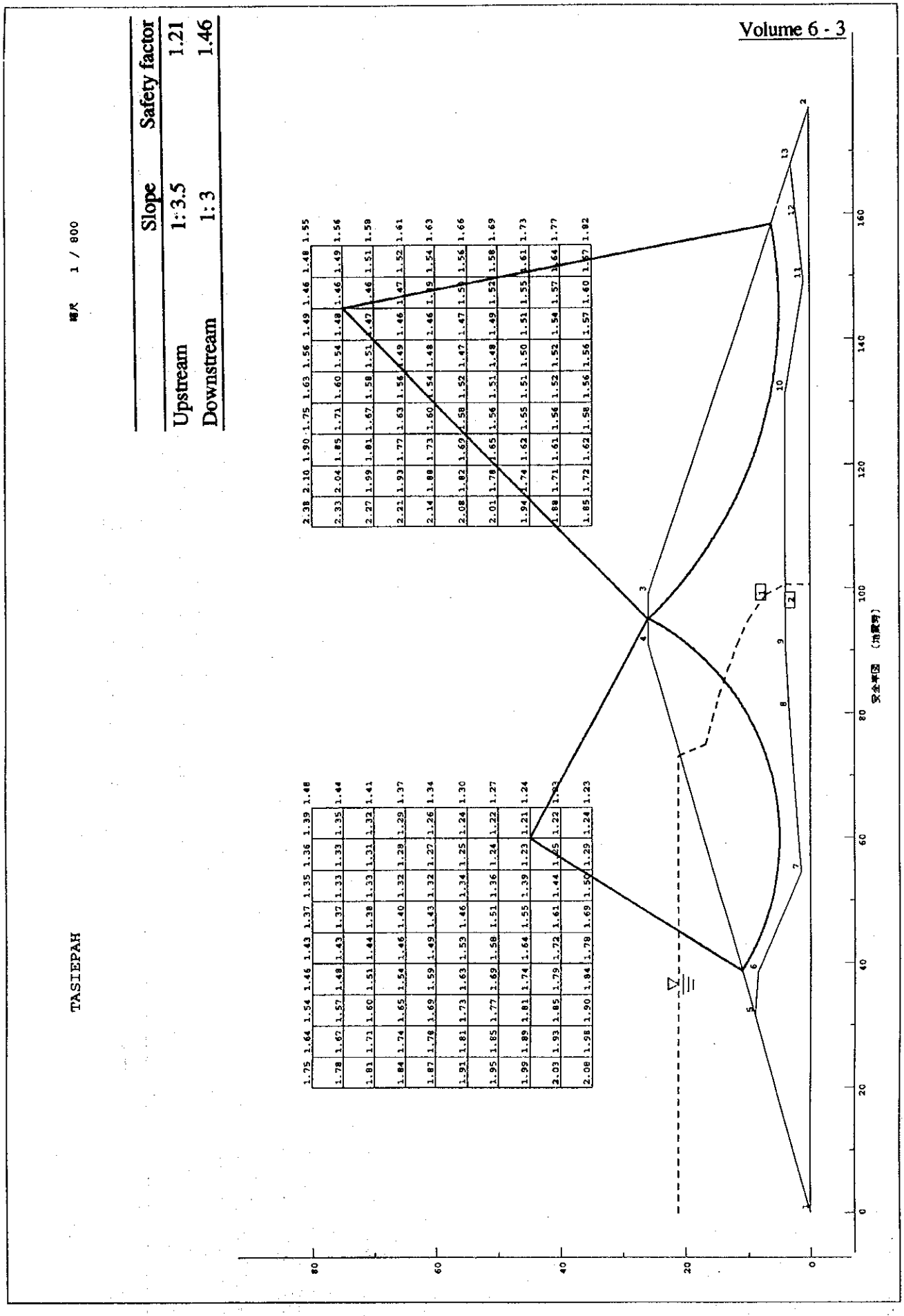


Figure 5.1 Stability Analysis

Tasiepah Scheme

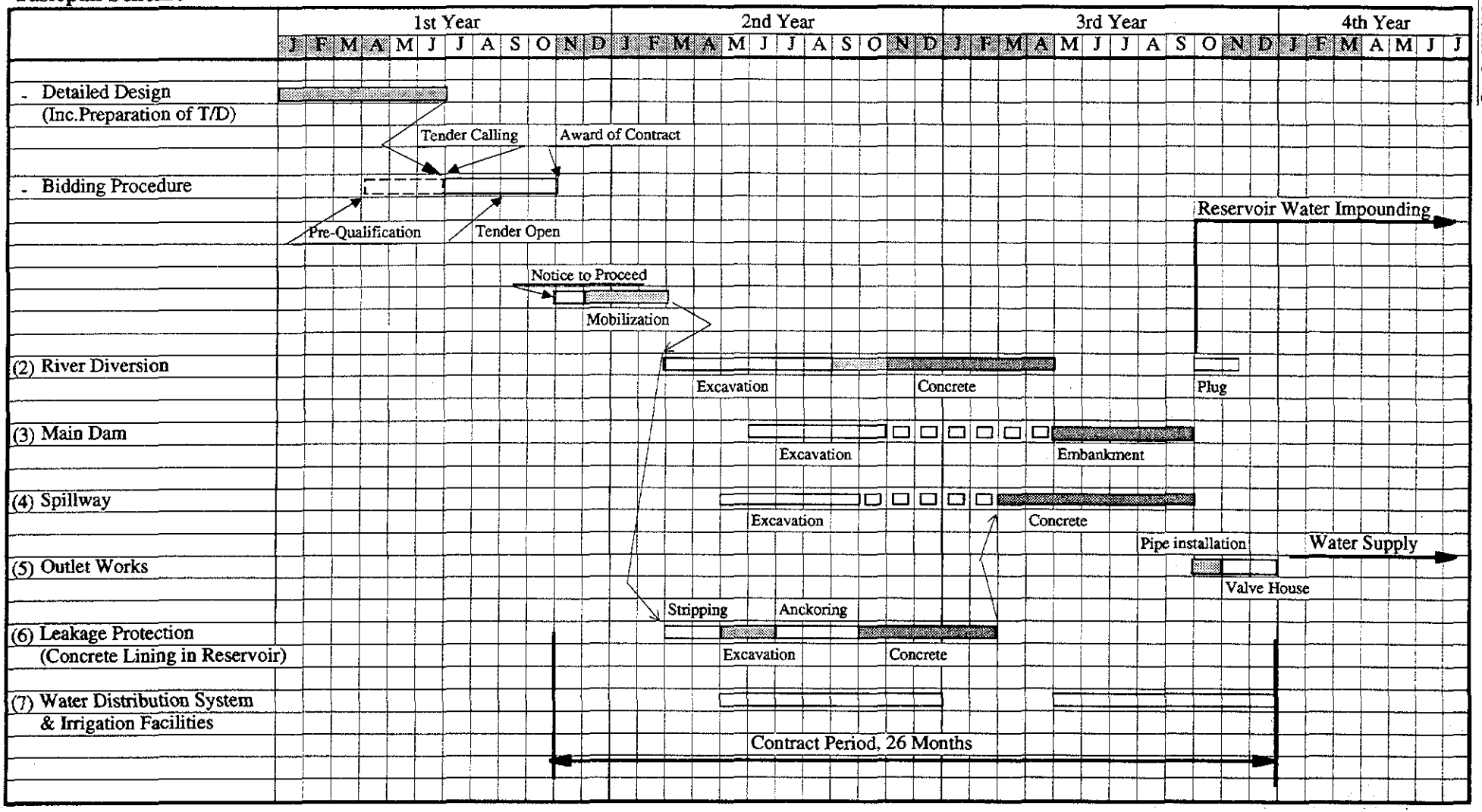
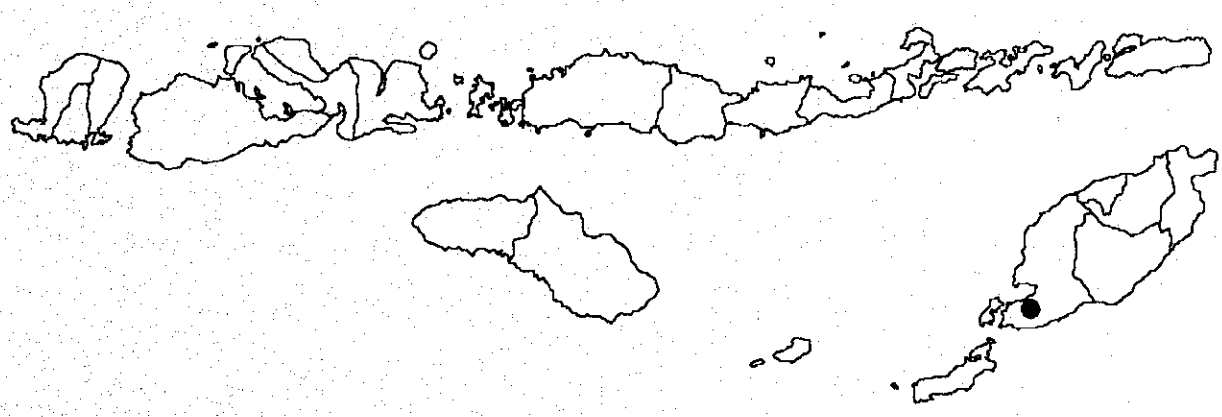


Figure 6.1 Construction Time Schedule

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

Feasibility Study on Tasiepah Embung Development Project

Attachments



Irrigation Water Requirement

Irrigation water demand is estimated at unit irrigation area of one hectare in semi-monthly base in order to consider the optimization of development scale and the water resource allocation plan, and to decide the basic dimensions of the Embung for the Tasiepah scheme. First, proposed cropping pattern for this scheme is made taking into considerations of existing cropped area and cropping pattern of the Embung's beneficially area. Second, water demand calculations per hectare are made based on the established cropping patterns and climatic conditions of this scheme. Water demand is estimated by the following formula :

Irrigation Water Demand = (Etc + IR + RW + P - ER) / IE x A

Where, Etc = crop consumptive use = Eto x kc
Eto = evapotranspiration
kc = crop coefficient
IR = land preparation water (for paddy)
RW = layer replacement water (for paddy)
P = percolation loss (for paddy)
ER = effective rainfall
IE = irrigation efficiency
A = irrigation area

(1) Crop consumptive use (Etc)

The crop consumptive use is calculated as

Etc = kc x Eto

Where, Etc : crop consumptive use (mm/day)
Eto : evapotranspiration (mm/day)
kc : crop coefficient

