WORLD HEALTH ORGANIZATION

ORGANISATION MONDIALE DE LA SANTÉ

SOUTH-EAST ASIA REGION

SEA/EH/269
27 September 1982
RESTRICTED

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NUSA TENGGARA TIMUR RURAL WATER SUPPLY PROJECT, INDONESIA

DEVELOPMENT OF DESIGNS AND CONSTRUCTION OF DOMESTIC RAIN-WATER COLLECTION AND STORAGE SYSTEMS FOR DRINKING WATER USE

Prepared by THE WORLD HEALTH ORGANIZATION
Acting As Executing Agency

for

THE UNITED NATIONS DEVELOPMENT PROGRAMME

NTT Rural Water Supply Project, Department of Health,
Nusa Tenggara Timur Province

KUPANG - December 1981

SEA/EH/269

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1. INTRODUCTION

The Province of Nusa Tenggara Timur is located between 8°.31'N and 11°.1'S latitude and 118°E - 125°E longitude (Fig.1) and extends across Timor, Flores and Sumba groups of islands. The area is divided into 12 regencies and subregencies as illustrated in Figure 2. The population of NTT Province as per 1980 census is 2 737 000 (Timor 1 008 000, Flores 137 400 and Sumba 355 000). Many homes in the island and coastal areas are dependent on rainwater for domestic purposes. This is because either ground water is saline, or it is not available or the ground is rocky and therefore difficult to dig wells, and springs/rivers are far from the village. The population of such areas is usually poor scattered in a range of population varying from 100 to 500. Owing to the very high cost of construction, operation and maintenance of pumping or gravity water supply systems from a far-off spring source or other sources, the rainwater collection systems for individual houses or communes are often planned to meet the drinking water requirement for such areas. This report, therefore, attempts to develop an approach for the design of optimal rainwater collection and storage systems.

2. COMPONENTS OF THE RAINWATER COLLECTION TANK SYSTEM

The system components are: roof surface (of tiles or galvanized mild steel sheets), rainwater gutters (of galvanized mild steel sheets), rainwater drain pipes (of fabricated mild steel sheets or AC or PVC non-pressure pipes or large-diameter bamboo pipes), small straining filter, storage tank with overflow, wash-out and outlet pipe with a tap for withdrawal of controlled/restricted daily water requirement as and when required.

Rain, after falling on the roof surface, partly evaporates especially during dry periods at low intensity showers; some may overflow from the rainwater gutters while the remaining flows down to the storage tank. Not all the water flowing into the storage tank is, however, available for drinking purposes because part of it overflows and some leaks out or evaporates from the tank. The remaining quantity is available for meeting the drinking water needs.

3. PRESENT DESIGN GUIDELINES OF THE DEPARTMENT OF HEALTH

The following guidelines issued by the Ministry of Health to all the provincial departments of health for the construction of rainwater collection tank systems are being implemented:

(1) Per capita daily water requirement: 5-10 litres

(2) Dry spell period - 3 months

(3) Number of persons per tank 100 (20 families)

(4) Capacity of masonry tank 45 m^3 or alternatively ferro-cement tanks 10 or 20 m^3 capacity.

(5) Roof area to suit local rainfall; to collect sufficient rainwater for filling the tank, roof and gutter system of three houses is to be utilized to fill a tank of 45 m^3.

(6) Designs

The following designs are being adopted:

(a) NOMINAL CAPACITY 45 M^3
Masonry tank 5m x 5m

1.75 deep (43.75 m3)

(b) NOMINAL CAPACITY 9 M^3 or 10 M^3
Ferro-cement tank 3m in diameter 1.3m deep (9.10 m^3) or

1.42m deep (10 m^3)

(7) Designs are for guidance and could be modified to suit the local conditions and availability of local materials.

(8) The work is not to be contracted but undertaken with people's participation under the supervision of Health Department staff.

4. PARAMETERS INFLUENCING STORAGE CAPACITY

Before commenting on the existing designs and the guidelines, it is necessary to examine various parameters which affect the storage capacity under the local conditions of NTT. The following parameters have, therefore, been considered while evaluating the design:

(1) Rainfall and its distribution

(2) Per capita daily water requirement

(3) Dry spell period in a year

(4) Number of persons per family

(5) Nature of roof surface and effective roof area

(6) Run-off and evaporation-cum-leakage losses

(7) Safety from short spell of no rain in a month preceding or succeeding the dry, no-rain period in a year.

This report attempts to delineate the possible combinations of roof area and tank size required to meet a specified per capita daily water demand for a selected probability of failure in a no-rain period.

4.1 Rainfall and Its Distribution

The mean annual rainfall isohetals for NTT Province is given in Figs. 3.1, 3.2 and 3.3. A study of the rainfall data reveals that the annual rainfall varies from a maximum of 4 321 mm at spatial and Manggarai regency to a minimum of 481 mm at Sumba Timur with inter-annual variations.

There is a large variation in the monthly rainfall pattern. Three to four months in the year are generally dry. The available rainfall data for ten stations varying from 25 years to 9 years of records are given in Tables 1.1 to 1.4. A summary of mean annual rainfall and standard deviations of the data available is shown in Table 1.15.5.

The maximum daily rainfall for Sumba Timur and Kupang is 174 and 197 mm respectively.

4.2 Per Capita Daily Water Requirement

Storage capacity is related to per capita water supply and the variations in precipitation. The higher the per capita supply, the longer is the storage needed, and consequently higher is the rain-water storage cost. Therefore, storage for only the drinking water requirement has to be provided while designing a rain-water storage system.

The following per capita water requirements have been adopted for the design.

West Java	5 lpcd	By rural water supply project West Java OTA 33/5-7.
Central & East Java	5-6 lpcd	Programme for rain-water collection tank in Madura East Java by DIAN DESA.
Thailand	4 lpcd	"The potentials of Ferrocement and related materials for USAID by Dr Ricardo Pama and C. Phramratapongsi"
Sikka Regency, Flores-NTT	4.0 lpcd	Actual field survey by this project in October 1980.

The aim should be to provide as high a rate of supply as feasible at a reasonable cost. To determine the quantity of water being actually collected and transported by families during summer for meeting their drinking water requirement, a survey was conducted by the project staff in Sikka regency in October 1980. It was found that a family transports about 2 bamboos full of water daily for meeting their drinking water needs. The actual quantity per bamboo was 12 litres. The average number of persons per family were 5.5 to 6. The actual per capita water requirement transported, therefore, works out at 4 litres per day. The report prepared for USAID by Mr Ricardo Pama and Mr Phromratanapongsi also suggests a design based on a per capita daily supply of 4 litres for rain-water collection system in Indonesia.

The project, therefore, analyses the system storage capacities required for a per capita supply of 4 and 5 lpcd.

4.3 Dry Spell Period in a Year

From the rainfall data referred to earlier, it is clear that the dry period in a year varies from 3-8 months.

4.4 Number of Persons Per Family

The regency and subregency-wise number of persons per family as per the 1980 census are given in Tables 4.1 to 4.12. The average number of persons per family in various regencies is as follows:

Regency	Nos. of persons per household
Kupang	4.81
Timor Tengah Selatan	4.67
Timor Tengah Utara	5.12
Belu	5.29
Sumba Timur	5.30
Sumba Barat	6.20
Manggarai	6.13
Ngada	6.78
Ende	6.06
Sikka	6.06
Flores Timur	5.87
Alor	5.07

4.5 Nature of Roof and Roof Area

4.5.1 Nature of roof surface

Rural housing in NTT is classified into permanent, semi-permanent and temporary. Semi-permanent and temporary houses - a large percentage in a desa - have thatched roofs. Such houses are unsuitable for rain-water collection because fine organic particles flow along with the rain-water, imparting colour, smell, taste and pollution to water, rendering it unfit for storage and subsequent human consumption. Only those houses which have galvanized mild steel sheet roofing or tile roofing are, therefore, considered for the development of rain-water collection systems.

4.5.2 Gross roof area

The housing improvement and resettlement programme of the Government of Indonesia for NTT envisages the following four types of houses:

Type	Plinth Area m x m	Roof Size m x m	Roof Area m^2
Type I	6 x 6	8 x 8	64
Type II	6 x 7	8 x 9	72
Type III	6 x 8	8 x 10	80
Type IV	7 x 8	9 x 10	90

Owing to limited resources, most of the houses planned for resettlement are, however, of Type I or Type II; these have galvanized corrugated metal roof.

The height of the lower edge of the roof varies from 240 to 250 cm above ground level.

The roof areas of the houses of doctors and employees of puskesmas are as tabulated below:

	Plinth Area m2	Roof Area m2
For Puskesmas Doctor		
Type I	70	103
Type II	70	103
For Sanitarian/midwife	50	84

4.5.3 Effective area

The effective area of the roof draining rain-water to the rain-water gutters and then to the tank will depend upon the type of house, the location of the tank, capacity of the gutters and the arrangement of rain-water pipes conveying roof water from the gutters to the tank. Any corner bend on the rain-water gutter reduces its capacity by 25%. The length of the gutters, as effective roof area per capita draining in to the filter, assuming the number of persons per house as 6,is tabulated below:

Standard House Type, Plinth Area m x m	Storage Tank Located at Side Corner. Effective Room Area-m^2		Gutter Length/m		Storage Tank Located at the Back. Effective Roof Area-2		Gutter Length/m	
	Total	Per Cap.	Total	Per Cap.	Total	Per Cap.	Total	Per Cap.
Type I, 6 x 6	32	5	16	2.66	48	8	24	4
Type II, 6 x 7	36	6	17	2.9	54	9	25	4.16

Very few families are, however, fortunate to have a house even of 6 m x 6 m size as being adopted for the resettlement areas. Because of the joint family system many houses have more than one family in one house. A roof area of more than 3-4 m^2 per capita contributing flow to the tank, is, therefore, hardly likely to be available.

In West Java a roof area of 2.0 square metres per capita was adopted for design evaluation. For the analysis of storage capacity, however, calculations have been worked out with roof area as 2 m^2, 3 m^2, 4 m^2, and 5 m^2 per capita for calculating the rainwater flow to the tank to determine the effect of area on the tank capacity.

4.6 Run-Off and Evaporation Losses

Run-off and evaporation losses with galvanized metal sheet roofing may be quite small in the rainy season but may be appreciably higher during very low rainfall when atmospheric temperature is high. (Ref. Table 2.1 and 3.1 for temperature and evaporation losses). A run-off-cum-evaporation loss from the roof surface as 15% is adopted for storage design calculations.

Since the storage tank is covered and water-proof, not much water is likely to evaporate. A 5% leakage-cum-evaporation loss from the tank surface is, however, adopted for design evaluation.

4.7 Safety Against a Short Spell of no Rainfall Preceding and Succeeding a Long, Dry Spell

The analysis of storage capacity required for a selected roof area and supply per capita in a year is based on the monthly rainfall. However, storage may fall short owing to daily variations in the precipitations. This is clear from a detailed analysis based on daily rainfall for Sumba Timur regency, wherein it is computed that the storage required is about 7% more than that computed on the monthly dry spell data. To cover such an eventuality, 7% extra storage has been provided on the storage computed on monthly rainfall data. A provision of 10 cm in the height of the tank is provided as dead storage.

5. STORAGE TANK CAPACITY

5.1 Maximum Average Per Capita Supply Possible

It has been analysed how much per capita gross storage (including evaporation and leakage from the tank) is feasible if every drop of rain-water (after evaporation losses,etc. from the roof) is retained in the tank. The possible per capita supply figures are given in Tables 6.1 to 6.10 for various regencies. It is clear that to provide 4 to 5 lpcd even in a drought year, a minimum roof area of 3-4 m^2 (more than 2 m^2) is necessary.

5.2 Storage Capacity

As the rainfall is concentrated over 4-8 months a year, if attempts to retain every drop of rainwater are made, balancing storage capacity becomes considerably higher compared to the case when storage is provided to meet the maximum no-rainfall, dry period requirement at a restricted supply of 4 or 5 lpcd. This is because the total rainfall is much more than required to provide a continuous supply of 4 or 5 lpcd.

This difference will be more noticeable in Kupang than Sumba Timur because the average rainfall for Kupang is higher than that in Sumba Timur, whereas the dry spell period remains almost the same.

5.2.1 Storage for longest dry spell needs

The maximum dry period of no rainfall in NTT is 7 to 8 months in the area with a total annual rainfall of 1500 mm or less. The most critical storage to meet the dry period needs (no-rainfall months), works out as follows:

Most critical storage required for the dry period of 8 months:

(1) At 4 lpcd required 4 x 30 x 8 = 960 litres per capita

(2) At 5 lpcd required 5 x 30 x 8 = 1 200 litres per capita

Thus about 25% more storage is required if one adopts a dry period daily per capita supply as 5 lpcd.

The storage calculations have, however, been worked out on a year-to-year basis to meet the requirement at 4 or 5 lpcd for a roof area of 2,3,4 and 5 m^2 per capita for all the stations using available data. The storage capacities required have been tabulated in Tables 7.1 to 7.10 and the storage required for different dependabilities is given in Tables 8.1, 8.2 and 8.3. It is clear from the calculations that about 170 to 847 litres storage capacity per capita is required with a roof area of 4 m^2 to meet water requirements at 4 lpcd with 90% dependability.

5.3 Storage Analysis

The total storage required for all the regencies for 90% dependability is worked out in Tables 8.2, 8.3 for 4 lpcd and 5 lpcd supply capacity respectively. The storage so computed includes adjustment for daily variations in rainfall (7%) and for leakage and evaporation from the tank(5%). A summary of the same is given on page 8.

5.4 Storage Capacity Per Family

Based on the analysis of storage requirements, it is found that some regencies require less storage than others even for a higher rate of supply as they have less variations in the monthly rainfall. Hence it may be desirable to divide the regencies into two broad categories, Group I requiring more storage capacity than Group II. The suggested storage capacities are:

Group I - Sumba Timur, Flores Timur, Kupang, Sikka, Ngada, Belu and Alor.

These are to be provided with a family storage of 5000 litres. Leaving a dead storage height of 10 cm and maximum height of the tank limited to 1.6 m, these regencies are to be provided with a tank of 1.90 m x 1.90 m x 1.6 m for each

household. With this the regencies Kupang, Belu and Alor will have a capacity to supply more than 5 lpcd whereas the others will have a capacity of 4 lpcd or more.

Group II - Sumba Barat, Ende and Manggarai.

These are to be provided with a family storage of 3600 litres. Again,making provisions for dead storage and maximum height, a tank of 1.55 m x 1.55 m x 1.60 m has to be provided for each household in these regencies and it will have a capacity to supply at more than 5 lpcd.

Regency	Total Storage Required (Litres) For 4 lpcd			5 lpcd	
	Storage per capita litre	Nos. per family	Storage per family litre	Storage per capita litre	Storage per family litre
Sumba Timur	948	5.3	5 024	1 207	6 397
Flores Timur	832	5.87	4 883	1 040	6 105
Kupang	814	4.81	3 915	1 030	4 954
Sikka	796	6.06	4 824	1 054	6 387
Ngada	784	6.54	5 127	1 349	8 822
Belu	651	5.29	3 444	822	4 348
Alor	553	5.07	2 804	723	3 666
Sumba Barat	411	5.95	2 445	582	3 463
Ende	321	5.86	1 881	458	2 684
Manggarai	191	6.13	1 704	278	1 704

6. COMMENTS ON THE PRESENT DESIGN GUIDELINES AND DESIGNS OF THE MINISTRY OF HEALTH

6.1 Per Capita Daily Water Requirement

A per capita daily water supply of 4-6 litres during the dry spell period is feasible for NTT province as analysed and discussed earlier with a reasonable storage.

6.2 Dry Spell Period

The dry spell period in NTT varies from 3-8 months (6 months being quite common) in a year. The criteria of 3 months dry spell for sizing of storage are therefore, not applicable. A detailed analysis of storage required is advisable with rainfall data, preferably of long duration as done in the present case.

6.3 Number of persons Per Tank

At present a storage tank of 45 m^3 is provided to meet the requirements of 100 persons (20 families). The storage requirement for 100 persons obviously is a very large storage system. Such a large system is obviously not feasible owing to:

(1) Non-availability of roof area of about 300-400 m2.

(2) Arrangement of rainwater gutters required to convey rain-water to the storage tank.

6.4 Capacity of the Tank

The capacity of the tank is too big to fill in NTT rural housing and rainfall conditions as discussed in 6.5 below.

6.5 Roof Area Sufficient to Suit Local Rainfall

It is recognized that the roof area of a single house may not be able to yield enough water to fill a tank of 45 m3 capacity. It has, therefore, been suggested that roof area and rain-water gutters of three houses may be connected to the single tank of 45 m3 capacity.

As per rainwater and roof area analysis already presented, 1 m3 capacity requires a roof area of 4 m^2. The 45 m3 capacity tank will, therefore, require a roof area of 180 m^2.

Normally, more than 50 m2 roof area per family of 5 persons may not be available. Thus roof area of more than 3 houses will be required to fill a tank of 45 m^3 capacity. The rural houses in NTT are very much scattered and distances between houses is several metres in most of the cases. Therefore, it is impractical to combine the roof area of 2 or more houses and to plan for building rain-water gutters. Even in the case of schools and gereja's it may be difficult to collect roof water from a roof area greater than 40 sq. m without having to make elaborate arrangements for the support of rain-water gutters.

6.6 Structural Features

6.6.1 Masonry tank

(a) Capacity

The size of the tank is 5m x 5m, 1.75m deep.

The capacity of the tank is, therefore, 43.75 m^3. not 45 m3. Fig. No. 4.

(b) Foundation

Very heavy foundation 8m x 8m with actual foundation as 55 m2 (64-9) has been planned for a tank with a water depth of 1.75m. This is unusually heavy. The depth of the foundation is 1.4m, which is excessive.