The crop coefficients for paddy and beans given by FAO and Irrigation Design Standard, KP -01 by PU, DGWRD are used for the calculations as shown below :

Crop coefficient (Kc)

Month	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Paddy	1.10	1.10	1.05	1.05	0.95	0.00		
Upland Paddy	1.10	1.10	1.10	1.10	1.10	1.05	0.95	0.00
Beans	0.50	0.75	1.00	1.00	0.82	0.23		
Red onion	0.50	0.60	0.95	0.75				
Leaf vegetable	0.50	0.70	0.95	0.90				
Maize	0.50	0.59	0.96	1.05	1.02	0.95	0.60	

Source : FAO and KP-01

(2) Evapotranspiration (Eto)

Evapotranspiration can be estimated by some empirical equations using meteorological data. Major calculation methods are introduced by FAO Irrigation and Drainage Paper No.24, " Crop Water Requirement " which is quoted in the Design Criteria KP-01 by PU, DGWRD. Monthly evapotranspirations are computed in this study by using the Modified Penman method introduced in the above.

(3) Land preparation water requirement (IR)

Land preparation water requirements for paddy include a pre-saturation amount to increase moisture in the dry field to a workable condition, and water to compensate for evaporation and percolation loss during the period of land preparation. The land preparation period is assumed to be 30 days. Initial application depth for land preparation of paddy fields is taken at 250 mm, including presaturation of the soil, pudding of soil, and water requirements for nurseries.

For the calculation of the irrigation requirements during land preparation, Van de Goor and Zijlstra's formula as described in Irrigation Design Standard (KP-01) is used.