(c) Wall thickness

Wall thickness at the bottom is about 1.5m for a tank with a water depth of 1.75m only whereas a thickness of 0.45m is adequate.

6.6.2 Alternative Design of RCC. Fig. No. 5

The tank design of RCC, may be all right structurally but its construction by local staff in rural areas is not feasible. Recently alternative ferro-cement tank designs of 9 m3 capacity have been developed. The comment on the design is as below:

6.6.3 9/10 M^3 Ferro-Cement Tank Kesehatan Design

(a) The structural details ot the ferro-cement tank are not available, but it is presumed that the reinforcement as adopted by DIAN DESA is being adopted elsewhere. Comparing the reinforcement with the design prepared by the Ferro-Cement Centre AIT, Bangkok and Structural Engineering Research Institute, Madras, India, it appears that the reinforcement and chicken-wire net and junction details of walls and floors are unsatisfactory for building a water-proof tank.

(b) The actual thickness under field conditions is more than 3 cm (5 cm or so). An evaluation to determine how many ferro-cement tanks constructed are able to hold water needs to be made.

7. SUGGESTED DESIGN CAPACITY OF STORAGE TANKS

Past experience has established that:

(1) The rain-water collected in the tanks constructed for communal use gets exhausted within 2-3 months after the rains, mainly owing to uncontrolled draw off by too many people.

(2) The rain-water tanks of 45 m^3 capacity require a large roof area and an elaborate arrangement and long length of rain-water gutters which often are not available. As a result the tank is not always up to the design level.

(3) The construction of a rain-water tank has to be sturdy and water-proof to prevent water loss after collection.

It is, therefore, suggested that the construction of smaller tanks for individual households should be encouraged as recommended to provide 4 to 5 lpcd supply throughout the year wherever feasible.

The larger capacity tanks as interconnected multiple units of the suggested household tanks may be adopted for public places like hospitals, schools, gereja, masjid, and offices and joint family households. However, the multiplier is to be based on the demand for water and the roof area

available. As an alternative, 10 m^3 or 20 m^3 capacity ferro-cement tanks when suited may be adopted.

Keeping in view the above suggestions the following designs of two different capacity tanks have been developed for individual household and community rain-water tanks in NTT.

7.1 Masonry Tank Design

(1) (a) Size 1.9m x 1.9m x 1.6m high or multiples thereof.

(b) Size 1.55m x 1.55m x 1.6m high or multiples thereof.

(2) Useful capacity for:

(a) 5.14 m^3 or multiples and actual capacity = 5.78 m^3

Useful capacity for:

(b) 3.42 m^3 or multiples and actual capacity = 3.85 m^3.

(3) Foundation: Local stone compacted under the floor with masonry foundation under the walls.

(4) Walls: Masonry in cement mortar 1:3, plastered in cement mortar 1:2, 18mm thick in 2 layers.

(5) Floor: Ferro-cement floor with chicken-wire net 5 cm thick in 1:2 cement mortar (water:cement ratio 0.4).

(6) Roof: Ferro-cement roof slab 6 cm thick with MS reinforcement and 2 layers of chickenwire mesh.

(7) Filter: Perforated slab with sand and gravel topped with open jointed bricks or big stones to prevent disturbance of sand underneath.

(8) Overflow chamber (optional).

It has been mentioned that the tank is designed for a once in 10 years failure and 90% dependability. Therefore, in most of the years more rain-water is available, at least during the rainy season, than 4 to 5 lpcd for which the tank has been designed. As the capacity of the tank is limited, the rain-water will naturally overflow to waste. Since in wet regions a high supply rate is aimed at, it is not considered worthwhile to provide additional storage at added cost to collect the overflow. It is, therefore, suggested that a chamber with a wooden cover should be provided to store overflowing water for daily use, at least during the rainy season.

(9) As the height of the roof is limited, the tank floor cannot be raised above the ground. The tap being almost at the floor level, a pit has to be constructed to place the bucket under the tap. A pit has been provided accordingly with the open jointed floor so that spilled out or rain-water may soak into the ground, if it cannot be drained. If topography permits, a drain should be provided for the waste water; the site should be dressed and sloped away from the tank to prevent rain-water seeping to the foundation.

(10) A water-level inspection pipe has been provided with a cap.

(11) For entry into the tank a removable galvanized sheet cover for domestic tanks and a man-hole for large-capacity with a ferro-cement roof is suggested.

7.2 Ferro-Cement Tank Design, Drawing No. 005B and 005C

The designs of a circular ferro-cement concrete tank with domical and flat roof are illustrated in Fig. 005B and 005C.

	As per West Java Project Domestic Roof Circular		Alternative Design Flat Roof
Nominal capacity	5 m^3	10 m^3	10 m^3
Size	2 m Ø	2.9 Ø	2.94m Ø
Water depth	1.60 m	1.60 m	1.60 m
Actual capacity	5.024 m^3	10,0 m^3	10.86 m^3

The structural design reinforcement is based on the designs developed by the West Java rural water supply project. The alternative designs for a ferro-cement tank are developed by the Structural Engineering Research Institute, Madras, and International Ferro Cement Centre, Bangkok. Other design features are similar to the one mentioned earlier on the masonry tank.

The quantity of materials for the construction of various tank designs are given in Annex 1 to 7 and the comparative cost estimates are given in Annex 8.

8. FINANCING AND IMPLEMENTATION STRATEGY

The Government provides funds under the Inpres budget for the construction of rainwater collection tanks every year. The 1981-82 Inpres budget provides for the construction of 160 rain-water tanks each of 10 m^3 capacity at a cost of Rp. 104 million. In addition, Rp. 46 million for the construction of 115 rain-water tanks in NTT at an estimated cost of Rp.400 000 each has also been provided in the Central Budget. In the 1981-82 budget, UNDP/WHO will provide technical support for design, construction, supervision, evaluation and monitoring.

It is suggested that the desa with a critical water problem, with no alternative source and with a scattered population should be selected for the implementation of the programme in 1981-82. Desas where housing improvement and other development activities are planned and which have been listed for the provision of a rain-water system should be given priority. The approach should be to provide as many rain-water tanks as feasible for individual family use because control of water from a community rain-water collection tank is not feasible. Any house owner ready to convert his thatched roof to metal roof at his cost to avail of the aid for rain-water collectors should be given priority in assistance. The construction of a tank as per design 005A and 005B is suggested.

9. CONSTRUCTION MANAGEMENT

The construction of the storage tanks as per design should be undertaken by the kabupaten health and P.U. staff with the participation of local people. While contractors should not be engaged, local labour can be taken for the construction on daily wages basis. This is as per the guidelines issued by the Ministry of Health. The possibility of engaging local people on a subcontract or "food for work" for building the tank should be explored by the house owner to cut down the cost. The house owner should at least contribute or collect local materials. Those who collect material first should be given priority, provided they have galvanized mild steel or tile roof. This policy should be publicized in advance so that people have time to make arrangements for materials. The Regency Government's contribution could be cement, bricks, steel, pipes, fittings, chicken-wire net, mild steel sheets for gutters and rain-water pipes, wood for framework and in some cases, at least the transport cost of sand or gravel/stone. The guidelines for construction are given in Annex 9.

10. RESPONSIBILITY

The Hygiene and Sanitation Section in the Provincial Office of the Dinas Kesehatan Dati I, in consultation with the concerned regency health staff, should be responsible for the implementation of the rain-water collection tank programme. In particular, it should:

- Provide designs and training to Kabupaten staff in construction methodology.
- Assist and guide the construction of tanks through the Kabupaten health office.
- Supervise the construction.
- Supervise the evaluation and monitoring.

11. TRAINING

Model tanks should be built under the supervision of sanitarian and health controllers. Masons should be trained in the construction and supervision and should be engaged on a monthly basis to guide and assist local masons engaged for construction work. Local masons and casual labour should be engaged as and when required.

12. EVALUATION AND MONITORING

Kabupaten and provincial health staff will report regularly to the Chief, Hygiene and Sanitation, after the construction is completed.

13. SUMMARY AND RECOMMENDATIONS

The proposal and the plan in this report are for a rain-water collection system for the supply of drinking water in the twelve regencies of NTT Province. The rainfall in these regencies exhibits large variations spatially and temporally. The maximum annual rainfall is 4321 mm in Manggarai regency and the minimum annual rainfall is 481 mm in Sumba Timur. Their corresponding annual averages are 3220 mm and 839.78 mm respectively. The maximum standard deviations are 966.14 mm in Ngada regency and 245.89 mm in Sumba Timur.

The number of persons per household varies from a minimum of 4.8 in Kupang regency to a maximum of 6.60 in Ngada with reported increasing trends in population. The per capita residential roof area available for the collection of rain-water will rarely exceed 4 to 5 m^2 The drinking water requirement is 4 lpcd which is presently being collected from surface water sources and transported in bamboos by individuals over large distances.

The alternative of providing drinking water through wells is difficult because of the hard rocky strata, and non-availability of groundwater. In some regions the groundwater is saline. A centralized water supply scheme with surface water source is prohibitively costly. So the objective is to provide as much reliable drinking water supply as possible, at a reasonable cost through a rain-water collection system for individual households.

14. HYDROLOGIC ANALYSIS OF RAIN-WATER COLLECTION SYSTEM

The domestic rainwater collection and storage system has been analysed for 10 regencies for which a representative station's monthly rainfall data are available. The adequacy of storage has been checked with respect to the daily rainfall distribution available for one year (1976-77) for the station Mahau in Sumba Timur regency. The storage requirement derived from the monthly rainfall data for various regencies is adjusted for daily variation through a fixed percentage (7%) derived for Mahau station.

The storage analysis is based on the following:

(1) The water year is considered from 1 December to 30 November.

(2) The storage requirements are on an annual basis and no year-to-year carry over is contemplated.

(3) Only 85% of rainfall is assumed available for collection after accounting for evaporation and initial losses (assumed at 15%).

(4) The storage provided is 90% dependable, i.e., failure may statistically average once in ten years.

Minimum roof assumed for collecting rainwater is 4 m^2 per capita. The per capita storage requirement so computed is given below:

Regency	Total storage per capita required for: 4 lpcd	5 lpcd
Sumba Timur	948	1207
Flores Timur	832	1040
Kupang	814	1030
Sikka	796	1054
Ngada	784	1349
Belu	651	822
Alor	553	723
Sumba Barat	411	582
Ende	321	458
Manggarai	191	278

The regencies have been divided into two groups and the following specific recommendations are made for each group.

15. RECOMMENDATIONS

(1) Group I: Regencies: Sumba Timur, Flores Timur, Kupang, Sikka, Ngada, Belu and Alor.

These are to be provided with a useful family storage tank of 5 m^3 capacity (about 772 to 1068 litres per capita). Providing a dead storage height of 10 cm and restricting the maximum height of the tank to 1.6m,

these regencies are to be provided with a tank of 1.90 m x 1.90 m x 1.6 m (5.78 m^3 for each household. With this the regencies Belo and Alor will have the capacity to supply water at more than 5 lpcd whereas the remaining will have a supply capacity of at least 4 lpcd.

(2) Group II: Regencies: Sumba Barat, Ende and Manggarai.

These are to be provided with a useful family storage tank of 3.6 m^3 capacity (about 600 litres per capita). Again, making provision for dead storage and keeping the maximum height of the tank as before, a tank of 1.55 m x 1.60 m (3.85 m^3 has to be provided for each household in these regencies and it will have a capacity to supply about 5 lpcd.

(3) Detailed precipitation for regencies TTS and TTU are not available. However, based on the spatial distribution of annual rainfall the following suggestions are made.

The spatial mean and standard deviations of TTS correspond to that of Kupang and that of TTU to that of temporal average and standard deviation of the Mahau station. In view of this, the two regencies may be provided with storage similar to the regencies under Group I.

(4) The tank designs may be prepared as provided in the report. The height of the tank recommended being the same in all cases, the dimensions of the side walls and foundation depths remain the same. The overall dimensions in plan and elevation and section only need slight adjustments to suit the proposed dimensions of the tank.

(5) A standard size for the whole of NTT Province is not a desirable feature as it offers no specific advantage if it is to be constructed with locally available materials and talent. Also, some of the regencies used similar storage even with higher rates of supply owing to a relatively uniform time-distribution of rainfall.

(6) Public places like masjids, gerejas, schools and public offices in the regency may be provided with twin or quadruplet units of domestic tanks suggested for that regency depending on the demand. This, in turn, will depend on the number of persons to be served and the period of occupancy, and the feasibility of water collection which depends on the roof area available for rain-water collection.

(7) The general recommendations are summarized in the following table. It may be noted that useful storage in different regencies would cover a specific continuous dry spell period (vide col. 5 of the table at page 18). However, the planning of storage is not based on the concept of a continuous dry spell. It is based on monthly rainfall (input) and monthly demand (output), further adjusted for daily variations.

(8) The design of the tank selected should suit the local conditions. In general, masonry tanks as per local site conditions are suggested as these could utilize the unskilled labour of the beneficiaries themselves.

(9) The edge of the tank should be about 1m from the outside face of the building wall.

(10) People's participation should be encouraged by publicizing the policy that those who co-operate will be provided assistance in the form of cement, steel, pipes and fittings and staff for supervising construction. Efforts should be made even to persuade local people to provide as much voluntary labour as possible.

TABLE: SUMMARY OF RECOMMENDATIONS FOR RAINFALL COLLECTION SYSTEM FOR NTT REGION, INDONESIA

Regencies	Gross per capita recommended Litres	Per capita useful storage Litres	Assumed Min.. daily supply per person	Maximum continuous dry period covered days	Recommended size of tank for a family of six persons	Recommended capacity for Masjids, Gerejas, Schools and Public Offices	Recommended arrangement roof areas m2/person	Collection Gutter Length m/person
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kupang, Sumba Timur, Flores Timur, Sikka, Ngada	1009.40	950	4	237.5	1.9m x 1.9m x 1.6m high ($5.5m^3$)	Two or more units of 1.9m x 1.9m x 1.6m high with inter-connection.	4	2
Belu Alor	1009.40	950	5	190	as above	"	4	2
Sumba Barat Ende Manggarai	605.6	570	5	114	1.55m x 1.55m x 1.6m high (3.85m)	Two or more units of 1.55m x 1.55m x 1.6m high with inter-connection.	4	2

Col. 2: Per capita gross tank capacity

Col. 3: 90% dependable (i.e., failure may occur on an average once in 10 years)
The storage capacity calculation of Table 8.4 includes 9% correction for variation of daily rainfall over monthly and 5% for evaporation and leakage losses

Col. 5: Maximum continuous dry period which the useful storage can cover = Col. 3/Col. 4

Col. 6: Tank capacity including dead storage capacity of 10 cm this included in the 950 and 590

Col. 7: Should be based on demand and maximum roof area available for rain-water collection.

Col. 8 & 9: Run-off loss from roof surface assumed as 15%.

Annex 1

GUIDELINES FOR CONSTRUCTION

005A, 005B, 005C

1. Select desa for rain-water collection tank systems in consultation with Regency Planning Department and of the list of desas falling within the areas identified for rain-water collection by the Project. Talk to the villagers, explain to them the Programme, and find their preference of design - masonry or ferro-cement.

2. Contact Kepala Desa, R.T. and notify the people about the programme seeking their participation by way of arranging local materials, labour, etc. Ask them to approach Kepala Desa for registration of their request for rain-water collection, financing and construction, indicating the extent of their contribution by way of local material, labour and cash.

3. Collect the survey data on the following tabular form.

3.1 Name of Desa(Kampung (Subdesa)

Name of House Owner	Type of Roof	Roof Area	Proposed Location of Rain-water Tank	Indication of Willingness by way of Local Labour by Cash/ Material
1.				
2.				

3.2 School, Gereja/Masjid, Police Station, Pasar, Balai, Desa etc.

Name of Institution	Type of Roof	Roof Area	Available Space Construction	Remarks
1.				(a) In case of school No. of students.
2.				(b) In case of church No. of people attending the service

4. Capacity

4.1 For an individual house provide 5 m3 capacity and for a joint family house (2 or 3 families) 10 capacity. Effective roof area should not be less than 40 m^2 and a $10m^3$ capacity tank and $20m^2$ for a $3m^3$ tank.

4.2 For school, office, church 10 m^3 or 20 m^3 capacity, one or more tanks based on the criteria that effective roof area is not less than 4 m^2 per m^3 of tank capacity.

4.3 Effective roof area is the roof area which will be draining through rain-water gutters and rain-water pipe to the filter and to the rain-water collection tank.

5. Depth of Water and Size of the Tank

Check the height of the edge of the roof to the ground level; if it is 2.3 m or more, adopt the standard design. If the height available is less than 2.3 m reduce the depth of water accordingly and fix the tank size to provide the desired capacity of 5m^3 10m^3 or 20m^3 as the case may be.

6. Select Type of Tank

If stone, gravel and sand are available locally, construction of a stone masonry tank 5m^3 or 10m^3 capacity may be preferable and more sturdy. The cost may also be comparable to the ferro-cement tank. Dressed stone may be used in place of random stone. If good bricks are available locally at a competitive rate the same may be used instead. Masonry tank may be preferred from the point of view of hot weather with bright sunshine. A ferro-cement tank(West Java design) may be tried if good supervision and quality control is possible, and the tank construction site is shaded by trees.

7. Location of the Tank

Locate the tank near the corner so that at least two long lengths of gutter can feed the tank with roof water. Keep the edge of the tank about 1m from the face of the wall. Cut all the branches of trees from which leaves are likely to fall on the roof of the house because leaves are likely to flow along with the rain water to the rain-water gutter, then through the rain-water drain pipe to the filter over the roof of the rain-water tank.