(4) Percolation (P)

Deep percolation is the water that flows through the soils occupied by the root system of the crop to underlying soils, and is therefore unavailable to the crops. Infiltration is the entry of water into the soils and is purely a surface phenomenon. The loss of water to deep percolation can be controlled by whatever is effective in limiting permeability or infiltration. Deep percolation is continuing use of water in producing paddy rice. Percolation occurs from paddy production areas due to the continuous free water surface maintained for most of the production period. This value will vary depending on the permeability, and in some cases the infiltration rates of the soil used for rice production. Percolation rate to estimate the irrigation demand in this scheme is assumed to be 2 mm/day over the rice producing area referring to the Irrigation Design Standard (KP-01).

Upland crops are not subject to submergence during production where any submergence, even for short term periods, may have a detrimental effect in crop production. Therefore, percolation is a field loss and is treated as a reduction in field application efficiencies.

(5) Water layer replacement (RW)

Twice water layer replacements, each of 50 mm at about 1 month and 2 months after transplanting, are considered according to the Irrigation Design Standards (KP-01). The normally flooded field is drawn down at these times in order to apply fertilizer and to carry out weeding operations. The water layer must then be replaced an allowance of 50 mm in the above periods. This allowance is not required for upland crops.

(6) Effective rainfall (ER)

Rains which fall directly on the irrigated area reduce the amount of supplemental water needed to meet the total water requirements. Only a portion of the total rainfall is effective in meeting crop requirements since some of it runs off the cultivated area and some percolates beyond the crop root zone. Estimation of effective rainfall for paddy rice irrigation is adopted at 70 % of once in 5 years rainfall and as for upland crops irrigation is adopted the USDA-SCS method as recommended in KP-01.

(7) Irrigation diversion requirement

Irrigation diversion requirements are calculated by considering the irrigation efficiency which is divided into following two components. :

a) a conveyance efficiency which account for losses from the main and secondary canal system.

b) a farm efficiency which account for losses from the tertiary canal system and the farm field irrigation application activities.

In this study, the following irrigation efficiencies for paddy and upland crops are adopted taking the information in the Irrigation Design Standard (KP-01), DGWRD into considerations.

Irrigation Efficiency

Canal	Irrigation Efficiency	
	Paddy	Upland crops
Main canal system	90 %	90 %
Secondary canal system	80 %	80 %
Tertiary system / Application efficiency	90 %	70 %
Over all	64.8 %	50.4 %

Source : Irrigation Design Standards, KP-01, DGWRD

Irrigation efficiencies of 65 % for paddy and 50 % for upland crops are applied.

Attachment - 2

Result of Soil Laboratory Test in Tasipah

Bor.No. (Depth)	Formation Classification	Unified Soil Content(%)	Water (g/cm3)	Unit Weight	Specific Gravity
B1(3.0m)	Detritus	CL	14.9	1.85	2.5
B2(7.0m)	Coral limestone	CL	81.1	1.41	2.44
B3(4.0m)	Noele siltstone	-	23.4	2	2.57
B4(3.0m)	Terrace deposit	CL	20.8	1.91	2.64
B6(15.0m)	Noele siltstone	MH	114.2	1.29	2.61
B7(16.0m)	Noele siltstone	SM-SC	92.7	1.45	2.5
B8(14.0m)	Coral limestone	SM-SC	11.4	-	2.56
B9(16.0m)	Coral limestone	SM-SC	19.5	2.17	2.68
B11(3.0m)	Terrace deposit	CL	33.2	1.79	2.69

Result of Rock Test in Tasipah

Sample	Formation	Unit Weight (g/cm3)	Specific Gravity	Unconfined Compression (kg/cm3)
B4(6.0m)	Coral limestone	2.36	2.76	148.18
B6(4.0m)	Noele siltstone	2.42	2.61	190.23

Attachment-3

SUMMARY OF LABORATORY TEST

PROJECT : Embung Tasiepah
LOCATION OF PROJECT : Ds. Oefafi, Kec. Kupang Tengah
DISTRICT : Kupang
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)	%	38.78	30.70	34.06	23.89	30.51	31.59
Unit Weight	(γ w)	g/cm3						
Maximum Dry Density	(γ d max)	g/cm3	1.440	1.420	1.351	1.450	1.470	1.43
Optimum Moisture Content	(Wopt)	%	28.25	31.00	31.00	27.60	26.00	28.77
Specific Gravity	(Gs)	-	2.46	2.67	2.60	2.76	2.60	2.62
Liquid Limit	(LL)	%	76.90	80.65	79.05	48.50	69.25	70.87
Plastic Limit	(PL)	%	30.06	31.79	28.97	25.57	27.57	28.79
Plastic Index	(PI)	%	46.84	48.86	20.08	22.93	41.68	36.08
Shrinkage Limit	-	%	38.96	38.46	20.52	9.56	17.11	24.92
Angle of Internal Friction	(ϕ)	°	9	21	34	13	31	21.60
Cohesion (UU/CU)	(C)	kg/cm2	3.270	1.550	1.095	1.175	1.000	1.62
Permeability	(K)	cm/sec	2.13E-06	2.43E-06	1.54E-06	2.17E-06	4.29E-06	
Passing of # 200 Sieve	-	%	85.74	86.15	84.09	54.97	69.03	
Clasification of Soil			CL	CH	MH	CL	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 : Ocitua
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
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
	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	

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
	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					

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 : Oeltus
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	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

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
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	I	1 2 3 4 5 6	· Vegetations in the catchment area should be protected by means of artificial remedy

3. Human 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
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	

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
	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	

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
	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	

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
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

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 : Tasicpah
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
	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	

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
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	

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
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)