8. Preparation of Site and Foundation

Dress the site to remove heaps of stones and loose surface. Mark out the tank foundation and excavate to the desired depth. Examine if the foundation soil is loose or natural compact earth. If firm soil, water and ram it thoroughly by putting some gravel and silt or sand to fill voids. DO NOT CONSTRUCT ON LOOSE, FILLED UP SOIL.

9. Construct the Tank as per Drawing

In the case of a masonry tank, inside plastering should be done in 2 or 3 layers and should be well cured. The final coat should be a sealing coat with neat cement. The corners should be rounded up with a bottle and bottom slab should be anchored with the wall by providing a water stop. In case of ferro-cement tank strict control of water:cement ratio and binding of mortar is necessary. Another very important point of leakage is the point of outlet or washout where the pipes are grouted. The grouted place of pipe should be provided with spiders and the wall portion should be stiffened with additional plaster.

10. Overflow and Drain

The tank is supplied by 10 cm size rain-water pipes. When the rainfall is heavy the tank may overflow. A large, 80 mm dia overflow pipe is, therefore, suggested to prevent overflow from the filter top. To prevent the overflowing water from reaching the foundation of the tank, a drain to this should be provided. THIS IS NOT TO BE OVERLOOKED.

The provision of an optional, overflow chamber will protect the supply and this water can be used during the rainy season.

11. Outlet Chamber

The outlet chamber is shown below ground level. The floor of the chamber should be kept uncemented with loose, jointed bricks or stones so that it soaks spilled out water. Wherever possible, water should be drained out by providing an opening and a drain in the side wall.

12. Inspection Opening

Often, one would like to know the depth of water in the tank. This is possible through a 3" Ø pipe with a cap, using a depth gauge rod. For annual cleaning of the tank, the G.I. roof can be unbolted (5 m^3 and 10 m^3 capacity) and refixed after cleaning. In the alternative design with RCC roof, a manhole has been provided.

13. Gutters

The gutter is the most important component of the rain-water collection system. It should, therefore, be installed and supported properly with brackets at a spacing of about 40 cm c/c. This work should not be left to the house-owner, but should be constructed along with the tank.

14. Rain-Water Pipe

If land is available within 1 m from the wall for the construction of the rain-water tank of 5 m^3 or 10 m^3 capacity, in most cases a long length of rain-water pipe will not be required. The pipe could be made by MS steel sheet by moulding at the site in the form of a pipe or even a half-round channel of length.

Annex 2

ESTIMATE OF QUANTITIES OF MATERIAL
FOR 9 M3 CAPACITY FERRO-CEMENT TANK
(AS PER DIAN DESA DESIGN FOR MADURA)

Serial No.	Name of Material	Unit	Quantity
1.	Portland Cement	Bag	16
2.	Sand	M3	1.5
3.	(a) Mild steel iron rod, 8mm in diameter, 6 m long	M	24
	(b) Iron rods 5 mm in diameter	M	100
4.	Galvanized chicken-wire net (Nag brand)	Roll	50 m2
5.	Binding wire	Kg	1.5
6.	Water tap 3/4" in diameter	Nos.	1
7.	G.I. Pipe outlet 3/4" in diameter (30 cm long)	Sheet	1
8.	G.I. Pipe overflow 2" in diameter (15 cm long)	Sheet	1
9.	G.I. Pipe washout 1" in diameter 20 cm long with plug	Sheet	1
10.	Corrugated galvanized sheet roof 28 BWG, 90 cm x 180 cm	Sheet	3
11.	Filter slab 25 x 75	Nos.	3
12.	Sand for filter	M3	0.1
13.	Gravel for the filter	M3	0.1
14.	Framed aluminium screen(40cmX40cm)	Sheet	1
15.	Gutter of galvanized sheet 28 BWG 0.9 x 1.8m, 20 cm diameter	M	10
16.	Brick or large stone over the filter bed	Nos.	3
17.	Rain-water pipe of 28 BWG galvanized iron sheet, 10 cm diameter	M	0.5
18.	Water-proof expoxy paint	Litres	
19.	Mosquito net	Piece	1
20.	Nails	Kg	1/2
21.	Plywood 1.2m x 2.4m	Sheet	8
22.	Bamboo	Nos.	4
23.	Planks 3 cm x 20 cm x 2 m	Nos.	2

Annex 3

ESTIMATE OF QUANTITIES OF MATERIAL
FOR 9 M3 CAPACITY FERRO-CEMENT TANK
(3 M DIAMETER, 1.3 M DEEP)

(AS PER KESEHATAN DESIGN)

Serial No.	Name of Material	Unit	Quantity
1.	Cement	Bag	17
2.	Sand	M3	1.5
3.	(a) Mild steel Iron rods 5 mm in diameter 6 m long	M	192
	(b) Mild steel iron rods 8 mm diameter 6 m long	M	30
4.	Galvanized chicken-wire net 1 m wide	M2	40
5.	Binding wire	Kg	1.5
6.	Water tap	Nos.	1
7.	G.I. outlet 3/4" diameter 30 cm long	Sheets	1
8.	G.I. Pipe overflow 2" diameter 15 cm long	Sheets	1
9.	G.I. Pipe wash aut 1" diameter 20 cm long with plug	Sheets	1
10.	Galvanized sheet cover 28 BWG 90 cm x 180 cm in size	Piece	2
11.	Filter slab 25 cm x 50 cm x 5 cm thick	Nos.	2
12.	Sand for filter	M3	0.05
13.	Gravel for filter	M3	0.05
14.	Coconut fibre for filter	-	-
15.	Brick or large stone over the filter bed	Nos.	3
16.	Gutter of galvanized sheet 28 BWG 0.9 m x 1.80 m, 20 cm diameter	M	10
17.	Rain-water pipe of 28 gauge galvanized M.S. Sheet, 10 cm diameter	M	0.5
18.	Water-proof expoxy paint	-	-
19.	Mosquito net	Piece	1
20.	Nails 15 cm long	Kg	1/2
21.	Triplex plywood 1.2 m x 2.4 m	Sheets	8
22.	Bamboo long	Nos.	6
23.	Plank 3 cm x 30 cm, 2 m long	Nos.	6

Annex 4

ESTIMATE OF QUANTITY OF MATERIAL FOR
10 M3 CAPACITY FERRO-CEMENT CONCRETE TANK
(2.4) M DIAMETER AND (2.3) M DEEP

(AS PER DESIGN OF STRUCTURAL ENGINEERING
RESEARCH INSTITUTE, MADRAS, INDIA)

Serial Number	Name of Material	Unit	Quantity
1.	Portland Cement	Bags	18
2.	Sand	M3	1.0
3.	Mild steel rods 8MM for reinforcement.	Kg	152
4.	Binding wire	Kg	2.5
5.	G.I. wire square woven mesh with 18.0 gauge wire	M2	105
6.	Bib cock 1/2" diameter 10 gauge wire	Nos.	1
7.	Galvanized iron 1/2" diameter pipe for outlet, 15 cm long	Nos.	1
8.	Galvanized iron 3" diameter pipe for overflow, 15 cm long	Nos.	1
9.	Galvanized iron wash out pipe 1-1/2" diameter 20 cm long	Nos.	1
10.	Observation and depth gauge pipe 3" diameter, 20 cm long with a cap	Nos.	1
11.	RCC filter plate 65 cm diameter	Nos.	1
12.	Sand for filter	M3	0.03
13.	Gravel for filter	M3	0.03
14.	Stones	M3	0.03
15.	Gutter of galvanized sheet 28BWG, 0.90m x 1.8m, 20 cm diameter	M	10
16.	Brick or large stone over the filter bed.	Nos.	3
17.	Rain-water pipe of 28 BWG galvanized iron 10 cm diameter	Sheet	0.5
18.	Water-proof expoxy paint inside	Litre	4.0
19.	Mosquito net	Piece	1
20.	Nails	Kg	1/2
21.	Plywood, 1.2m x 2.4m sheet (Use 5 times)	Nos.	1
22.	Bamboo	Nos.	4
23.	Planks 20 cm x 3 cm x 2 m	Nos.	2

Annex 5

ESTIMATE OF QUANTITIES OF MATERIAL FOR
10 M^3 CAPACITY FERRO-CEMENT CONCRETE TANK
(2.2 M) DIAMETER AND (2.63 M) DEEP)

(AS PER DESIGN OF INTERNATIONAL FERRO-CEMENT RESEARCH)

Serial Number	Name of Material	Unit	Quantity
1.	Portland cement	Bags	14
2.	Sand	M3	0.9
3.	Mild steel rods, 8 mm Ø for reinforcement	Kg	95
4.	Galvanized mesh 12 mm square with 18 or 20 gauge wire	M2	160
5.	Binding wire	Kg	2.5
6.	Bib cock 1/2" diameter	Nos.	1
7.	Galvanized iron outlet pipe, 1/2" diameter, 30 cm long.	Nos.	1
8.	Galvanized iron overflow pipe, 3" diameter, 20 cm long along with one socket for screen.	Nos.	1
9.	Galvanized iron wash-out pipe 1" diameter 20 cm long	Nos.	1
10.	Observation and depth gauge pipe 3" diameter, 20 cm long with a cap	Nos.	1
11.	R.C. filter slab 65 cm Ø	Nos.	1
12.	Sand for filter	M3	0.03
13.	Gravel for filter	M3	0.03
14.	Stones	M3	0.03
15.	Gutter of galvanized sheet 28 BWG 0.9 m x 1.8 m, 20 cm in diameter	M	10
16.	Bricks or large stone over the filter bed	Nos.	3
17.	Rain-water pipe of 28 BWG, galvanized iron sheet 10 cm in diameter	M	0.5
18.	Water-proof expoxy paint inside	Litres	4.0
19.	Mosquito net	Piece	1
20.	Nails	Kg	1/2
21.	Plywood sheet 1.2 x 2.4 m	Nos.	1
22.	Bamboo	Nos.	4
23.	Plank 3 cm x 2.05 cm x 2.5 m long 8 Nos. for 5 times	Nos.	8

Annex 6

ESTIMATE OF QUANTITIES OF MATERIAL FOR
10 M3 CAPACITY FERRO-CEMENT TANK
(2.9 M DIAMETRE, 1.6 M DEEP)

(AS PER WEST JAVA RURAL WATER SUPPLY PROJECT DESIGN)

AS PREPARED BY THE PROJECT

Serial Number	Name of Material	Unit	Quantity
1.	Cement	Bags	18
2.	Clean sand 2.5 mm size	M^3	1.4
3.	Galvanized wire 5 mm diameter BWG8	Kg	74.0
4.	Chicken wire net with 0.7 mm Size 1.0 m width, Fish brand	M	50.0
5.	Binding wire 0.65 cm diameter	Kg	2.0
6.	Water tap 1/2"	Nos.	1
7.	Galvanized outflow pipe 3/4" diameter 45 cm long	Set	1
8.	Drainout pipe, galvanized iron 1-1/2" diameter 20 cm long with one plug	Set	1
9.	Galvanized iron overflow pipe 20 cm long 1-1/2" diameter	Set	1
10.	Water depth measurement pipe 4" diameter 30 cm long with plug	Set	1
11.	Filter plate of RCC 65 cm in diameter for filter	Set	1
12.	Filter sand	M^3	0.035
13.	Filter gravel	M^3	0.02
14.	Coconut husk for filter	M^3	0.035
15.	Brick or large stone for filter bed	Nos.	3
16.	Gutter of galvanized iron sheet 28 BWG, 20 cm diameter	M	10
17.	Rain-water pipe of MS, sheet 28 BWG, cm diameter	M	0.5
18.	Water-proof epoxy paint	Litres	4.0
19.	Mosquito net	Piece	1
20.	Nails	Kg	1/2
21.	Plank 3 cm x 20 cm x 2-1/2 m	Nos.	2
22.	Bamboo	Nos.	8
23.	Plywood for shuttering 1.2 m X 2.4 m. 8 Nos. for 5 times	Sheets	8

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Annex 7

ESTIMATE OF QUANTITY OF MATERIAL FOR 10 M3 CAPACITY FERRO-CEMENT CONCRETE TANK (2.94m)M DIAMETER AND (1.65m)M DEEP

(PREPARED BY THE PROJECT)

Serial Number	Name of Material	Unit	Quantity
1.	Portland cement	Bags	18
2.	Sand		10
3.	Mild steel rods 8 mm diameter for reinforcement	Kg	120
4.	Binding wire	Kg	2.5
5.	G.I. Wire square woven mesh 10 x 10 with BWG 20 gauge wire		150
6.	Bib cock 1/2" diameter 10 gauge wire	Nos.	1
7.	Galvanized iron 1/2" diameter pipe for outlet, 15 cm long	Nos.	1
8.	Galvanized iron 3" diameter pipe for overflow, 15 cm long	Nos.	1
9.	Galvanized iron wash-out pipe, 1-1/2" diameter 20 cm long	Nos.	1
10.	Observation and depth gauge pipe, 3" diameter 20 cm long with a cap	Nos.	1
11.	RCC filter plate 65 cm diameter	Nos.	1
12.	Sand for filter	M^3	0.03
13.	Gravel for filter	M^3	0.03
14.	Stores	M^3	0.03
15.	Gutter of galvanized sheet 28 BWG, 0.90 X 1.8 M, 20 cm diameter	M	10
16.	Brick or large stone over the filter bed	Nos.	3
17.	Rain-water pipe of 28 BWG galvanized iron 10 cm diameter	Sheet	0.5
18.	Water-proof expoxy paint inside	Litre	4.0
19.	Mosquito net	Piece	1
20.	Nails	Kg	1/2
21.	Plywood, 1.2m X 2.4m sheet (Use 5 times)	Nos.	1
22.	Bamboo	Nos.	4
23.	Planks 20 cm X 3 cm X 2M	Nos.	2

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Annex 8

ESTIMATE OF QUANTITY OF MATERIAL FOR
(10 M^3 CAPACITY MASONRY TANK)
(1.8M x 1.8M x 1.60M TWIN UNIT)

(AS PER DESIGN PREPARED BY THE PROJECT)

Serial Number	Name of Material	Unit	Quantity
1.	Cement	Bag	38
2.	Clean sand	M^3	4
3.	Iron rods 5 mm	Kg	45
4.	Chicken wire merk	M^3	24
5.	Binding wire	Kg	0.5
6.	Water tap 1/2" diameter	M	1
7.	Outlet pipe 1/2" diameter	M	0.45
8.	Washout pipe 1" 45 cm long with a plug	Nos.	1
9.	Galvanized overflow pipe 3" diameter 45 cm long with socket	Nos.	1
10.	Water depth measurement pipe 3" diameter, 40 cm long with cap, 3" diameter	Nos.	1
11.	28 BWG galvanized sheet roof 0.9 x 1.8 M	Nos.	1
12.	Filter slab 3Nos. 24 x 75 x 5 cm	Nos.	3
13.	Filter sand	M^3	0.04
14.	Filter gravel and stopes	M^3	0.11
15.	Framed screen 80 x 80 cm with wire mesh, 1 mm X 1 mm opening	Nos.	1
16.	Brick or stone (For wall and foundation)	M^3	7.5
17.	20 cm diameter gutter of 28 gauge galvanized sheet 45 cm wide	M	10
18.	3 mm x 20 mm flat iron stays	Nos.	26
19.	Rain-water pipe of galvanized MS sheet of 10 cm diameter	M	0.5
20.	Mosquito net	Piece	1
21.	Bamboo	Nos.	4
22.	Plank 3 cm, 20 cm width 1.8 m long	Nos.	1
23.	Plywood 1.2 M x 2.4 M	Nos.	1

COMPARATIVE COST ESTIMATES OF 10 M^3 CAPACITY TANKS OF DIFFERENT DESIGNS

ITEM	UNIT RATE	FERRO-CEMENT TANK DESIGN								MASONRY DESIGN	
		As per West Java Project		Design by the Project		Design as per SRI Madras, India		Design as per F.C.R.I.Bangkok		Design by the Project	
		2.9mØ x 1.6m		2.94mØ x 1.6m		2.4mØ x 2.3m		2.2mØ x 2.63m		1.8m x 1.8m x 2.	
		Design No. 5		Design No. 6		Design No. 3		Design No. 4		Design No. 7	
		Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Cement	3000/bag	18	54 000	18	54 000	18	54 000	14	42 000	38	114 000
2. Clean sand	4500/m3	1.4	6 300	1.8	6 300	1.0	4 500	0.9	4 050	4	18 000
3. Galvanized rods	1000	74.0	74 000	120	120 000	152	152 000	95	95 000	45	45 000
4. Binding wire	1200/kg	2kg	2 400	2.5Kg	3 000	2.5	3 000	2.5	3 000	1/2	500
5. Chicken-wire net	1000/m2	50	50 000	-	-	-	-	-	-	24	24 000
6. Steel wire mesh 10 x 10 mm of 20 SWG	1000/m2	-	-	150	150 000	160	160 000	160	160 000	-	-
7. Water tap	5000	1	5 000	1	5 000	1	5 000	1	5 000	1	5 000
8. G.I. outlet pipe	1500	1,3/4"	1 500	1,1/2"	1 000	1/2	1 000	1,1/2"	1 000	1/2"	1 000
9. Drain out pipe	1500	1,1/2"	1 500	1,1"	1 000	1 1"	1 000	1, 1"	2 000	1"	2 000
10. Galvanized overflow pipe	2000	1,1-1/2"	2 000	1,3"	5 000	1,3"	5 000	1,3"	5 000	3"	5 000

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Annex 9

Annex 9

COMPARATIVE COST ESTIMATES OF 10 M^3 CAPACITY TANKS OF DIFFERENT DESIGNS

ITEM	UNIT RATE	FERRO-CEMENT TANK DESIGN								MASONRY DESIGN	
		As per West Java Project		Design by the Project		Design as per SRI Madras, India		Design as per F.C.R.I.Bangkok		Design by the Project	
		2.9mØ x 1.6m		2.94mØ x 1.6m		2.4mØ x 2.3m		2.2mØ x 2.63m		1.8m x 1.8m x 2.	
		Design No. 5		Design No. 6		Design No. 3		Design No. 4		Design No. 7	
		Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
11. Water depth measurement pipe	5000	1	5 000	-	-	-	-	-	-	1	5 000
12. Filter plate of RCC	3000	1	3 000	1	3 000	1	3 000	1	3 000	1	3 000
13. Filter sand	300	-	300		300		300		300		300
14. Filter gravel	400		400		400		400		400		400
15. Coconut husk for filter	200		200		200		200		200		200
16. Brick or large stone for filter	180		200		200		180		180		200
17. Gutter of galvanized iron sheet 20 cm Ø with F.I. stays	6000	10m	10 000	10m	10 000	10m	10 000	10m	10 000	10m	10 000
18. Rainwater pipe of sheet iron	1000	1/2	1 000	1/2	1 000	1/2	1 000	1/2	1 000	1/2	1 000
19. Water proof epoxy point	20 000	4	10 000	4	10 000	4	10 000	4	10 000	4	10 000

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COMPARATIVE COST ESTIMATES OF 10 M^3 CAPACITY TANKS OF DIFFERENT DESIGNS

ITEM	UNIT RATE	FERRO-CEMENT TANK DESIGN								MASONRY DESIGN	
		As per West Java Project		Design by the Project		Design as per SRI Madras, India		Design as per F.C.R.I.Bangkok		Design by the Project	
		2.9mØ x 1.6m		2.94mØ x 1.6m		2.4mØ x 2.3m		2.2mØ x 2.63m		1.8m x 1.8m x 2.	
		Design No. 5		Design No. 6		Design No. 3		Design No. 4		Design No. 7	
		Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount	Qty	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
20. Mosquito net	220		200		200		200		200		200
21. Nails	500		500		500		500		500		500
22. Planks	Local	Local	Local	Local	Local	Local	Local	Local	Local	Local	Local
23. Bamboo	Local	Local	Local	Local	Local	Local	Local	Local	Local	Local	Local
24. Brick or stone for wall	-	-	-	-	-	-	-	-	-	7.5	Local
25. Plywood for shuttering 1.2X2.4m	3750/Sheet		5250		5250		5250		5250		
26. Brick or stone		Local contribution		Local contribution		Local contribution		Local contribution			Local
Total cost (1 to 26 above)			232 450		376 250		416 530		348 080		235 300
Overhead charges Labour 30% x incentive, transport material etc.			69 735		112 875		124 959		104 424		70 590
T o t a l			302 185		489 125		541 489		452 504		305 890
Reason for variation in cost		Dome roof comparative less reinforcement		Flat roof, More reinforcement		Flat roof, more reinforcement as per structural institute.		Dome roof, more reinforcement		Brick work RC roof excluding cost of brick or stones	

TABLE NO. 1.1 - MONTHLY RAINFALL DATA

IN MM

REGENCY: ALOR

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	193	267	127	126	37	13	-	-	-	14	27	64	868
2.	1970	185	263	183	42	72	67	3	-	-	97	93	532	1.537
3.	1971	289	282	301	256	259	13	13	-	58	434	-	-	1.905
4.	1972	113	223	159	55	69	30	5	-	-	-	132	197	983
5.	1973	405	312	428	135	189	50	4	12	59	3	58	-	1.655
6.	1974	-	118	243	62	4	29	-	1	41	59	198	92	847
7.	1975	233	420	258	177	162	39	31	24	30	144	-	-	1.488
8.	1976	301	193	143	126	29	14	17	-	-	44	26	92	985
9.	1977	324	263	274	52	24	15	8	10	2	-	38	79	1.002
10.	1978	206	235	152	86	40	71	54	22	6	104	108	233	1.317
11.	1979	199	142	120	21	319	31	25	-	-	70	167	119	1.213

Note: Maximum dry period with practically no rain = 7 months.

TABLE NO. 1.2 - MONTHLY RAINFALL DATA

IN MM

REGENCY: BELU

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	192	269	204	-	-	-	-	-	-	-	-	371	1.036
2.	1970	151	207	104	210	199	63	-	-	-	51	153	270	1.408
3.	1971	297	280	264	62	91	43	19	5	37	-	270	180	1.548
4.	1972	130	181	326	76	120	92	-	-	-	-	9	236	1.170
5.	1973	279	277	234	207	78	66	33	30	80	17	205	182	1.688
6.	1974	393	308	188	154	145	85	131	58	56	90	435	197	2.240
7.	1975	159	178	289	182	172	36	-	-	-	-	-	-	1.016
8.	1976	220	138	187	53	18	30	35	16	16	60	139	141	1.053
9.	1977	394	262	288	100	76	59	32	-	10	-	102	225	1.548
10.	1978	253	446	216	90	226	60	143	91	17	42	145	284	1.975
11.	1979	233	225	284	38	101	34	22	-	-	26	27	341	1.331

Note: Maximum dry period with practically no rain = 7 Months.

TABLE NO. 1.3 - MONTHLY RAINFALL DATA

IN MM

REGENCY: ENDE

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	176	253	163	46	38	6	186	7	39	50	-	-	964
2.	1971	727	219	417	33	154	155	169	65	58	189	253	115	2.554
3.	1972	229	132	159	84	48	8	11	3	-	33	29	168	904
4.	1973	275	276	242	220	90	22	89	77	64	132	104	850	2.441
5.	1974	138	239	152	141	21	68	39	7	74	-	346	218	1.443
6.	1975	197	306	328	224	191	122	81	47	235	150	24	290	2.195
7.	1976	360	209	271	63	62	197	65	8	-	51	-	-	1.286
8.	1977	378	288	170	105	74	69	14	36	30	95	-	-	1.259
9.	1978	338	225	203	-	101	153	132	84	62	80	134	433	1.945
10.	1979	259	239	224	69	179	99	39	39	66	51	88	157	1.509

Note: Maximum dry period with practically no rain = 7 Months.

TABLE NO. 1.4 - MONTHLY RAINFALL DATA

IN MM

REGENCY: FLORES TIMUR

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	-	-	-	-	.	-	-	-	-	-	-	81	81
2.	1970	399	199	35	106	92	50	2	-	34	31	90	157	1,195
3.	1971	241	338	202	53	101	-	-	-	-	-	-	133	1,068
4.	1972	52	119	182	37	-	-	-	6	5	-	85	145	712
5.	1973	277	145	144	201	69	-	19	20	24	80	232	-	1,211
6.	1974	404	311	216	80	71	9	35	-	21	69	205	117	1,538
7.	1975	372	377	367	220	106	5	7	21	57	140	-	637	2,209
8.	1976	747	249	293	36	35	-	-	-	-	14	90	130	1,594
9.	1977	366	371	240	75	3	-	-	-	-	-	-	241	1,326
10.	1978	299	454	135	103	70	91	150	13	18	43	166	237	1,779
	Mean	351	285	202	100	61	17	24	7	18	42	96	200	1,404
	Max	747	454	367	220	106	91	150	21	57	140	232	637	2,209
	Min	52	119	35	36	-	-	-	-	-	-	-	-	712

TABLE NO. 1.5 - MONTHLY RAINFALL DATA

IN MM

REGENCY: MANGGARAI

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	433	762	679	283	57	18	16	45	91	78	286	367	3 115
2.	1970	865	897	573	316	196	132	30	21	88	218	527	370	4 233
3.	1971	710	700	856	312	291	62	35	23	126	328	618	260	4 321
4.	1972	225	388	484	206	109	-	-	3	9	145	528	399	2 496
5.	1973	525	435	260	147	125	54	47	21	150	120	260	295	2 439
6.	1974	700	473	248	337	170	70	156	56	340	219	250	286	3 305
7.	1975	425	479	565	467	384	101	54	10	245	270	424	404	3 921
8.	1976	536	223	442	134	89	48	24	45	21	126	267	312	2.267
9.	1977	493	495	464	163	128	51	11	12	39	58	133	373	2 121
10.	1978	632	434	421	215	208	278	136	96	167	228	339	508	3 662
11.	1979	386	763	606	270	260	110	39	17	43	203	226	417	3 346

Note: Maximum dry period with practically no rain = 7 Months.

TABLE NO. 1.6 - MONTHLY RAINFALL DATA

IN MM

REGENCY: KUPANG

MAPOLI (PMG. No. 470)

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1954	-	-	-	-	-	-	-	-	-	-	-	631	631
2.	1955	231	874	32	64	75	25	38	0	0	60	270	75	1 744
3.	1957	303	636	141	5	0	0	65	0	0	0	125	591	1 870
4.	1958	120	372	241	0	0	0	20	0	0	27	92	122	994
5.	1959	275	218	258	146	89	27	0	0	0	27	36	87	1 161
6.	1960	514	427	195	46	74	0	0	0	0	0	38	126	1 420
7.	1961	358	553	78	44	0	0	0	0	0	30	33	67	1 163
8.	1962	668	352	26	75	61	25	29	18	30	69	87	273	1 713
9.	1963	884	656	563	325	138	0	0	0	0	0	0	44	2 610
10.	1964	19	34	410	3	0	0	0	0	0	160	188	120	934
11.	1968	385	726	371	107	226	62	153	60	0	62	90	215	2 457
12.	1969	318	454	146	36	33	133	0	0	0	65	0	361	1 546
13.	1970	156	192	206	166	0	0	0	0	28	11	298	310	1 367
14.	1971	357	705	673	25	0	0	0	0	4	19	163	305	2 251
15.	1972	166	229	234	25	26	7	0	0	0	0	145	126	958
16.	1974	870	826	324	137	31	0	0	0	31	23	187	399	2 828
17.	1975	230	337	365	127	58	0	17	0	21	345	541	506	2 547
18.	1976	805	368	534	0	0	0	0	0	0	4	28	274	2 013
19.	1977	404	592	87	0	0	0	0	0	0	0	0	274	1 357

Note: Maximum dry period with practically no rain = 7 Months

Rainfall data for the years 1956, 1965, 1966, 1967 and 1973 are not available.

TABLE NO. 1.7 - MONTHLY RAINFALL DATA

IN MM

REGENCY: NGADA

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	257	3 608	198	78	57	-	-	-	-	-	-	-	4 198
2.	1970	214	104	81	40	-	-	46	-	-	-	-	-	485
3.	1971	369	342	369	69	200	48	25	20	44	-	-	-	1 486
4.	1972	144	134	212	43	7	-	-	-	-	-	-	124	664
5.	1973	313	210	265	451	287	33	22	21	35	96	337	294	2 346
6.	1974	438	271	239	234	181	-	-	22	69	107	387	132	2 080
7.	1975	436	477	672	549	19	70	26	-	-	-	-	-	2 421
8.	1976	360	209	271	63	63	197	65	8	-	51	-	-	1 286
9.	1977	275	287	245	91	70	36	15	9	28	4	31	340	1 346
10.	1978	429	186	300	99	55	131	134	153	27	25	110	287	1 936
11.	1979	246	213	238	71	114	121	41	66	25	77	142	294	1 648

Note: Maximum dry period with practically no rain = 7 Months.

TABLE NO. 1.8 - MONTHLY RAINFALL DATA

IN MM

REGENCY: SIKKA

WAIOTY-STATION

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1971	----	----	----	----	Data not	available	----	----	----	----	152	191	343
2.	1972	117	133	172	9	0	0	0	0	0	0	32	163	626
3.	1973	256	232	170	368	180	31	31	31	62	132	59	210	1 767
4.	1974	294	295	190	37	22	67	0	0	26	105	151	121	1 308
5.	1975	181	161	208	125	84	30	18	15	16	143	175	0	1 156
6.	1976	463	191	255	29	25	3	8	1	7	0	59	66	1 107
7.	1977	437	308	294	58	29	0	0	1	5	1	11	274	1 222
8.	1978	275	242	159	386	75	135	47	150	14	75	131	149	1 838
9.	1979	256	183	227	34	95	33	4	5	15	43	98	135	1 128
10.	1980	227	210	25	65	22	95	2	0	0	5	74	115	746

Note: Maximum dry period with practically no rain = 7 Months

TABLE NO. 1.9 - MONTHLY RAINFALL DATA

IN MM

REGENCY: SUMBA BARAT

Sl. No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1969	188	332	362	311	170	5	-	-	-	107	138	188	1 801
2.	1970	553	319	383	218	177	41	54	-	118	146	362	434	2 805
3.	1971	345	484	461	177	291	45	41	12	61	166	357	211	2 651
4.	1972	120	290	506	186	90	20	-	-	5	66	204	334	1 821
5.	1973	337	277	273	265	153	41	34	53	121	123	130	156	1 961
6.	1974	521	453	381	178	173	55	9	90	235	170	206	258	2 729
7.	1975	217	239	235	216	196	45	47	36	105	267	293	495	2 391
8.	1976	334	103	236	143	52	10	22	22	23	58	99	207	1 309
9.	1977	446	366	244	87	122	29	-	8	22	13	156	319	1 416
10.	1978	286	441	245	254	156	250	70	50	73	130	289	437	2 681
11.	1979	183	318	431	231	199	67	47	31	53	180	150	387	2 227

Note: Maximum dry period with practically no rain = 7 Months

TABLE NO. 1.10 - MONTHLY RAINFALL DATA

IN MM

REGENCY: SUMBA TIMUR

MAUHAU

No.	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	1954	125	66	76	112	101	8	0	4	30	9	40	242	813
2.	1955	226	98	117	61	63	77	50	0	0	26	148	107	1 009
3.	1956	183	263	108	31	36	73	17	23	0	7	34	303	1 078
4.	1957	149	268	123	21	0	0	32	0	0	0	5	138	736
5.	1958	64	368	130	30	8	8	5	0	0	0	57	48	754
6.	1959	367	173	102	59	203	232	0	0	0	1	8	106	1 241
7.	1960	95	215	144	162	2	0	0	0	2	2	19	170	811
8.	1961	234	251	34	58	20	0	0	0	0	0	0	70	667
9.	1962	247	269	51	102	43	0	5	18	0	0	43	182	1 627
10.	1963	243	194	136	72	31	0	0	0	1	0	0	81	758
11.	1964	69	163	219	8	20	3	0	0	0	60	142	44	728
12.	1965	193	91	190	45	0	0	0	0	0	0	33	105	657
13.	1966	160	226	234	31	5	2	0	0	0	0	29	142	1 166
14.	1967	252	275	216	44	0	0	0	0	2	1	0	164	954
15.	1968	337	264	95	45	135	25	71	15	0	0	10	198	1 195
16.	1969	177	241	147	4	12	55	0	0	0	9	8	193	846
17.	1970	121	136	93	143	7	0	0	0	26	16	38	168	748
18.	1971	142	240	134	72	48	0	0	0	0	43	139	108	926
19.	1972	74	159	153	18	9	0	0	0	0	0	0	68	481
20.	1973	186	212	209	205	95	35	0	31	3	0	115	252	1 344
21.	1974	180	303	197	53	15	0	0	0	0	25	68	126	967
22.	1975	237	91	220	233	185	13	0	6	0	195	108	184	1 436
23.	1976	46	109	304	5	0	0	0	0	0	0	33	91	588
24.	1977	184	256	268	23	2	0	0	0	0	0	11	142	886
25.	1978	227	219	186	90	9	2 193	484	23	0	122	5	2 011	1 240
26.	1979	928	1 947	1 133	296	72	446	0	0	0	46	107	769	619

Note: Maximum dry period with practically no rain = 7 Months

TABLE NO. 1.11 - SUMMARY OF RAINFALL

REGENCY: BELU & NEIGHBOURING AREA

Station Number P3 SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
4001	475	Atapupu	3	12	1 109	1 812	908	79	171	12 Jan 1905
4002	474	Besikama	9	11	1 487	2 357	1 114	541	402	May 1923
4003	474a	Atambua	325	59	1 487	2 294	831	177	207	3 May 1939
4004	474b	Halilulik	400	54	1 227	1 925	678	153	303	Jun 1932
4005	474c	Lahurus	600	46	2 890	7 476	1 041	285	268	Mar 1934
4006	474d	Sukabihanawa	9	33	1 450	2 086	821	488	288	1 May 1939
4007		Betun-Tobaki	50	35	1 357	2 281	909	433	250	29 Nov 1974
4008		Welulik	900	8	1 657	2 429	1 231	136	90	3 Mar 1977
4009		Nenuk-Missi	200	8	1 351	1 477	1 099	153	94	8 Jan 1977
4010		Wedomo	500	5	-	-	-	-	-	-
4011		Boas	100	5	-	-	-	-	344	28 Nov 1974
4012		Besikama (New)	10	3	-	-	-	-	100	1 Jan 1977
4013		Manumuti-Benain	18	2	-	-	-	-	-	-
4014		Oebau	500	2	-	-	-	-	116	30 Nov 1977
4015		Taaba	100	2	-	-	-	-	-	-
4016		Lahurus (New)	514	2	-	-	-	-	123	26 Feb 1978

TABLE NO. 1.11 - SUMMARY OF RAINFALL

REGENCY: BELU & NEIGHBOURING AREA

Station Number P3	Station Number SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
4017			Biodukfoho	415	2	-	-	-	-	200	5 Jan 1978 6 Apr 1978
4018			Sukabitetek	210	2	-	-	-	-	-	-
			Balibo	566	20	1 498	2 319	885	125	470	13 Jan 1959
			Fohorem	599	20	1 502	2 814	161	504	286	16 May 1960
			Lolotaï	794	19	3 184	7 660	1 165	1 199	267	16 May 1960
			Maliana	278	20	2 239	3 014	1 293	323	224	25 Dec 1959
			Maumali	200	7	2 194	3 166	959	273	140	24 Jan 1973
			Nitibe	775	16	1 575	2 964	958	79	279	26 Feb 1968
			Oe-Silo	460	20	1 602	2 344	979	134	302	21 Jan 1966
			Pante Makessar	2	20	1 120	1 783	753	101	197	20 Feb 1968
			Suai	71	20	1 564	1 870	956	539	260	30 Nov 1964