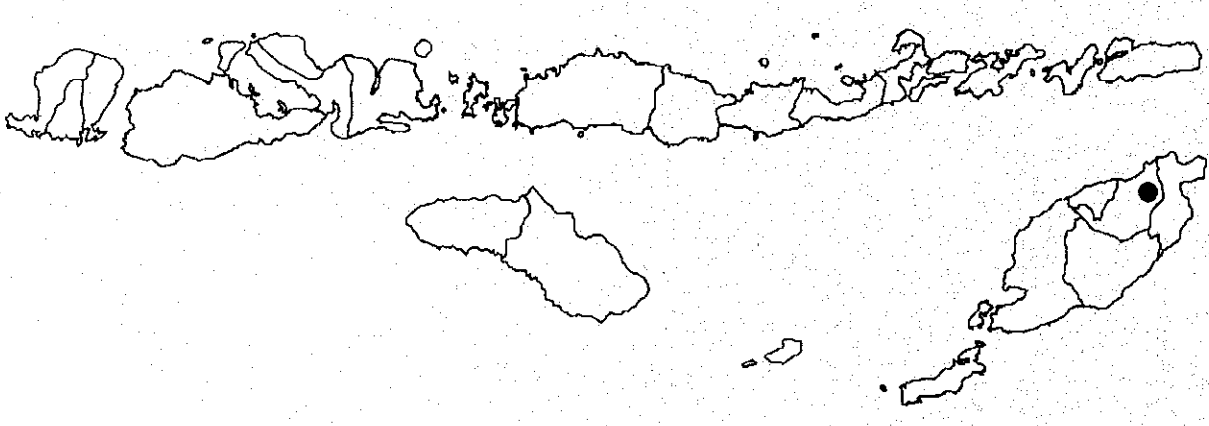
Directorate General of
Water Resources Development,
Ministry of Public Works

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

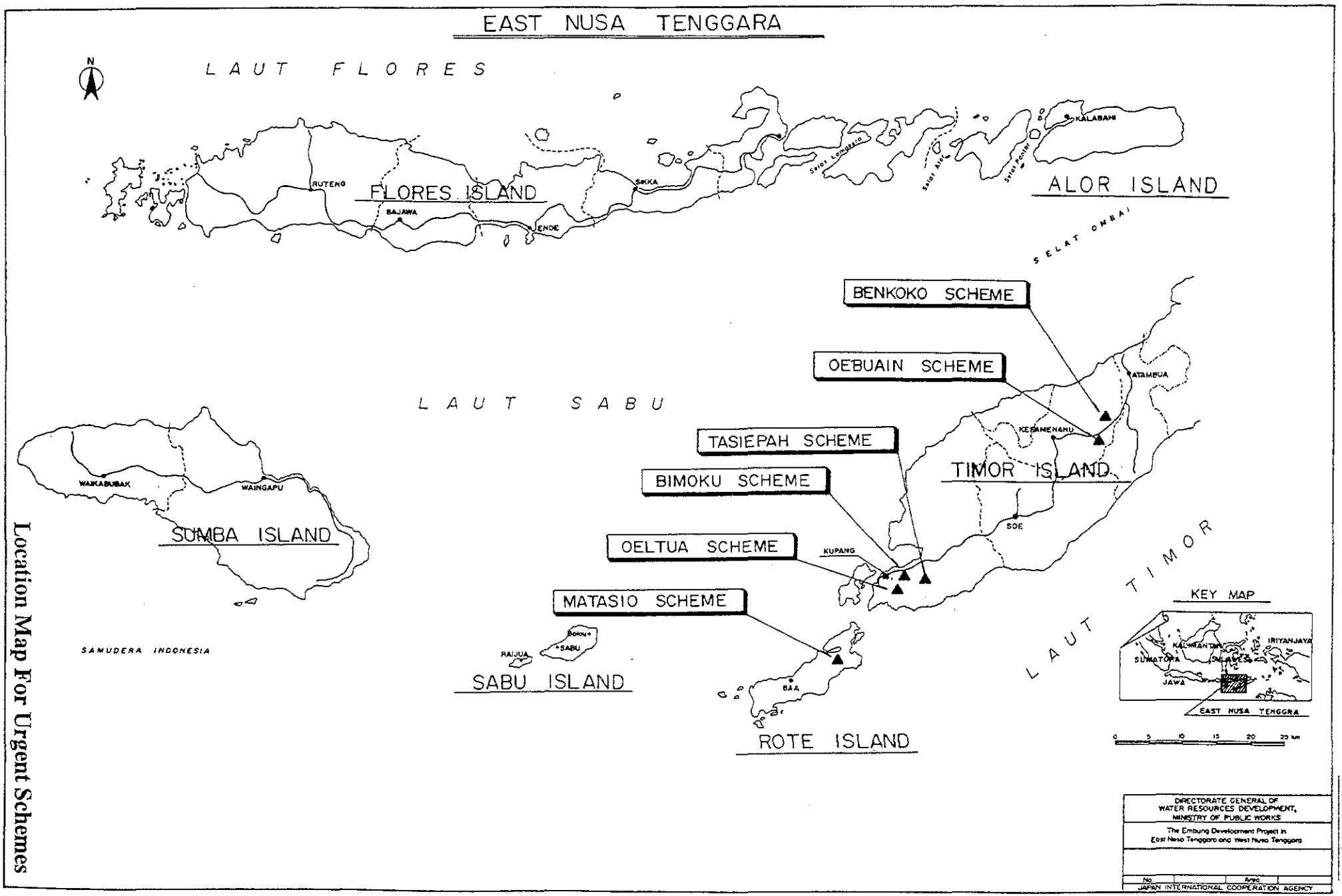
Volume 6-4

Feasibility Study
on
Benkoko Embung Development Project

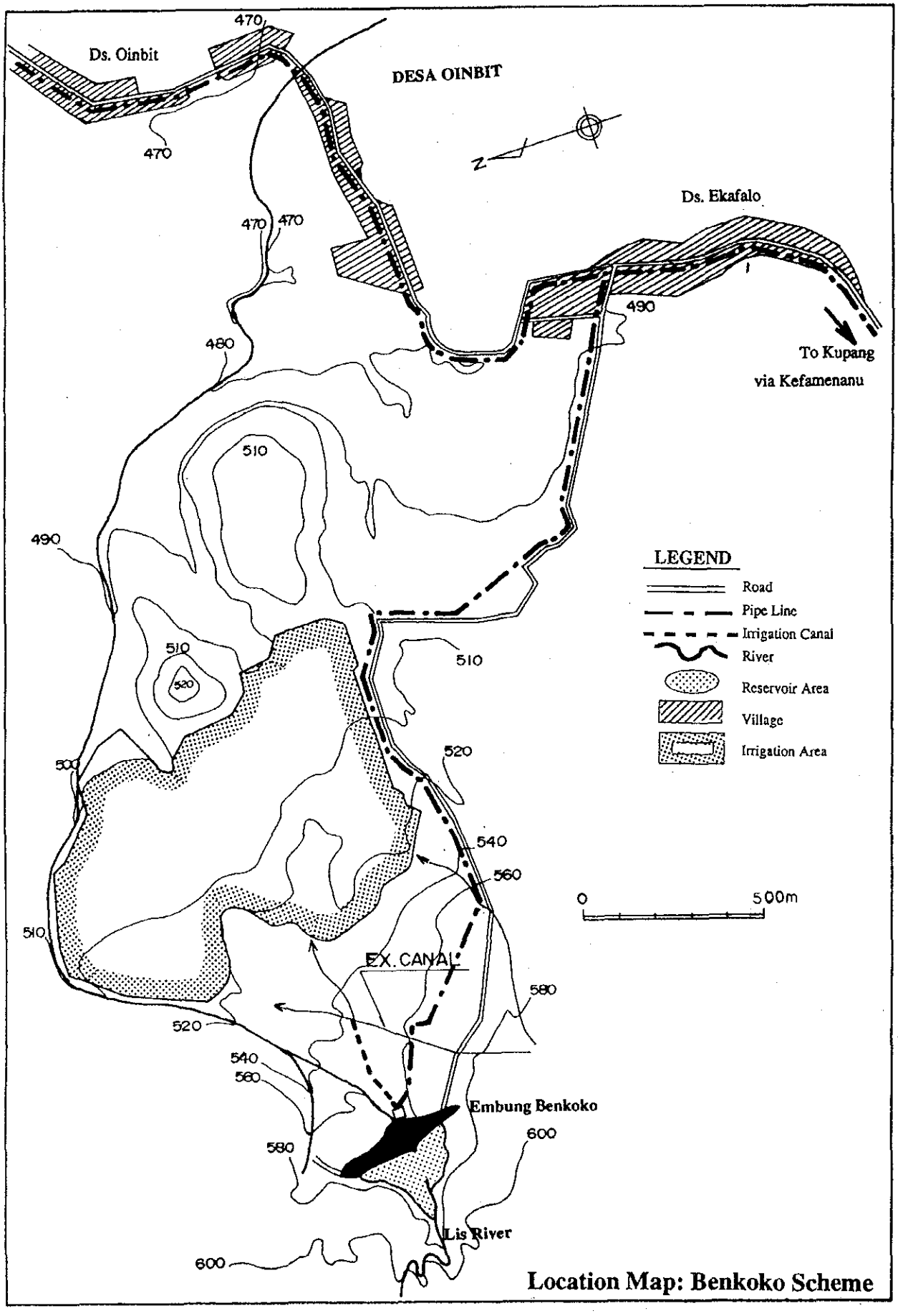


May 1995

Nippon Koei Co., Ltd.



Location Map For Urgent Schemes



Location Map: Benkoko 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 6-4

FEASIBILITY STUDY
ON
BENKOKO EMBUNG DEVELOPMENT PROJECT

Table of Contents

List of Tables

List of Figures

List of Attachments

1. PRESENT SITUATION OF THE PROJECT AREA

1.1 Location and Topography

The Project area is located in around 155 km of northeast of Kupang, the capital of East Nusa Tenggara (NTT) Province, in the middle part of Timor island. The proposed site of Benkoko Embung has coordinates of 124°44'28" east longitude and 9° 22' 45" south latitude.

The Project area extends on the right bank of the Lis river, a tributary of the Maubesi river. It is surrounded by hillockies and mountains. A mountainous hill with gentle slope is distributed along the Lis river and, at the proposed Embung site forms valley short in depth and long in width. The Project area ranges from 465 to 575 m in elevation. The potential area for irrigated agriculture including the existing paddy is gently.

Main residential zone in the Project area is Oinbit Village (Desa) in the Sub-district (Kecamatan) of Insana of the District (Kabupaten) of Timor Tengah Utara. This village within the Project area consists of three sub-villages (Dusun); Oinbit, Ekafalo and Maonmuti in Oinbit 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 1,000 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 58 mm. Mean annual temperature is 25.4°C with the average maximum temperature of 29.8°C and the average minimum temperature of 20.2°C. Mean relative humidity is 87.0%. 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 1.97 km/hr. Tables 1.1 and 1.2 show monthly rainfall record and climate data both at the Kefamenanu station, respectively.

The Lis river, which is the tributary of Maubesi river, as a potential water resource is a perennial stream with a catchment area of 2.30 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 Permian, the Tertiary and the Quaternary. The Permian is formed of limestone called the Maubisse Formation. The Tertiary is composed of Chaotic rock called the Bobonaro Complex. The Quaternary is formed by debris, terrace deposits and river deposits. With regard to geological formation, the Maubisse Formation consists of well bedded limestone being compact hard rock. The Bobonaro Complex mainly comprises massive claystone, which is distributed horizontally to the river bed. Thick debris of 7 to 14 m overlay the Bobonaro Complex. Terrace deposits comprises gravel found in a limited part along the river. Recent river deposits are derived from river sediments 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 silty clay to silty clay loam, 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 678 ha is used for agriculture activities comprising wet paddy field of 237 ha and dry upland of 390 ha, estate crop field of 40 ha, and grass land and unirrigated field of 11 ha. Out of the wet paddy field, 85 ha are provided with irrigation facilities diverting seasonal flow from the Lis river and the rest are idle. 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 1,779 and the number of households was 356 in total. The breakdown of population and household by sub-village is shown in Table 1.3. The average family size is 5.0 persons. Dominant ethnics are originated from the native Timor with a few people from Belu. The majority of inhabitants are Christian and engaged in agriculture. Their average education attainment is primary school grade.