TABLE NO. 1.12 - SUMMARY OF RAINFALL

REGENCY: KUPANG

Station Number P3	Station Number SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
1001		470	Kupang	15	63	1 424	2 224	766	67	197	Feb 1918
1002		470c	Baun	400	29	1 438	2 116	843	76	-	-
1003		470d	Camplong	200	39	1 538	2 942	757	127	174	Jan 1965
1004		470e	Lelogama	900	24	2 958	4 035	2 216	425	187	Dec 1967
1005		470f	OEsao	40	38	1 243	1 782	776	88	123	Dec 1965
1006		470g	Penfui	115	33	1 384	2 027	720	74	186	26 Feb 1976
1007			Bokong	50	25	1 226	1 643	957	126	310	Dec 1975
1008		470	Mapoli-Kupeng	50	24	1 702	2 828	934	127	308	Jan 1891
1009			NoEkele	50	24	1 355	2 283	1 057	68	155	6 Jan 1968
1010			NoElbaki	35	2	-	-	-	-	-	-
1011			Tarus-Oenitu	50	25	1 246	1 545	788	70	178	27 Feb 1978
1012			BuraEn	480	13	1 326	-	-	160	-	-
1013		470y	Pasir Panjang	4	9	1 410	2 063	571	61	-	-
1014			OEkabiti	50	6	1 680	2 400	1 352	54	165	14 Dec 1976
1015			Hueknutu	170	3	-	-	-	-	112	25 Feb 1978

TABLE NO. 1.12 - SUMMARY OF RAINFALL

REGENCY: KUPANG

Station Number P3 SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
1016		Naiklieu	5	2	-	-	-	-	200	9 Mar 1977
1017		Pariti	15	2	-	-	-	-	171	25 Feb 1978
1018		Baun	370	2	-	-	-	-	-	-
1019		Tarus	20	-	-	-	-	-	-	-
1020		Oiletsala	360	2	-	-	-	-	-	-
1021		Nauwen	10	2	-	-	-	-	220	26 Feb 1978
1022	470k	Tubu	320	2	-	-	-	-	125	27 Feb 1978
1023		Naibonat	20	2	-	-	-	-	75	4 Feb 1978
1024		Kumlol	130	19	1 510	1 854	1 019	232	108	12 Mar 1978
1025		Oililak	390	2	-	-	-	-	204	26 Feb 1978
1026		Batuliti	25	1	-	-	-	-	-	-
1027		Oilbioin	310	1	-	-	-	-	96	10 Jan 1978

TABLE NO. 1.13 - SUMMARY OF RAINFALL

REGENCY: T.T.S.

Station Number P3 SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
2001	471	Niki-Niki	800	69	1 345	2 052	843	256	330	Apr 1918
2002	472	Kapan	1 000	63	1 942	2 367	1 404	587	215	Apr 1918
2003	471a	SoE	850	57	1 459	2 562	927	232	209	Apr 1941
2004	471b	Kolbano	25	-	-	-	-	-	-	-
2005	472a	Loli	328	13	1 269	1 882	882	86	195	May 1939
2006	472b	Nunkolo	400	25	2 330	2 688	2 079	1 119	92	24 Jan 1978
2007		Oelbubuk	1 100	25	1 829	2 603	1 181	547	122	30 Nov 1974
2008		Putain	350	25	1 528	2 140	523	734	-	6 Nov 1974
2009		Bena	20	7	-	-	-	391	-	-
2010		Oinlasi	811	22	1 500	1 960	904	489	100	27 Apr 1973
2011		Panite	50	25	848	1 208	540	113	205	25 Nov 1974
2012		Boentuka	160	4	-	-	-	-	96	25 Nov 1978
2013		OEbobo	269	4	-	-	-	-	-	-
2014		Oeoh	280	4	-	-	-	-	116	19 Dec 1975

TABLE No. I.13 - SUMMARY OF RAINFALL

REGENCY: T.T.S.

Station Number P3	Station Number SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
2015			Toineke	16	2	-	-	-	-	-	-
2016			Oebelo	3	3	-	-	-	-	-	-
2017			Noilnoni	420	2	-	-	-	-	-	-
2018			Nifukani	670	2	-	-	-	-	-	-
2019			Polen	330	2	-	-	-	-	-	-
2020			Huetalan	770	2	-	-	-	-	-	-
2021			Fatimnasi	1 470	2	-	-	-	-	-	-
2022			Bati	760	2	-	-	-	-	155	27 Feb 1978
2023			Kolbano (New)	25	2	-	-	-	-	-	-

TABLE NO. 1.14 - SUMMARY OF RAINFALL [illegible] AVAILABLE [illegible]

REGENCY: T.T.U.

Station Number		Station Name	Elev (m)	Period of Record	Mean Annual	Range		Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
P3 SA	PMG					Maximum	Minimum			
3001	473	Noiltoko	550	10	1 474	1 986	1 025	-	100	Oct 1917
3002	473a	Kefamenanu	1 000	54	1 340	3 908	638	203	350	May 1939
3003	473b	Wini	3	9	773	1 454	375	92	185	May 1939
3004	473c	Oelolok	200	45	1 051	1 345	713	189	308	May 1939
3005	473d	Oeluan	600	2	990	-	-	-	76	Dec 1941
3006	473e	Konotuef	300	7	1 229	1 320	1 021	243	120	Feb 1958
3007		Oeminaat	400	10	1 074	1 423	505	153	-	-
3008		Eban	1 000	5	-	-	-	-	100	3 Jan 1975
3009		Kaubele	18	6	-	-	-	-	88	15 Jan 1976
3010		Lurasik	300	6	-	1 887	863	-	210	29 Nov 1974
3011		Sufa	800	6	-	-	-	-	192	1 Dec 1974
3012		Oepuan	-	-	-	-	-	-	-	-
3013		Oenenuk	367	4	-	-	-	-	110	29 Nov 1977
3014		Noemuti	230	4	-	-	-	-	75	26 Nov 1975

TABLE NO. I.14 - SUMMARY OF RAINFALL

REGENCY: T.T.U.

Station Number P3 SA	Station Number PMG	Station Name	Elev (m)	Period of Record	Mean Annual	Range Maximum	Range Minimum	Dry Season (May-Oct)	Daily Max.	Date of Daily Max.
3015		Maubesi	350	4	-	-	-	-	100	8 Jan 1977
3016		Baurasi	600	3	-	-	-	-	165	2 Feb 1978
3017		Ekoni	507	2	-	-	-	-	86	26 Feb 1978
3018		Tapenpah	295	2	-	-	-	-	119	30 Nov 1977
3019		Manufui	388	2	-	-	-	-	117	29 Nov 1977
3020		Fatauhau	580	2	-	-	-	-	114	24 Feb 1977
3021		Teeba	470	2	-	-	-	-	-	-
3022		Fatuoni	20	3	-	-	-	-		-
3023		Timleco	10	5	-	-	-	-	458	27 Feb 1978

TABLE NO. 2 - MEAN TEMPERATURE IN PROJECT AREA, 1976 TO 1978 (^{O}C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
KEFAMENANU												
1976	23.3	23.3	23.5	23.1	22.2	21.5	22.7	23.2	24.8	26.7	27.4	26.4
1977	25.6	25.7	25.0	-	-	22.1	22.2	22.8	24.5	25.9	27.3	26.6
1978	25.0	25.5	26.1									
OEBOBO												
1976	-	27.4	26.8	25.9	-	26.3	24.3	25.3	26.7	27.5	25.7	26.7
1977	28.6	29.0	29.0	28.4	27.4	25.3	24.5	25.2	26.5	20.6	23.1	23.8
1978	24.3	23.7	22.5									
PENFUI												
1976	25.9	26.3	-	27.2	-	-	-	-	26.7	-	28.6	27.2
1977	26.6	26.4	26.4	27.3	-	-	25.2	25.9	-	-	-	-
1978	27.1	26.4	27.6									

TABLE NO. 3 - MONTHLY EVAPORATION (A-PAN) (mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
KEFAMENANU												
1976	-	-	-	-	128	-	-	238	278	-	-	-
1977	-	-	-	149	140	-	-	233	271	327	-	214
1978	174	149	176									
OEBOBO												
1976	-	136	132	-	147	-	-	217	257	-	-	-
1977	-	-	-	-	141	140	220	223	217	269	272	242
1978	140	-	-									

TABLE NO. 4.1 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

10. ALOR REGENCY

NO.	Sub-Regencies	No. of Population	No. of Household
1.	Kopeta Kalabahi	18 716	3 373
2.	Alor Barat Laut	23 096	4 639
3.	Perw. Alor Barat Laut	12 828	3 219
4.	Alor Barat Days	18 223	3 546
5.	Alor Selatan	6 319	1 276
6.	Alor Timur	9 089	1 876
7.	Perw. Alor Timur	6 340	1 309
8.	Pantar	15 274	2 732
9.	Perw. Pantar	15 063	2 643
	T o t a l : -	124 948	24 613

No. of persons per household: 5.07

Source - 1980 Census.

TABLE NO. 4.2 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

4. BELU REGENCY

No.	Sub-Regencies	No. of Population	No. of Household
1.	Kopeta Atambua	9 372	1 476
2.	Tasifeto Barat	17 823	3 215
3.	Perw. Tasifeto Barat	7 242	1 470
4.	Tasifeto Timur	15 699	3 065
5.	Perw. Tasifeto Timur	5 875	1 181
6.	Lamaknen	14 634	3 033
7.	Malaka Barat	38 364	7 418
8.	Perw. Malaka Barat	7 726	1 350
9.	Malaka Timur	20 818	4 287
10.	Perw. Malaka Timur	9 765	1 871
11.	Malaka Tengah	19 547	3 525
12.	Perw. Malaka Tengah	14 208	2 309
	T o t a l : -	181 073	34 200

No. of persons per household : 5.29

Source - 1980 Census.

TABLE NO. 4.3 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

4. ENDE REGENCY

No.	Sub-Regencies	No. of Population	No. of Household
1.	Ende	24 574	3 974
2.	Kopeta Ende	40 802	5 989
3.	Detusoke	15 173	2 861
4.	Perw. Detusoke	9 322	1 880
5.	Meurolle	13 834	2 412
6.	Perw. Meurolle	6 313	1 220
7.	Nanggapande	18 558	2 904
8.	Welewaru	7 788	4 167
9.	Perw. Weleweru. I.	9 098	2 419
10.	Perw. Wolowaru II.	8 409	1 689
11.	Ndona	20 946	3 710
	T o t a l : -	201.609	33 255

No. of persons per household: 6.06

Source - 1980 Census.

TABLE NO. 4.4 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

REGENCY: FLORES TIMUR

No.	Sub-Regencies	No. of Population	No. of Household
1.	Larantuka	21 648	3 382
2.	Perw. Ilemendiri	6 717	1 009
3.	Tanjung Bunga	13 097	2 165
4.	Wuleng Gitang	15 391	2 286
5.	Perw. Wuleng Gitang	8 206	1 400
6.	Solor Timur	12 784	2 437
7.	Adonara Barat	14 026	2 128
8.	Perw. Adonara Barat	5 696	1 027
9.	Adonara Timur	19 818	3 423
10.	Perw. Adonara Timur I.	17 859	3 699
11.	Perw. Adonara Timur II.	11 654	2 422
12.	Perw. Adonara Timur III.	12 050	2 218
13.	Koordinator Lembata	13 854	2 672
14.	Lobatukan	7 701	1 470
15.	Ile Ape	14 461	2 859
16.	Omesuri	13 021	2 141
17.	Atadei	11 397	2 264
18.	Beasuri	15 656	2 657
19.	Solor Barat	13 438	2 207
	T o t a l :-	257 687	43 866

No. of persons per household: 5.87

Source - 1980 Census.

TABLE NO. 4.5 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

1. KUPANG REGENCY

No.	Sub-Regencies	No. of Population	No. of Household
1.	Kupang Utara	31 730	5 026
2.	Kupang Selatan	59 909	9 569
3.	Kupang Barat	26 617	5 711
4.	Kupang Tengah	28 900	5 988
5.	Kupang Timur	29 817	6 152
6.	Amarasi	30 904	6.377
7.	Amfoang Utara	13 023	7 186
8.	Amfoang Selatan	14 187	2 094
9.	Fatuleu	29 428	5 774
10.	Sabu Barat	38 512	8 050
11.	Sabu Timur	16 914	3 619
12.	Lobalain	14 808	3 236
13.	Pantai Baru	8 987	2 025
14.	Rote Barat Daya	16 027	3 370
15.	Rote Tengah	10 346	2 394
16.	Rote Barat Laut	20 758	4 543
17.	Rote Timur	12 161	2 665
	T o t a l:-	403 167	83 779

Number of persons per household: 4.81

Source - 1980 Census.

TABLE NO. 4.6 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

7. MANGGARAI REGENCY

No.	Sub-Regencies	No. of Population	No. of Households
1.	Kopeta Ruteng	25 963	3 662
2.	Ruteng	40 398	7 129
3.	Perw. Ruteng	14 618	2 285
4.	Borong	29 591	4 768
5.	Perw. Borong	25 238	3 901
6.	Cibal	24 097	4 030
7.	Lambaleda	18 310	3 061
8.	Perw. Lambaleda	32 997	5 106
9.	Elar	16 115	2 210
10.	Perw. Elar	14 241	2 225
11.	Satar Mese	32 752	5 385
12.	Lembor	31 444	5 480
13.	Kuwus	25 194	4 200
14.	Perw. Kuwus	15 119	2 667
15.	Reok	16 580	2 705
16.	Komodo	19 236	3 543
17.	Perw. Komodo	15 632	2 438
	T o t a l: -	397 525	64 795

Number of persons per household: 6.13

Source - 1980 Census

TABLE NO. 4.7 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

REGENCY: NGADA

No.	Sub-Regencies	No. of Population	No. of Households
1.	Bajawa	14 417	2 033
2.	Perw. Bajawa	9 453	1 569
3.	Kopeta Bajawa	8 310	1 076
4.	Aimere	15 150	2 550
5.	Aesesa	15 088	2 796
6.	Perw. Aesesa	5 179	369
7.	Boawae	21 897	2 818
8.	Mauponggo	26 086	3 701
9.	Golewa	23 450	3 520
10.	Nangaroro	19 597	2 792
11.	Riung	13 948	2 221
	T o t a l : -	172 575	25 445

No. of persons per household: 6.54

Source - 1980 Census

TABLE NO. 4.8 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

6. SIKKA REGENCY

No.	Sub-Regency	No. of Population	No. of Households
1.	Maumere	24 545	4 437
2.	Perw. Maumere	11 117	1 958
3.	Kopeta Maumere	26 706	4 219
4.	Tali Bura	18 014	3 116
5.	Perw. Tali Bura	14 219	2 293
6.	Lela	11 305	1 843
7.	Paga	23 694	3 941
8.	Perw. Paga	9 320	1 624
9.	Bola	25 257	3 830
10.	Nita	23 718	4 032
11.	Kewapante	31 761	4 897
	T o t a l : -	219 656	36 190

No. of persons per household : 6.06

Source - 1980 Census

TABLE NO. 4.9 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

9. SUMBA BARAT REGENCY

No.	Sub-Regencies	No. of Population	No. of Households
1.	Loli	18 133	3 261
2.	Kpeta Waikabubak	6 714	854
3.	Bratama	14 200	2 270
4.	Perw. Tanah Righu	19 097	1 431
5.	Kodi	33 822	5 754
6.	Perw. Kodi	13 842	2 547
7.	Wewewa Barat	35 203	5 424
8.	Wewewa Timur	31 210	4 967
9.	Perw. Wewewa Timur	8 036	1 308
10.	Walakala	13 335	2 738
11.	Perw. Walakala	9 255	1 884
12.	Katskutana	21 743	3 589
13.	Perw. Umbu Ratunggai	7 511	1 384
	T o t a l :-	232 101	37 411

Number of persons per household : 6.20

Source - 1980 Census

TABLE NO. 4.10 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

8. SUMBA TIMUR REGENCY

No.	Sub-Regency	No. of Population	No. of Households
1.	Pandawai	17 538	3 640
2.	Perw. Pandawai	7 217	1 308
3.	Kopeta Waingapu	22 893	3 674
4.	Kindi Umalulu	15 039	2 923
5.	Pahunga Lodu	11 411	2 324
6.	Paberiwai	14 574	3 119
7.	Perw. Paberiwai	6 692	1 170
8.	Tabundung	10 662	2 011
9.	Lewa	16 946	3 051
	T o t a l :-	123 073	23 220

Number of persons per household: 5.30

Source - 1980 Census

House-less family not included.

TABLE NO. 4.11 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

2. T.T.S. REGENCY

No.	Sub-Regency	No. of Population	No. of Households
1.	Amanuban Barat	18 656	4 117
2.	Perw. Amanuban Barat	7 347	1 691
3.	Kopeta So E	14 794	2 484
4.	Amanuban Selatan	25 656	5 224
5.	Perw. Amanuban Selaten	20 121	4 128
6.	Amanuban Tengah	33 314	7 068
7.	Amanuban Timur	28 612	6 390
8.	Perw. Amanuban Timur	17 848	3 955
9.	Amanatun Selatan	26 197	5 380
10.	Perw. Amanatun Selatan	17 174	3 511
11.	Amanatun Utara	23 649	4 443
12.	Mollo Selatan	14 584	3 111
13.	Perw. Mollo Selatan	9 253	1 866
14.	Mollo Utara	18 255	5 953
15.	Perw. Mollo Utara	14 195	2 644
	T o t a l:-	289 655	61 965

Number of persons per household: 4.67

Source - 1980 Census

TABLE NO. 4.12 - REGENCY-WISE NUMBER OF PERSONS PER HOUSEHOLD

3. TIMOR TENGAH UTARA REGENCY

No.	Sub-Regency	No. of Population	No. of Households
1.	Momafo Timur	31 103	6 015
2.	Perw. Momafo Timur	10 216	2 039
3.	Kopeta Kafemenanu	12 976	2 270
4.	Mimafo Barat	23 702	4 445
5.	Biboki Utara	8 950	1 763
6.	Perw. Biboki Utara	5 664	1 190
7.	Biboki Selatan	12 603	2 565
8.	Insana	21 312	4 407
9.	Perw. Insana	7 475	1 463
	T o t a l: -	134 092	26 157

No. of persons per household: 5.12

Source - 1980 Census

TABLE NO. 5 - RAINFALL STATISTICS OF VARIOUS REGENCIES

Regency	Station	No. of years of data	Mean annual rainfall (mm)	Standard deviation
Sumba Timur	Mauhau	26	839.78	245.89
Kupang	Mapoli	18	1 717.28	610.21
Sikka	Waioti	9	1 242.56	393.8
Flores Timur	Larantuka	9	1 402.44	476.33
Ngada	-	11	1 800.73	996.14
Manggarai	-	11	3 220.55	742.86
Ende	-	9	1 726.22	578.71
Alor	-	11	1 265.18	350.19
Sumba Barat	-	11	2 167.64	536.57
Belu	Atambua	21	1 451.62	364.81*

*Monthly data is listed for 11 years only.

SPATIAL AVERAGE AND STANDARD DEVIATIONS

Regency	No. of stations	Spatial Mean	Standard deviation
Kupant	14	1 531.43	436.31
Belu	18	1 694.06	572.92
T.T.S.	9	1 561.11	427.76
T.T.U.	7	1 133.00	234.02

TABLE NO. 6.1 - AVERAGE PER CAPITA RAINWATER AVAILABLE

REGENCY: ALOR

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	4.98	7.47	9.96	12.45
1971	11.35	17.03	22.7	28.38
1972	3.66	5.49	7.32	9.15
1973	8.63	12.94	17.25	21.56
1974	3.52	5.27	7.03	8.79
1975	7.5	11.25	15.0	18.75
1976	4.16	6.24	8.32	10.4
1977	5.13	7.7	10.27	12.83
1978	5.88	8.82	11.76	14.71
1979	6.18	9.27	12.36	15.45

TABLE 6.2

REGENCY: BELU

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	7.03	10.54	14.06	17.57
1971	7.63	11.44	15.26	19.07
1972	5.19	7.78	10.38	12.97
1973	8.11	12.17	16.23	20.28
1974	10.36	15.54	20.73	25.91
1975	5.65	8.47	11.3	14.12
1976	4.25	6.37	8.5	10.62
1977	6.82	10.23	13.64	17.05
1978	9.1	13.65	18.2	22.75
1979	5.93	8.9	11.87	14.83

TABLE NO. 6.3 - AVERAGE PER CAPITA RAINWATER AVAILABLE

REGENCY: ENDE

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970		Not available		
1971		Not available		
1972	3.96	5.59	7.93	9.91
1973	8.19	12.29	16.39	20.48
1974	9.66	14.5	19.33	24.16
1975	9.89	14.83	19.78	24.72
1976	7.34	11.01	14.68	18.35
1977	5.86	8.8	11.73	14.66
1978	7.04	10.56	14.08	17.61
1979	8.31	12.47	16.63	20.78

TABLE NO. 6.4 - AVERAGE PER CAPITA RAINWATER AVAILABLE
FLORES TIMUR REGENCY - LARANTUKA STATION

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	5.21	7.82	10.42	13.03
1971	5.09	7.63	10.17	12.72
1972	2.88	4.32	5.77	7.21
1973	6.32	9.48	12.64	15.8
1974	6.62	9.93	13.24	16.55
1975	8.33	12.5	16.66	20.83
1976	9.79	14.68	19.57	24.46
1977	5.52	8.28	11.04	13.8
1978	8.3	12.46	16.61	20.76

TABLE NO. 6.5 - AVERAGE PER CAPITA RAINWATER AVAILABLE
KUPANG REGENCY - MAPOLI STATION

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1955	10.71	16.07	21.42	26.78
1956	Data	Not Available		
1957	Data	Not Available		
1958	6.81	10.22	13.63	17.03
1959	5.58	8.37	11.16	13.95
1960	6.43	9.65	12.86	16.08
1961	5.69	3.54	11.38	14.23
1962	7.02	10.53	14.04	17.55
1963	13.22	19.83	26.45	33.06
1964	4.00	5.99	7.99	9.99
1965	Data	Not Available		
1966	Data	Not Available		
1967	Data	Not Available		
1968	Data	Not Available		
1969	6.52	9.78	13.04	16.3
1970	6.6	9.91	13.21	16.51
1971	10.51	15.76	21.01	26.27
1972	5.3	7.94	10.59	13.24
1973	Data	Not Available		
1974	Data	Not Available		
1975	11.36	17.05	22.73	28.41
1976	10.46	15.68	20.91	26.14
1977	6.32	9.48	12.64	15.8

TABLE NO. 6.6 - AVERAGE PER CAPITA RAINWATER AVAILABLE

REGENCY: MANGGARAI

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	19.7	29.55	39.4	49.25
1971	20.59	30.89	41.18	51.48
1972	10.98	16.47	21.96	27.44
1973	11.84	17.77	23.69	29.61
1974	15.44	23.15	30.87	38.59
1975	17.28	25.92	34.56	43.2
1976	10.99	16.48	21.97	27.47
1977	10.99	16.48	21.97	27.47
1978	16.43	24.64	38.85	41.07
1979	15.51	23.27	31.03	38.79

TABLE NO. 6.7

REGENCY: NGADA

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	2.26	3.39	4.52	5.65
1971	6.92	10.38	13.84	17.30
1972	2.52	3.77	5.29	6.29
1973	10.22	15.33	20.44	25.55
1974	10.45	15.67	20.89	26.12
1975	11.09	16.63	22.18	27.72
1976	5.99	8.99	11.99	14.99
1977	5.08	7.62	10.16	12.7
1978	9.26	13.9	18.53	23.16
1979	7.64	11.46	15.29	19.11

TABLE NO. 6.8 - AVERAGE PER CAPITA RAINWATER AVAILABLE
SIKKA - REGENCY - WAIOTI

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1972	3.05	4.57	6.09	7.62
1973	7.99	11.98	15.98	19.97
1974	6.51	9.76	13.01	16.27
1975	5.95	8.92	11.9	14.87
1976	4.85	7.27	9.7	12.12
1977	5.64	8.45	11.27	14.09
1978	9.14	13.71	18.29	22.86
1979	5.32	7.98	10.64	13.3
1980	4.01	6.01	8.01	10.01

TABLE NO. 6.9

REGENCY: SUMBA BARAT

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1970	11.92	17.88	23.84	20.8
1971	13.39	20.08	26.77	33.47
1972	7.91	11.86	15.82	19.77
1973	9.97	14.96	19.94	24.93
1974	12.24	18.35	24.47	30.59
1975	10.03	15.05	20.06	25.08
1976	7.44	11.16	14.88	18.6
1977	7.92	11.88	15.84	19.79
1978	11.94	17.91	23.97	29.54
1979	10.84	16.26	21.68	27.1

TABLE NO. 6.10 - AVERAGE PER CAPITA RAINWATER AVAILABLE

SUMBA TIMUR REGENCY - MAUHAU

Year	Possible litres per capita supply			
	Assumed roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2
1954-55	5.16	7.74	10.32	12.9
1956	4.11	6.16	8.22	10.27
1957	4.2	6.29	8.39	10.49
1958	3.76	5.64	7.53	9.41
1959	5.56	8.33	11.11	13.89
1960	3.48	5.22	6.96	8.7
1961	3.57	5.36	7.14	8.93
1962	3.95	5.92	7.9	9.87
1963	4	6	8	10
1964	3.56	5.34	7.13	8.91
1965	2.78	4.16	5.15	6.94
1966	3.69	5.53	7.38	9.22
1967	4.34	6.51	8.68	10.85
1968	5.41	8.11	10.81	13.52
1969	3.96	5.95	7.93	9.91
1970	3.6	5.4	7.2	9.0
1971	4.59	6.89	9.18	11.48
1972	2.43	3.64	4.85	6.07
1973	5.4	8.1	10.8	13.5
1974	5.09	7.64	10.18	12.75
1975	6.59	9.88	13.17	16.46
1976	3.17	4.76	6.34	7.93
1977	3.89	5.83	7.78	9.72
1978	5.5	8.24	10.99	13.74
1979	3.56	5.33	7.11	8.89

TABLE NO. 7.1 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: ALOR

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	$2\ m^2$	$3\ m^2$	$4\ m^2$	$5\ m^2$	$2\ m^2$	$3\ m^2$	$4\ m^2$	$5\ m^2$
1970	630.36	452.35	449.8	447.25	419.2	360.35	357.8	355.25
1971	467.2	395.85	370.6	349.5	345.2	301.70	279.6	257.5
1972	-	664.55	646	588.25	-	522.75	493	470.75
1973	598.8	438.6	349.8	242.0	394.4	293.1	226.8	180.0
1974	736.8	573.75	510.0	470.5	522.8	420.75	376.4	347.5
1975	429.4	293.8	188.4	150	277.2	171.8	120	120
1976	849	738.5	628	517.5	635	524.7	414	356.25
1977	966.7	840.1	740.2	669.25	722.7	609.65	535.4	485.25
1978	440.7	272.85	209.8	186	283.9	172.6	148.8	125
1979	550.8	467.2	419.6	372	397.8	345.2	297.6	261.75

TABLE NO. 7.2 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: BELU

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1970	571.3	484.95	460	460	418.2	368	368	368
1971	633.1	499.8	411.4	355.75	419.1	346.8	284.6	232.75
1972	749.7	742.05	734.4	726.75	596.7	589.05	581.4	573.75
1973	403.2	207	97.2	82.75	227.8	84	66.2	51.75
1974	113.2	15.2	0	0	50.2	0	0	0
1975	853.8	823.2	792.6	765	670.8	640.2	612	612
1976	682.4	488.6	374	276.25	468.4	318.75	221	123.28
1977	619.1	507.9	472.2	436.5	440.5	384.9	349.2	325.5
1978	164.9	154.55	105.2	77.75	143.7	93.55	62.2	47.75
1979	798.4	637.05	544.4	451.75	554.4	458.05	361.4	293.25

TABLE NO. 7.3 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: ENDE

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1972	-	733.4	629.4	558.5	-	519.4	450.4	394.5
1973	183.5	93.9	75.2	56.5	82.6	63.9	45.2	26.5
1974	481.1	387.05	209.4	155	380.7	208.05	124	124
1975	109.2	88.8	68.4	48	79.2	58.8	38.4	18
1976	554.2	459.55	409.4	360	401.2	337.55	287.4	238
1977	529.4	318.75	188	150	317.2	165.75	120	120
1978	232.2	155	155	155	140.2	124	124	124
1979	283.5	117.75	44.8	0	160.6	49.1	0	0

TABLE NO. 7.4 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED
FLORES TIMUR - LARANTUKA STATION

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1970	644.3	466.65	387	330.25	413.1	321.15	264.2	239.5
1971	958.2	915	915	915	732	732	732	732
1972	993.9	947.6	906.8	873.25	774.4	733.6	696.6	689.25
1973	559.6	449.35	395.8	342.25	387.6	327.35	273.8	220.25
1974	585.5	444.25	389	333.75	384.2	322.25	267	211.75
1975	524	380.5	347.8	320.25	341.0	283.85	255.8	228.25
1976	925.5	853.25	781	711.75	711.5	639.25	569.4	552.5
1977	1087.4	1062.35	1059.8	1057.25	850.9	848.35	845.8	843.25
1978	334.2	271.3	208.4	173.25	242.1	173.3	138.6	112.25

TABLE NO. 7.5 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA
REGENCY - KUPANG - MAPOLI STATION

Year	Storage in litres for							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1955	725.2	451.35	395.8	342.25	480.2	327.35	273.8	244.0
1958	990.1	950.15	910.2	870.25	776.1	736.15	696.2	656.25
1959	765.7	685.5	609.0	535.5	579.0	502.5	428.4	382.5
1960	958.5	818.1	785.8	765.0	707.4	635.1	612.0	612.0
1961	1 060.5	947.15	856.2	802.25	794.1	703.15	614.8	612.0
1962	591.3	349.9	263.2	176.5	413.9	227.9	141.2	62.0
1963	919.0	915.0	915.0	915.0	732.0	732.0	732.0	732.0
1964	909.9	907.35	904.8	902.25	726.6	724.35	721.8	719.25
1969	766.1	599.25	544.0	488.75	522.1	447.0	391.0	335.75
1970	853.7	820.55	787.4	754.25	669.7	636.55	603.4	570.25
1971	988.4	947.6	906.8	866.0	774.4	733.6	692.8	652.0
1972	971.4	922.1	872.8	823.5	877.4	708.1	658.8	629.5
1975	601.8	520.2	480.8	448.5	448.8	391.2	358.8	326.5
1976	1 165.6	1 138.4	1 111.2	1 048.0	921.6	894.4	867.2	840.0
1977	1 072.1	998.15	924.2	850.25	828.1	754.15	680.2	606.25

TABLE NO. 7.6 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: MANGGARAI

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1970	223.7	179.95	136.6	93.25	191.3	117.95	74.6	34.75
1971	256	162.1	112.8	63.5	164	100.1	50.8	26.25
1972	589.6	579.4	569.2	559	467.6	457.4	447.2	437.0
1973	256.6	148.9	83.6	65.75	160.6	74.6	52.3	34.75
1974	90.8	12.2	0	0	28.2	0	0	0
1975	201.2	146.8	121	112.5	139.2	98.5	90	81.5
1976	375.4	258.1	154	77.5	253.4	138.5	62.0	30.75
1977	473.3	328.95	249.2	212.25	321.3	209.9	169.8	150.25
1978	0	0	0	0	0	0	0	0
1979	291.7	207.55	123.4	82.75	199.7	115.55	66.2	51.75

TABLE NO. 7.7 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: NGADA

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1970	-	-	-	875.4	-	-	699.6	660.5
1971	682.1	565.65	457.4	386.75	499.1	385.05	309.4	244
1972	-	-	1 205	1 195	-	-	986.2	950.25
1973	423.1	326.95	232.6	138.25	299.3	204.95	110.6	65.25
1974	455.3	403.9	385.2	366.5	333.3	311.9	293.2	274.5
1975	874.5	776.45	679	654.5	660.5	562.74	523	501.5
1976	554.2	459.55	409.4	359.25	401.2	337.55	287.4	237.25
1977	741.9	601.35	496.8	395.25	527.9	418.35	316.2	254
1978	216.6	172.4	128.2	84.75	155.6	111.4	67.2	23.0
1979	259.7	123.4	65	44	143.6	56.25	35	14

TABLE NO. 7.8 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA
SIKKA REGENCY - AT WAIOTI

Year	Storage in litres for:							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1972	-	-	1 080.6	1 045.75	-	871.45	836.6	817.75
1973	346.5	222.85	143.8	64.75	224.5	130.85	51.8	0
1974	656.6	527.4	398.2	349.5	473.6	344.4	279.6	257.5
1975	487.9	408.55	336.4	247.25	353.7	286.55	219.4	159.75
1976	-	1 038.4	926.2	814.5	875.6	763.4	651.2	549.0
1977	1 048.3	952.25	910.2	870.25	809.3	736.15	696.2	655.5
1978	153.7	114.3	102.4	90.5	96.2	84.3	72.4	60.5
1979	680.7	510	425.2	367.75	466.7	357	294.2	266.0
1980	-	603.8	591.2	585.25	616.2	474.15	468.2	462.25

TABLE NO. 7.9 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

REGENCY: SUMBA BARAT

Year	Storage in litres for							
	5 L P C D				4 L P C D			
	Roof area per capita				Roof area per capita			
	2 m^2	3 m^2	4 m^2	5 m^2	2 m^2	3 m^2	4 m^2	5 m^2
1970	298.5	217.75	155	155	206.5	125.75	124	124
1971	339.7	174.85	129.8	104	217.7	118.1	83.2	73
1972	530.3	546.25	525.0	503.75	457.3	424.25	403.0	381.75
1973	242.4	133.6	50	5.5	150.4	52.75	8.4	0
1974	198.2	141.8	124.4	116.25	135.2	101.05	93.4	85.75
1975	242.4	133.6	32.6	0	150.4	41.6	1.6	0
1976	402.5	296.25	232.2	175.25	279.5	197.15	140.2	83.25
1977	612.6	581.45	520.2	450.25	489.6	428.4	367.2	309.25
1978	131.9	27.5	0	0	44	0	0	0
1979	273.4	125.96	49.6	0	151.4	49.1	18.6	0