1.6 Domestic Water Use

There exist 26 springs and 16 public wells in the Project area. In the Project area, water for their domestic use is piped from Naijalu' spring to public water tanks established in three sub-villages with the distance of 8 km. As this gravity pipeline has small capacity and low pressure, all inhabitants carry water for daily domestic use from another two springs, Pianini and Batneun, with the average distance of 10 km. Users of these water supply sources are suffering from long distance carriage of water. The present water use in each sub-village clarified under the Study is summarized as follows:

- In Oinbit Sub-village with 100 families and 494 persons, inhabitants have one public well at a distance of 40 m and three springs, Oenunu, Oeusiap and Fa'u at the average distance of 4 km for their own use. Further, they share another two springs, Mamtaom and Niufanamee at the average distance of 6 km, with inhabitants in Maonmuti Sub-village. The total number of livestock is equivalent to 325 heads of cow and water for these livestock use is taken from these public well and five springs in addition to the Naijalu', Pianini and Batneun springs;

- In Ekafalo Sub-village with 186 families and 873 persons, inhabitants have 10 public wells at the average distance of 30 m, Bnoknua, Oebiumana, Oebesa and Abun springs at the average distance of 2.5 km, Oeliso spring at a distance of 7 km and three springs, Naibani, Tfokoke and Maubifu at the average distance of 17 km for their own use. Further, they share another two springs, Neno and Nuku at the average distance of 7 km, with inhabitants in Maonmuti Sub-village. The total number of livestock is equivalent to 540 heads of cow and water for these livestock use is taken from these 10 each of public wells and springs in addition to the Naijalu', Pianini and Batneun springs; and,

- In Maonmuti Sub-village with 70 families and 412 persons, inhabitants have three public wells at the average distance of 40 m, Oetimo and Bimuit at the average distance of 4.5 km, Boenana, Maonmuti, Oepikan, Oekona and Ekamtalan springs at the average distance of 7 km. Further, they share Oepoto spring at a distance of 5 km with other villagers, two springs, Mamtaom and Niufanamee at the average distance of 7 km, with inhabitants in Oinbit Sub-village and two springs, Neno and Nuku at the average distance of 7 km, with inhabitants in Ekafalo Sub-village. The total number of livestock is equivalent to 294 heads of cow and water for these livestock use is taken from these three public wells and 12 springs in addition to the Naijalu', Pianini and Batneun springs.

1.7 Social Infrastructures

The access from the Kupang to the southern part of the Project area is a paved road maintained well as it is the trans-Timor road leading to Dili from Kupang. The proposed

Embung site and sub-villages are connected by unpaved gravel road to this main road. All the sub-villages in the Project area are served by rural electricity supply network. In the Project area, there is no hospital but one community health sub center and two health integrated posts.

More than two-thirds of 356 families have no facilities for bathing, defecating and washing inside their houses. Instead, they are using river bed and water of the Lia for these purposes. Under such circumstances, inhabitants in the Project area are often suffering from various diseases like vomiting and diarrhea, malaria, dysentery and trachoma, roundworm, and so on.

1.8 Agriculture and Livestock

In the Project area, there exists farm land of 678 ha as a whole in which currently cultivable land of 667 ha is included. The present cropped area amounts to 584 ha comprising rainfed wet season paddy of 152 ha, rainfed dry season paddy of 52 ha, maize of 365 ha and cassava of 15 ha. Irrigated rice cultivation is not practiced on the wet paddy field with irrigation facilities during the wet season due to poor drainage condition. Maize is the main crop grown on upland field under the rainfed condition. Other common crops are cassava. Recently, red onion has been introduced as Palawija crop. The present cropping pattern is single cropping of paddy on the wet paddy field, and maize or cassava on dry upland for the wet season as well as paddy on the wet paddy field for the dry season. The overall cropping intensity is thus 87% for the currently cultivable land.

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 1.2 ton/ha for the wet season paddy, 1.5 ton/ha for the dry season paddy, 2.4 ton/ha for maize and 4.6 ton/ha for cassava. Annual crop production is 260 tons for paddy, 876 tons for maize and 69 tons for cassava.

As of 1993, a total of 725 cows/buffaloes, 312 horses, 255 goats/sheep, 542 pigs and 584 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 cows and pigs are marketed to and slaughtered in Kefamenanu and Kupang.

1.9 Irrigation Facilities

In the Project area, there exists the wet paddy field of 237 ha of which irrigated paddy field of 70 ha in net are concentrated on the right bank of the Lis river at 1.0 km downstream from the proposed Embung site. Irrigation water is delivered from a spring through pipeline and well lined open channel running on the surface of mountain slope on the right bank of the Lis river. Due to poor drainage condition of paddy field and insufficient capacity of water supply system, irrigated farming has been intermittently practiced.

1.10 Agro-economy

In terms of agricultural extension services, one rural extension center (BPP) is established in Oinbit Village 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 surplus in their home economy with the average annual income of Rp. 1,302,100 and expenditure of Rp. 1,153,800 as shown in Table 1.5.

2. DEVELOPMENT NEEDS AND CONCEPTS

2.1 Development Needs

In the Project area, it is common for 1,779 inhabitants to carry water from available water sources to their homes at the average distance of 6,500 m throughout a year, even though they receive the minimum volume of water from the existing pipeline water distribution system for their daily use. Such long distant water carriage condition has caused waste of workable time and affected their health. Further, it has prevented farmers' willingness to introduce improved crop production system and to upgrade their primitive 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 through solution of the long distant water carriage problem from perennial water sources. In addition, the inhabitants are eager to get sufficient water nearby their houses for easier maintenance of their livestock which are their sources of nutrition and cash income.

The available land resources suitable for agricultural use amount to 678 ha in the Project area. The wet paddy field occupies 237 ha comprising irrigated paddy field of 85 ha and rainfed paddy field of 152 ha. Of these, a sizable farm land of 105 ha is located in the downstream area of the proposed Embung site comprising wet paddy field of 70 ha and dry upland of 35 ha. Although this wet paddy field is provided with irrigation facilities, the half of it is waterlogged for the wet season because of poor drainage condition. As a result, farmers grow the wet season paddy on well drained field and the dry season paddy on poor drained field both under rainfed condition. From the topographic viewpoints, dry upland of 35 ha is irrigable if irrigation facilities are provided. With improvement of drainage condition and using the existing irrigation water source, double cropping of irrigated paddy can be expected to be practiced on the presently poorly drained paddy field of 35 ha. With provision of additional irrigation water source, two cropping of the wet season paddy and the dry season Palawija can be expected to be practiced on the presently well drained paddy field of 35 ha under irrigated condition, and the dry season Palawija cultivation under irrigated condition can be additionally extended to dry upland of 35 ha. The following shows the proposed cropping pattern to be practiced by using newly developed water source facility.