TABLE 7.10 - YEAR-WISE GROSS STORAGE CAPACITY REQUIRED PER CAPITA

STATION: SUMBA TIMUR

Year	Storage in litres for:								Total R.F. mm
	5 LPCD				4 LPCD				
	RA. 2 m^2	3 m^2	4 m^2	5 m^2	RA. 2 m^2	3 m^2	4 m^2	5 m^2	
1954-55	599.1	421.2	371.6	349.5	385.1	301.7	279.6	257.5	1 108
1955-56	-	656.45	444.6	423.75	600.3	412.45	232	292.25	882
1956-57	-	1 072.1	1 022.8	973.5	877.4	828.1	778	729.5	901
1957-58	-	944.6	896.6	853.25	-	725.95	682.6	646.75	808
1958-59	823.1	775.05	742.9	726.75	643.1	590.65	581.4	573.75	1 193
1959-60	-	1 006.25	985	963.75	-	792.25	771	749.75	747
1960-61	-	1 089.4	1 002	985	-	814.4	788	771	767
1961-62	-	792.05	699.4	667.25	-	574.05	533.8	514.25	848
1962-63	-	988.4	961.2	934	803.2	778.4	747.2	727.75	859
1963-64	-	837.95	809.6	783.25	-	652.95	626.6	600.25	765
1964-65	-	-	963.2	929.75	-	788.9	743.8	715.75	596
1965-66	-	1 049.15	992.2	706.25	-	921.15	753.2	706.25	792
1966-67	-	1 100.15	1 065.2	1 057.25	896.1	856.15	845.8	843.25	932
1967-68	709.3	606.45	525.0	503.75	488.05	424.25	403	381.75	1 161
1968-69	-	995.6	920.8	846	-	755.6	676.8	602	851
1969-70	-	848.15	774.15	700.5	-	634.15	569.4	527.75	773
1970-71	-	687.95	619	610	581.3	503.95	488	488	986
1971-72	-	-	1 128.2	1 105.25	-	-	886.2	861.25	521
1972-73	647.7	589.05	530.4	471.75	494.7	436.05	377.4	347.5	1 159
1973-74	886.40	433.35	784	750	702.3	634	600	566	1 093
1974-75	577.7	561.55	545.4	529.25	455.7	439.55	423.4	407.25	1 414
1975-76	-	-	1 090.8	801	-	879.1	846.8	834.75	681
1976-77	-	1 128.2	1 097.6	1 067	-	884.2	853.6	823.0	835
1977-78	614.38	539.07	473.32	439.15	461.38	385.49	351.32	317.15	1 180.9
1978-79	-	813.17	712.9	699.97	-	579.25	559.98	546.97	763.4

TABLE NO. 8:1 - ABSTRACT OF STORAGE REQUIREMENT FOR DIFFERENT DEPENDABILITY

Regency	Station	Depend-ability	Per capita storage in litres with							
			Supply 5 LPCD				Supply 4 LPCD			
			Roof area				Roof area			
			$2m^2$	$3m^2$	$4m^2$	$5m^2$	$2m^2$	$3m^2$	$4m^2$	$5m^2$
Sikka	Wioty	100%	x	x	1 081	1 046	876	871	837	818
		88.9%	x	1 038	926	870	809	763	696	656
		77.8%	x	952	910	815	616	736	651	549
Sumba Barat		100%	612	581	525	504	490	428	403	382
		90%	530	546	520	459	457	424	367	309
		80%	340	296	232	175	280	197	140	124
Belu		100%	854	823	793	765	671	640	612	612
		90%	798	637	734	727	597	589	581	574
		80%	750	742	544	452	554	458	368	368
Alor		100%	x	840	740	669	x	610	535	485
		90%	967	739	646	588	723	525	493	471
		80%	849	665	510	471	635	523	414	355
Ende		100%	x	733	629	559	x	519	450	395
		90%	554	460	409	360	401	338	287	238
		80%	529	387	209	155	381	208	124	124
Manggarai		100%	590	579	569	559	468	457	447	437
		90%	473	329	249	212	321	210	170	150
		80%	375	258	154	113	253	139	90	82
Ngada		100%	x	x	x	1 195	661	563	986	950
		90%	x	x	1 205	874	528	418	700	661
		80%	875	778	679	855	499	385	523	502
Sumba Timur	Mauhau	100%	x	x	1 128	1 105	x	x	886	861
		96%	x	x	1 098	1 067	x	921	854	843
		92%	x	x	1 091	1 057	x	884	847	835
		88%	x	1 128	1 065	985	x	879	846	823
		84%	x	1 100	1 021	974	x	856	788	771
		80%	x	1 049	992	974	x	828	778	750

TABLE NO. 8.1 - ABSTRACT OF STORAGE REQUIREMENT FOR DIFFERENT DEPENDABILITY

Regency	Station	Depend-ability	Per capita storage in litres with							
			Supply 5 LPCD				Supply 4 LPCD			
			Roof area				Roof area			
			$2m^2$	$3m^2$	$4 m^2$	$5m^2$	$2m^2$	$3m^2$	$4m^2$	$5m^2$
Kupang	Mapoli	100%	1 166	1 138	1 111	1 084	922	894	867	840
		93.3%	1 072	998	924	915	877	754	732	732
		86.7%	1 061	950	915	902	828	736	722	719
		80%	990	948	910	870	776	734	696	656
Flores Timur	Larantuka	100%	1 087	1 062	1 060	1 057	851	848	846	843
		88.9%	994	948	915	915	774	734	732	732
		77.8%	958	915	907	873	732	732	699	689

TABLE NO. 8.2 - STORAGE ANALYSIS FOR 5 LPCD

Conditions	Sikka	Sumba Barat	Belu	Sumba Timur	Kupang	Flo-res Timur	Alor	Ende	Mang-garai	Ngada
90% dependable storage from $4m^2$ area in litres	941	520	734	1 078	920	929	464	409	249	1 205
Adjustment for daily flow variations 7%	66	36	51	75	64	65	45	29	17	84
5% for evapn. and leakage	47	26	37	54	46	46	32	20	12	60
Total storage per capita in litres	1 054	582	822	1 207	1 030	1 040	723	458	278	1 349

TABLE NO. 8.3 - STORAGE ANALYSIS FOR 4 LPCD

90% dependable storage for $4m^2$ area in litres	710	367	581	847	727	743	493	287	170	700
Adjustment for daily flow variations 7%	50	26	41	59	51	52	35	20	12	49
5% for evapn. and leakage losses	36	18	29	42	36	37	25	14	9	35
Total storage per capita in litres	796	411	651	948	814	832	553	321	191	784

TABLE NO. 9 - STORAGE REQUIREMENT BASED ON DAILY RAINFALL DATA
REGENCY - SUMBA TIMUR STATION - MAUHAU

DECEMBER 1976 - NOVEMBER 1977					
Month	Date	Rainfall mm	Available water from $4m^2$ roof area (in flow)	Withdrawal at the rate of 4 LPCD (outflow)	Sequent peak (S)
(1)	(2)	(3)	(4)	(5)	(6)
Dec. 1976	1-3	0	0	12	12
	4	7	23.8	4	0
	5	15	51.0	4	0
	6	10	34.0	4	0
	7	13	44.2	4	0
	8-11	0	0	16	16
	12	5	17	4	3
	13	3	10	4	0
	14-16	0	0	12	12
	17	25	85	4	0
	18	5	20	4	0
	19-30	0	0	48	48
	31	8	27.2	4	24.8
Jan. 1977	1	2	6.8	4	22
	2	0	0	4	26
	3	36	122.4	4	0
	4	22	74.8	4	0
	5	0	0	4	4
	6	5	17	4	0
	7	9	30.6	4	0
	8	4	13.6	4	0
	9-11	0	0	12	12
	12	3	10.2	4	5.8
	13	7	23.8	4	0
	14	1	3.4	4	0.6
	15-17	0	0	12	12.6
	18	6	20.4	4	0
	19	5	17.0	4	0
	20-24	0	0	20	20
	25	35	119.0	4	0
	26	21	71.4	4	0
	27-28	0	0	8	8
	29	2	6.8	4	5.2
	30	4	13.6	4	0
	31	22	74.8	4	0

TABLE NO. 9 - STORAGE REQUIREMENT BASED ON DAILY RAINFALL DATA
REGENCY - SUMBA TIMUR STATION - MAUHAU

(1)	(2)	(3)	(4)	(5)	(6)
Feb. 1977	1-3	0	0	12	12
	4	7	23.8	4	0
	5-6	0	0	8	8
	7	1	3.4	4	8.6
	8	17	57.8	4	0
	9	28	95.2	4	0
	10	0	0	4	4
	11	23	78.2	4	0
	12	30	102	4	0
	13	0	0	4	4
	14	13	44.2	4	0
	15	14	47.6	4	0
	16	39	132.6	4	0
	17	1	3.4	4	0.6
	18	1	3.4	4	1.2
	19-20	0	0	8	9.2
	21	1	3.4	4	9.8
	22	1	3.4	4	10.4
	23	0	0	4	14.4
	24	2	6.8	4	11.6
	25	0	0	4	15.6
	26	23	78.2	4	0
	27	2	6.8	4	0
	28	53	180.2	4	0
Mar. 1977	1	65	221	4	0
	2	1	3.4	4	0.6
	3	13	44.2	4	0
	4	0	0	4	4
	5	3	10.2	4	0
	6	1	3.4	4	0.6
	7	2	6.8	4	0
	8	63	214.2	4	0
	9	5	17	4	0

TABLE NO. 9 - STORAGE REQUIREMENT BASED ON DAILY RAINFALL DATA
REGENCY - SUMBA TIMUR STATION - MAUHAU

(1)	(2)	(3)	(4)	(5)	(6)
Mar. 1977	10	11	37.4	4	0
	11	9	30.6	4	0
	12-14	0	0	12	12
	15	7	23.8	4	0
	16-19	0	0	16	16
	20	2	6.8	4	13.2
	21	1	3.4	4	12.8
	22	53	173.4	4	0
	23	13	44.2	4	0
	24	1	3.4	4	0.6
	25-31	0	0	28	28.6
Apr. 1977	1	1	3.4	4	29.2
	2	1	3.4	4	29.8
	3	3	10.2	4	23
	4	5	17.0	4	10
	5	0	0	4	14
	6	2	6.8	4	11.2
	7-11	0	0	20	31.2
	12	9	36.6	4	0
	13-17	0	0	20	20
	18	2	6.8	4	17.2
Apr. 1977	19 to	0	0	160	177.2
May 1977	28				
	29	2	6.8	4	169.4
	30				
Nov. 1977	29	0	0	736	905.4 #
	30	11	37.4	4	872.0
Dec. 1976	1-3	0	0	12	884
	4	7	23.8	4	864.2
	5	15	51.0	4	817.2
	6	10	34.0	4	787.2
	7	13	44.2	4	747.0
	8-11	0	0	16	763
	12	5	17	4	750
	13	3	10	4	744

TABLE NO. 9 - STORAGE REQUIREMENT BASED ON DAILY RAINFALL DATA
REGENCY - SUMBA TIMUR STATION - MAUHAU

(1)	(2)	(3)	(4)	(5)	(6)
Dec. 1976	14-16	0	0	12	756
	17	25	85	4	675
	18	5	20	4	659
	19-30	0	0	48	707
	31	8	27.2	4	683.8
Jan. 1977	1	2	6.8	4	681.0
	2	0	0	4	685.0
	3	36	122.4	4	562.6
	4	22	74.8	4	491.8
	5	0	0	4	495.8
	6	5	17	4	482.8
	7	9	30.6	4	456.2
	8	4	13.6	4	446.6
	9-11	0	0	12	458.6
	12	3	10.2	4	452.4
	13	7	23.8	4	432.6
	14	1	3.4	4	433.2
	15-17	0	0	12	445.2
	18	6	20.4	4	428.8
	19	5	17.0	4	415.8
	20-24	0	0	20	435.8
	25	35	119.0	4	320.8
	26	21	71.4	4	253.4
	27-28	0	0	8	261.4
	29	2	6.8	4	258.6
	30	4	13.6	4	249.0
	31	22	74.8	4	178.2
Feb. 1977	1-3	0	0	12	190.2
	4	7	23.8	4	170.4
	5-6	0	0	8	178.4
	7	1	3.4	4	179.0
	8	17	57.8	4	125.2
	9	28	95.2	4	34
	10	0	0	4	38
	11	23	78.2	4	0
	12	30	102	4	0
	13	0	0	4	4

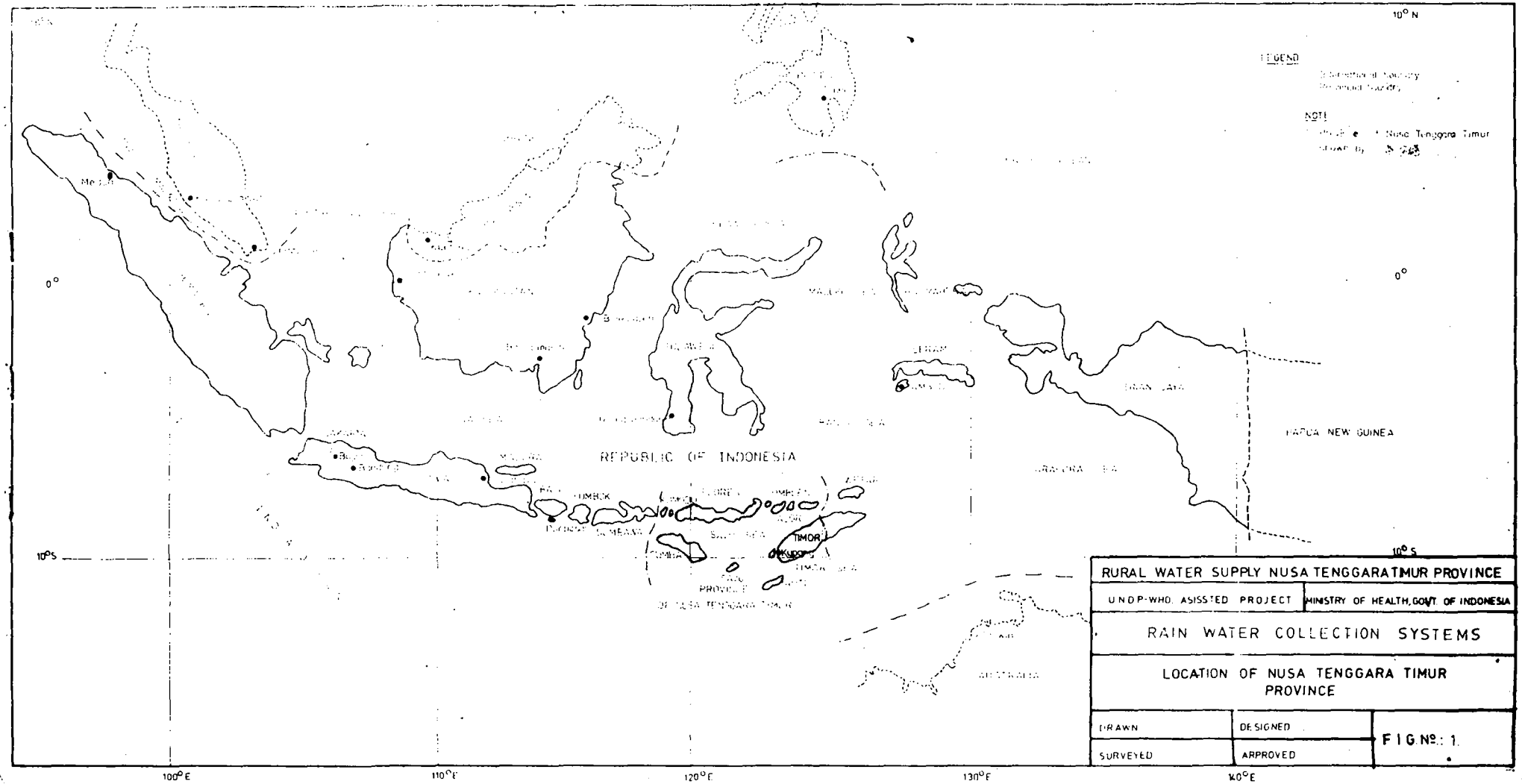
Stop S- value Repeat
Storage required = 905.4 litres
as against 853.6 litres based on monthly

NOTE: 1. Sequent peak is calculated by aquation S(I+1) = S(I) + outflow (I) - Inflow (I) with S(o) = 0

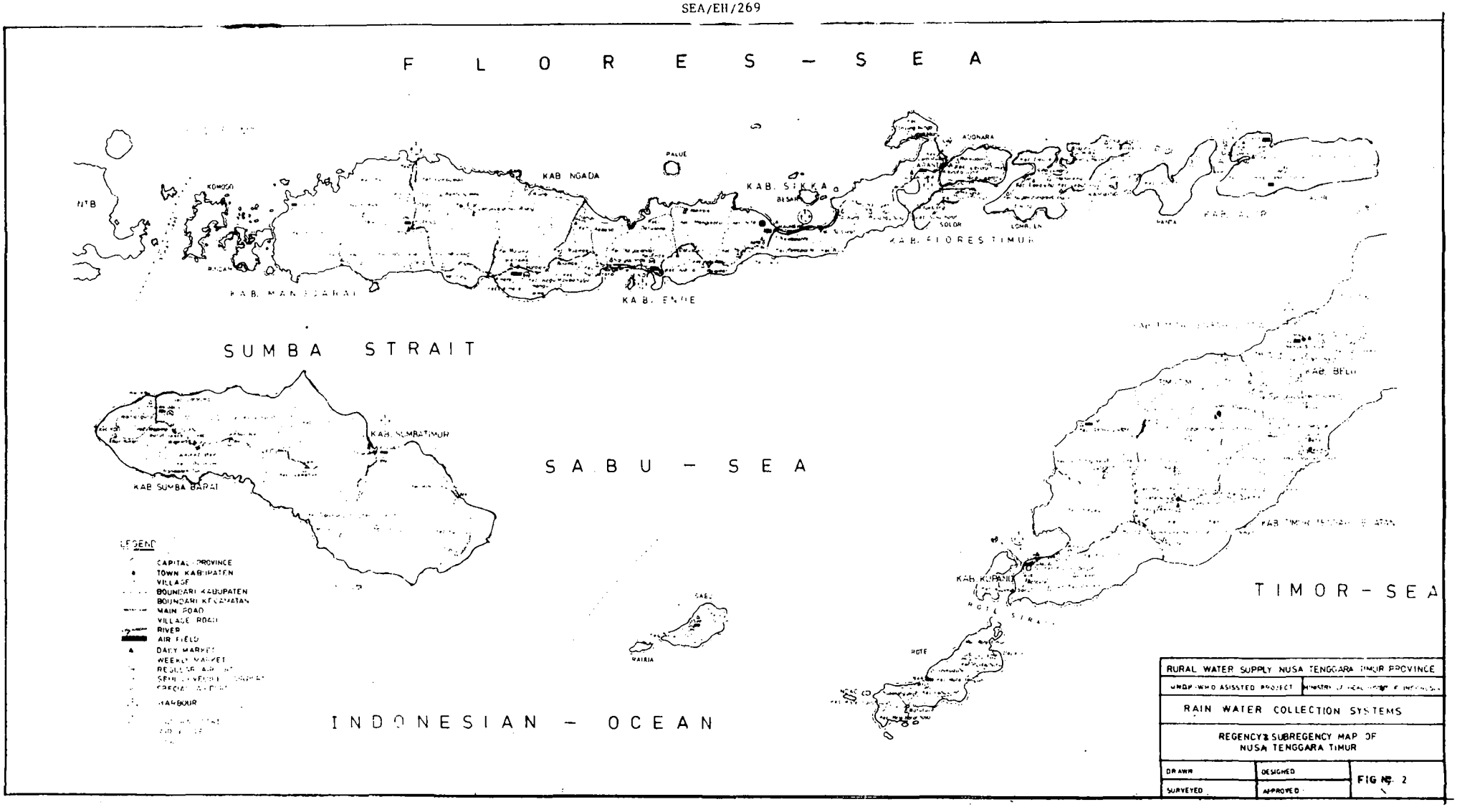
and S (I+1) = 0 if S(I+1) is negative at any stage.