Proposed Cropping Pattern

Crops	Area (ha)	Nursery	Transplanting/Planting	Harvesting
Wet Season				
- Paddy	35	Dec. 5 - Jan. 5	Jan. 1 - Feb. 1	Apr. 15 - May. 15
- Corn/Beans (Rainfed)	35		Dec. 16 - Jan. 16	Mar. 15 - Apr. 15
Dry Season				
- Red onion	70		Jun. 1 - Jul. 1	Jul. 30 - Aug. 30

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 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 2,101 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 46,012 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 936 cows/water buffaloes, 361 horses, 371 sheep/goats, 868 pigs and 1,104 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 21,756 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 irrigation paddy field of 1 ha amounts to 10,930 m^3 for irrigated paddy field of 1 ha and 14,020 m^3 for irrigated field, respectively.

2.3 Development Constraints

In and around the Project area, there are many perennial springs and groundwater resources, but these springs are located in very far places and public wells within the village have not enough source capacity to meet BHN. Such situation has forced inhabitants to carry their domestic water from and their livestock to springs at the average distance of 6.5 km throughout a year. The only one potential water resource in the Project area is thus the Lis river with the possibility of developing Embung as water reservoir.

In developing water resource potential of the Lis 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 Lis river nearby Oinbit Village. In the course of the Study, therefore, it is firstly to examine water resources development potential at this site called Benkoko 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 Benkoko 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 Benkoko 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 Lis river flows through rather deep and wide valley between mountain and hillock. The width of valley is around 400 m and the elevation of riverbed is El. 560.0 m . The left bank shapes steep slope of about 11° up to around El. 568.0 m and then becomes very gentle slope of about 4° up to about El. 585.0 m. The right bank is of rather steep slope of about 8° up to around El. 568.0 m and then becomes gentle slope of about 5° up to about El. 585.0 m. Elevation of mountain and hillock surrounding the proposed reservoir ranges about 580.0 to 700.0 m above sea level.

3.2 Geological Condition

Under the Study, geological investigation 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 Benkoko Embung, respectively.

The proposed site of Benkoko Embung is underlain by the Tertiary composed of debris and the Quaternary consisting mainly of claystone of Bobonaro Complex. The foundation rock of the proposed site is formed of debris found in the riverbed and claystone found in the both abutments. Some of top soil and small amount of the alluvial deposits are confirmed on the riverbed portion.

The result of field permeability test reveals that the coefficient of permeability is 5×10^{-5} cm/sec for the debris and 4×10^{-7} cm/sec for the claystone and rather constant in the vertical directions. 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 at least 10 for the debris and more than 14 for the claystone. The result of unconfined compression test on recovered core samples of drilling works shows that the unconfined compression strength varies from 186 to 195 kg/cm^2 and the geological formation of the debris and 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 debris and the terrace deposits. No major fault and landslide are recognized in the field. It is prospected that water leakage through the thick debris occurs in the reservoir area because of its high permeability. 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 Benkoko 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	94	49	CL
TP. 2	82	39	CH
TP. 3	87	65	CL
TP. 4	87	68	CH
TP. 5	87	65	CL

As physical property to oppose piping, mean value of Plastic Index (PI) is 28, 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 1.54 to 1.82 ton/m^3 and 1.69 ton/m^3 on an average, which are slightly low in comparison with 1.73 as an average of CL;
- Optimum moisture content (OMC) ranges from 15.3 to 23.0% and 18.7% on an average;
- The discrepancy between OMC and the natural moisture content (NMC) is approximately 23%, 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 for 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 28° and 1.56 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 30° for friction angle and 0.13 kg/cm^2 for cohesion by using the standard values of soil classified as "CL" of ASTM Unified Soil Classification.

(2) Sand and gravel materials

Sand and gravel materials to be used for the filter of the dam embankment and concrete aggregates is investigated in the Noelmina and Maubesi rivers. Quantity and quality of the gravel materials from the both rivers are sufficient for the filter drain and the concrete aggregates.

3.4 Availability of Water Resources

(1) Catchment yield

As for the Lis 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. The Kefamenanu rainfall station which is located in the east of the Benkoko Embung catchment has rainfall record of nearly consecutive 18 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 Kefamenanu station, river flow of the Lis 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 2.30 km^2;
- Less than 20 mm of half monthly rainfall is ignored for estimation; and,
- The base flow of 10 lit/sec from spring located at the upstream of proposed Embung site is estimated.

This estimation is made based on the rainfall record from 1976 to 1993. 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
167	164	126	72	66	37	37	27	33	39	70	140	978

(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, 15 years rainfall data of the Kefamenanu station from 1976 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	53
1 in 5 year	73
1 in 10 year	87
1 in 20 year	102
1 in 50 year	124
1 in 100 year	141
1 in 200 year	160

2) Design flood

The following 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	19
1 in 5 year	26
1 in 10 year	31
1 in 20 year	36
1 in 50 year	43
1 in 100 year	49
1 in 200 year	56

(3) Sediment load

There is no available data on sediment load on the Lis 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 5, 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 Benkoko Embung, the following three cases are compared:

- Case-1 : To develop Embung with the minimum height of 12.5 m to store water necessary for meeting domestic and livestock water demand. In this case, irrigation water can be also supplied to paddy field of 10 ha during only the wet season;

- Case-2 : To develop Embung with the height of 16.5 m to store water necessary for meeting domestic and livestock water demand as well as for irrigating presently well drained paddy field of 35 ha to grow the wet season paddy and the dry season Palawija crop; and

- Case-3 : To develop Embung with the height of 19.5 m to store water necessary for meeting domestic and livestock water demand as well as for irrigating the presently available and sizable farm land resources to the maximum extent.

(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 Lis river, discharge is generated from rainfall of the Kefamenanu 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.	935	20,477
Livestock (equivalent to cow)	Nos.	657	9,598

The 100% dependability of the above demand shall be secured by the proposed Benkoko 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	35	383
Maximum area in the dry season	70	22

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. 568.0 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. 580.0 m.

(3) Optimum development scale

From the topographic and hydrological points of view, there is no limitation to develop the proposed Embung in each case. For the purpose of improving inhabitants' living condition and also strengthening their production basis, the Case-3 is selected for the Study as the optimum development scale of Benkoko Embung with the height of 19.5 m and effective

storage capacity of 0.17 million cubic meters (MCM). The result of reservoir operation of the Case - 3 is shown in Figure 4.2.

4.2 Delineation of Beneficiary Area

By developing the proposed Benkoko Embung at the optimum scale, the beneficiary area of domestic and livestock water supply from Benkoko Embung covers the whole area of Oinbit Sub-village and a part of Ekafalo Sub-village with 935 inhabitants and 657 heads of cows in total. The beneficiary irrigation area comprises 35 ha for wet paddy field planting the wet season paddy and the dry season red onion and another 35 ha for dry upland growing the wet season rainfed beans and the dry season irrigated red onion. The beneficiary area in Benkoko scheme is shown in Dwg. - 401

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 Benkoko 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. As for the proposed countermeasures for water leakage in the reservoir, it is proposed to adopt earth blanket to cover the reservoir area up to El. 576.0 m so as to keep the water tightness of the debris layer in the reservoir.

The main components of Benkoko Embung are the main dam, spillway, river diversion conduit and water supply facility as shown Dwg. - 402. In order to provide the reservoir with the total storage capacity of 0.204 MCM, F.S.L is set at El. 576.0 m. Taking overflow depth of spillway and freeboard into account, the dam hight of Benkoko Embung becomes 19.5 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 50 m^3/sec from the catchment area of 2.3 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 200 mm below the dam body and valve house at the downstream of the main dam.

The principal features of Benkoko Embung are summarized below.

(1)	Reservoir	
	- Catchment area	2.3 km^2
	- F.S.L.	El. 576.0 m
	- Minimum operating level	El. 568.0 m
	- Effective storage capacity	170,000 m^3
	- Dead storage capacity	34,000 m^3
	- Gross storage capacity	204,000 m^3
	- Sediment deposition level	El. 567.4 m
(2)	Main dam	
	- Type	Homogeneous earthfill
	- Height	19.5 m above river bed
	- Crest elevation	El. 579.5 m
	- Crest length	413 m
	- Crest width	7.0 m
	- Upstream slope	1:3.5
	- Downstream slope	1:3.0
	- Total embankment volume	221,000 m^3
(3)	Spillway	
	- Design flood (1/100 year)	50 m^3/sec

- Type	Non gated overflow
- Crest elevation of overflow weir	El. 576.0 m
- Width of overflow weir	12.4 m
- Discharge capacity	50 m^3/sec
- Length	132 m

(4) River diversion

- Design flood (1/5 year)	15.7 m^3/sec
- Type	Pipe culvert
- Diameter	1200 mm x 2 nos.
- Length	130 m

(5) Water supply system

- Inlet structure	1.0 x 1.0 m with trashracks
- Pipe diameter	200 mm

(6) Blanket in the reservoir

- Type	Earth blanket
- Covering area	Up to El. 576.0 m and 39,000 m^2
- Thickness	2.0 m

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 Benkoko 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 576.0 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. - 402.

(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 a diameter of 1.2 m x 2 Nos. as a diversion facility as shown in Dwg. - 404. Since the volume of flood inflows from 2.3-km^2 catchment will be quite small as compared to the storage created by constructing low cofferdams, a 2.5 m high cofferdam with a crest level of El. 562.5 m would suffice to contain the dry season flood inflow of 15.7 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 20 m^3/sec.

Based on the result of comparative study on combination of overflow depth and width of the spillway, overflow depth at 1.5 m and width of 12.4 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. 576.0 m to coincide with F.S.L. Spillway bridge is not provided across the crest portion of the Spillway because of no access road from the right to the left abutment of the main dam.

The profile and sections of spillway are shown in Dwg. - 403.

(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 50.95 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 567.4 m. Fixed trashracks are provided on the intake structure. Cast iron pipe with diameter of 200 mm is connected from the intake structure to the downstream through the main dam. The detail of water supply inlet is given in Dwg. - 404

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. - 405.

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 village located at along the paved road at around 3 km downstream of the proposed Embung site. The total beneficiary inhabitants to be supplied with domestic water is estimated at 935 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 Benkoko Embung

Livestock	Numbers (heads)	Water demand (lit/head/day)
Cattle/Buffalo	574	40
Sheep/Goat	235	5
Pig	289	6
Poultry	711	0.6

Design discharge of pipelines is estimated at 0.95 lit/sec adding the design discharge of domestic water supply estimated at 0.65 lit/sec taking the above population and the domestic water demand of 60 lit/sec/day and livestock water supply estimated at 0.30 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 the Dwg. - 401. 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. - 407. Required water distribution boxes for domestic and livestock water supply are summarized below :

Water Distribution Facilities Requirement

Facilities	Quantities
Pipe Line	
- Dia. 50 mm	5.8 km
Related Facilities	
- Check valve	5 Nos.
- Air valve	3 Nos.
- Blow off	2 Nos.
- Division box for domestic water	10 Nos.
- Division box for livestock	26 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 70 ha in net at around 1.0 km downstream from the proposed Embung site expanding on the right side of the Lis river. Half area of this field has been irrigated by using spring water. The remaining half is not irrigated due to insufficient spring water volume to irrigate the whole area of 70 ha. There are well lined irrigation canals to deliver the irrigation water from the spring, which is situated at mountain side, to the cropped field existing over the hill.

In due consideration of the above situation and water resources allocation plan, the future irrigation area is to be 35 ha in net for the wet season paddy and 70 ha for the dry season red onions as Palawija crop.

(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. From the irrigation inlet box, irrigation water is lead to the existing irrigation canal through open channel with a distance of around 330 m. Irrigation water is delivered to wet paddy field through the existing irrigation canals.

General layout for this scheme is shown in Dwg. - 401 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 50 lit/sec for the net irrigation area of 35 ha. This design discharge is enough to flow design discharge for the dry season Palawija crop of 70 ha in net at peak time.

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 level is El. 557.00 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 existing paddy field from the Embung is constructed using concrete flumes taking into account 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, cross drain and irrigation division box. In addition, two division boxes are required at the end points of the existing canals to distribute the irrigation water to the paddy field since the canals are severely eroded at these points. Required irrigation facilities are summarized below and preliminary design of each facility is shown in Dwg. - 408.

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. 330 m
- Cross drain	1 Nos.
- Irrigation division box	3 Nos.