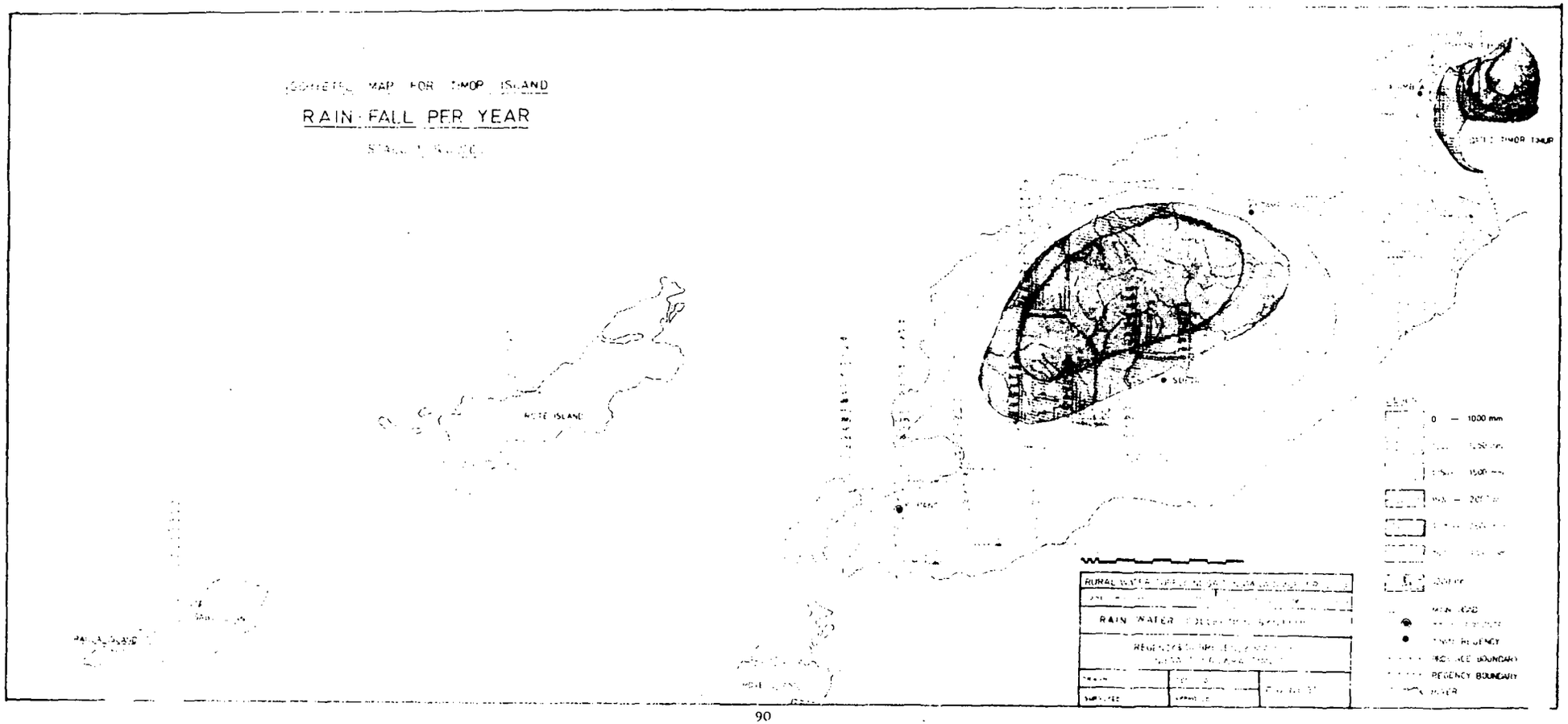
2. The calculation is continued for a second cycle of inflow assuming that the inflow repeats itself and is terminated at the time when sequent peak values start repeating.

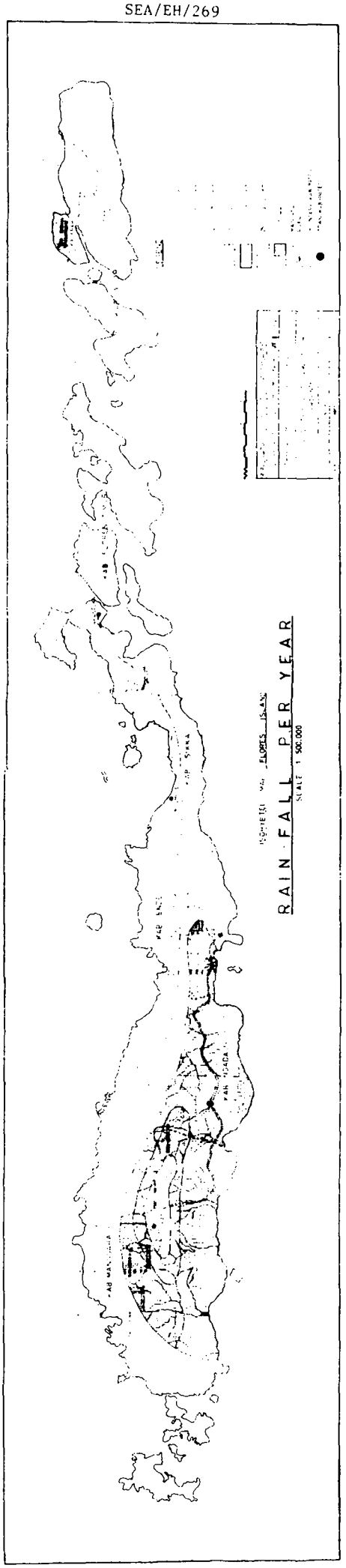
3. The storage required is the maximum of the sequent peaks calculated.



RURAL WATER SUPPLY NUSA TENGGARA TIMUR PROVINCE	
U.N.D.P.-WHO. ASISSTED PROJECT	MINISTRY OF HEALTH, GOVT. OF INDONESIA
RAIN WATER COLLECTION SYSTEMS	
LOCATION OF NUSA TENGGARA TIMUR PROVINCE	
DRAWN / DESIGNED	FIG No.: 1.
SURVEYED / APPROVED	


F L O R E S - S E A
KAB NGADA
KAB. SIKKA
KAB. FLORES TIMUR
KAB. MANGGARAI
KAB. ENDE
SUMBA STRAIT
KAB. SUMBA TIMUR
KAB SUMBA BARAT
S A B U - S E A
KAB. KUPANG
TIMOR - SEA
INDONESIAN - OCEAN
LEGEND
CAPITAL PROVINCE
TOWN KABUPATEN
VILLAGE
BOUNDARI KABUPATEN
MAIN ROAD
VILLAGE ROAD
RIVER
AIR FIELD
DAILY MARKET
WEEKLY MARKET
HARBOUR
RURAL WATER SUPPLY NUSA TENGGARA TIMUR PROVINCE
UNDP-WHO ASSISTED PROJECT
RAIN WATER COLLECTION SYSTEMS
REGENCY & SUBREGENCY MAP OF
NUSA TENGGARA TIMUR
DRAWN
DESIGNED
SURVEYED
APPROVED
FIG NO. 2

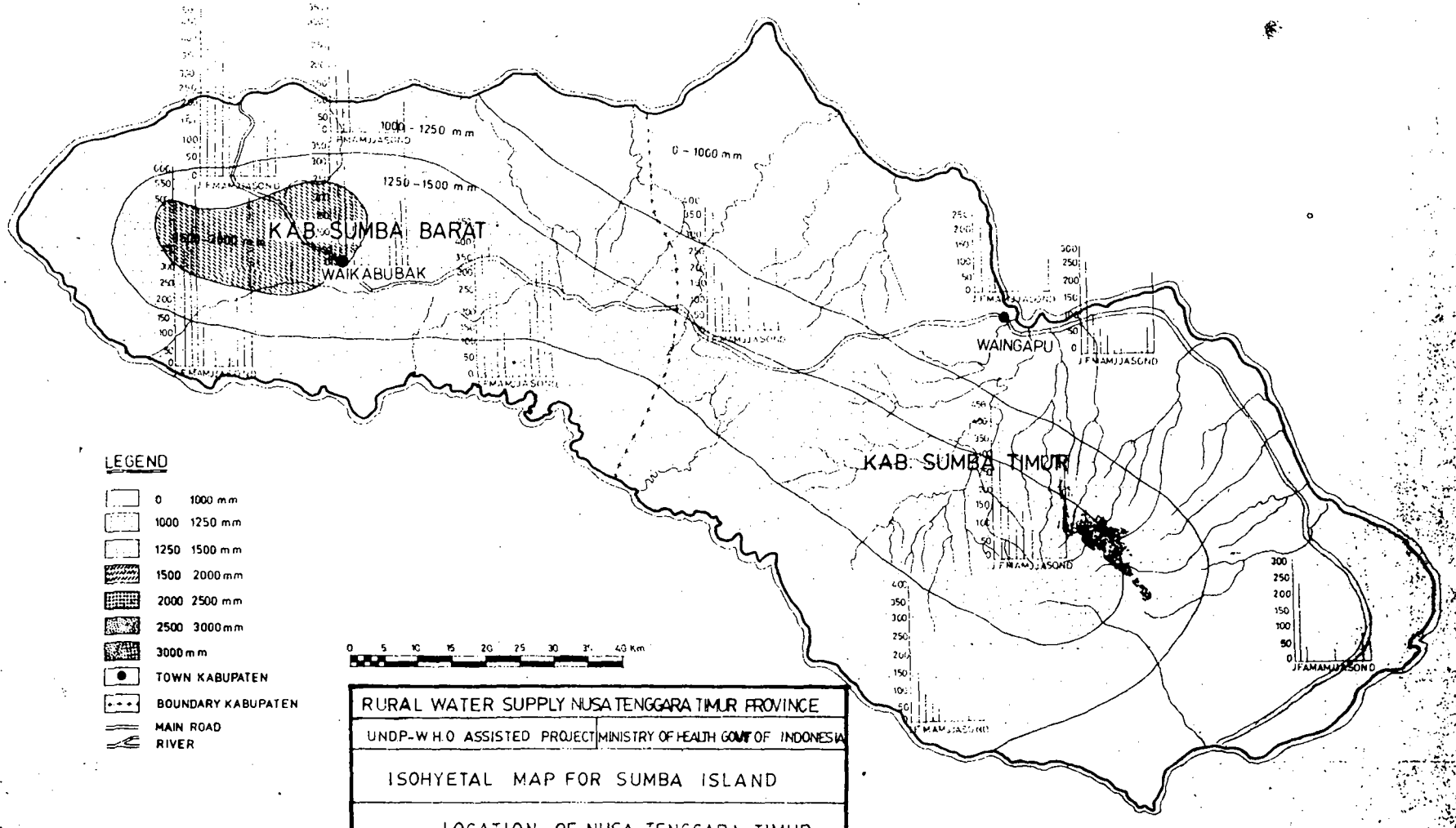

RAIN FALL PER YEAR
ROTE ISLAND
0 — 1000 mm


RAIN FALL PER YEAR

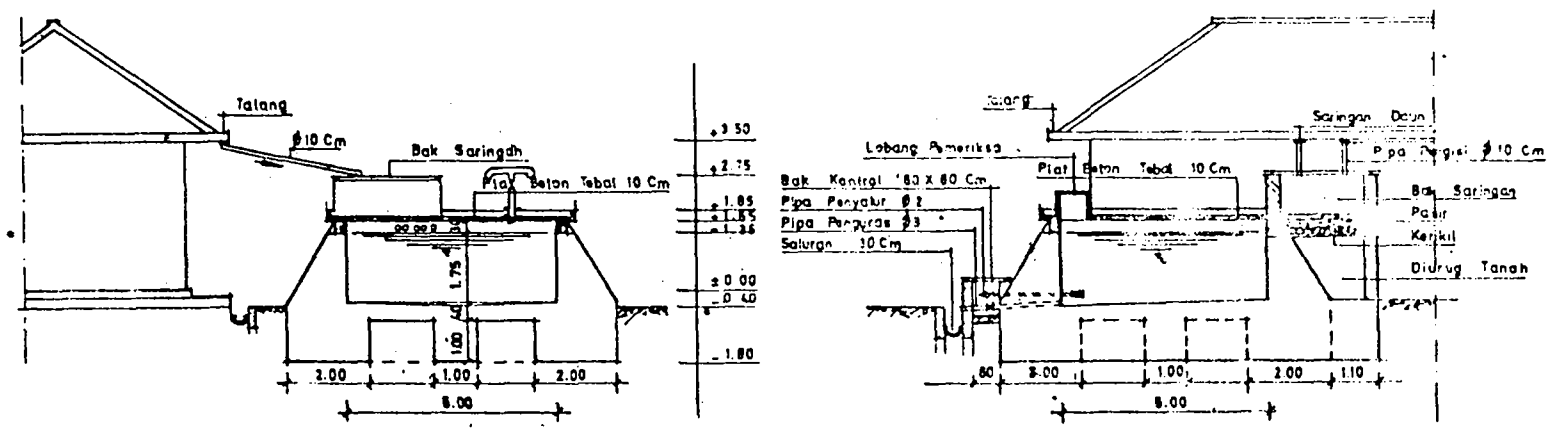
ISOHYETAL MAP FOR SUMBA ISLAND

RAIN FALL PER YEAR

SCALE 1:500 000

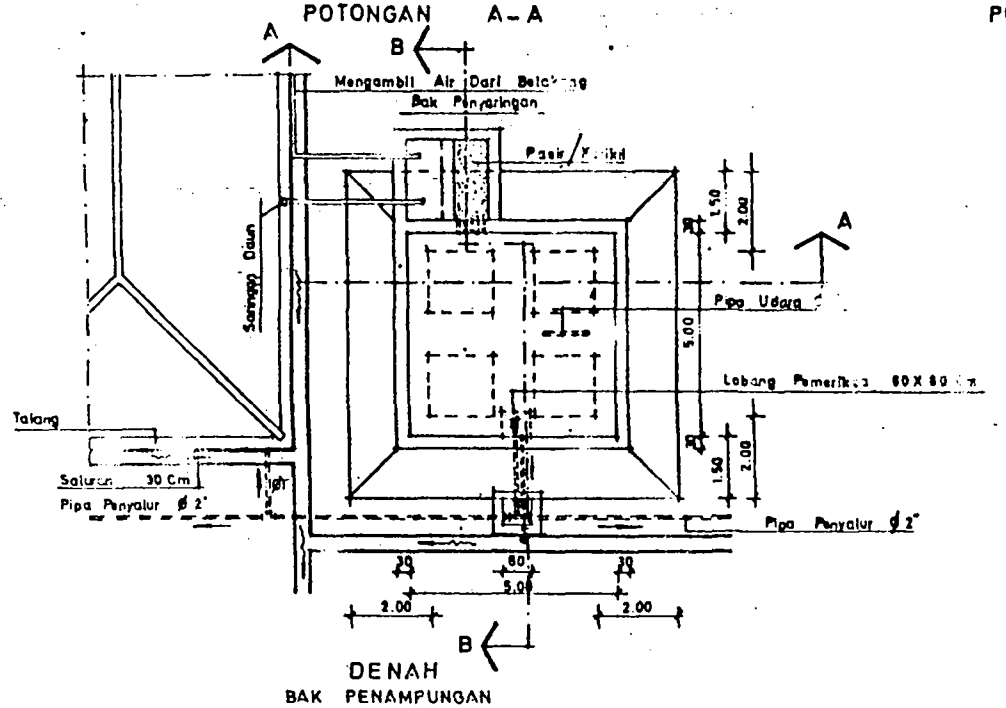


RURAL WATER SUPPLY NUSA TENGGARA TIMUR PROVINCE		
UNDP-W.H.O ASSISTED PROJECT	MINISTRY OF HEALTH GOVT OF INDONESIA	
ISOHYETAL MAP FOR SUMBA ISLAND		
LOCATION OF NUSA TENGGARA TIMUR PROVINCE		
DRAWN	DESIGNED	FIG. NO. 3.3
SURVEYED	APPROVED	



POTONGAN A–A

POTONGAN B–B

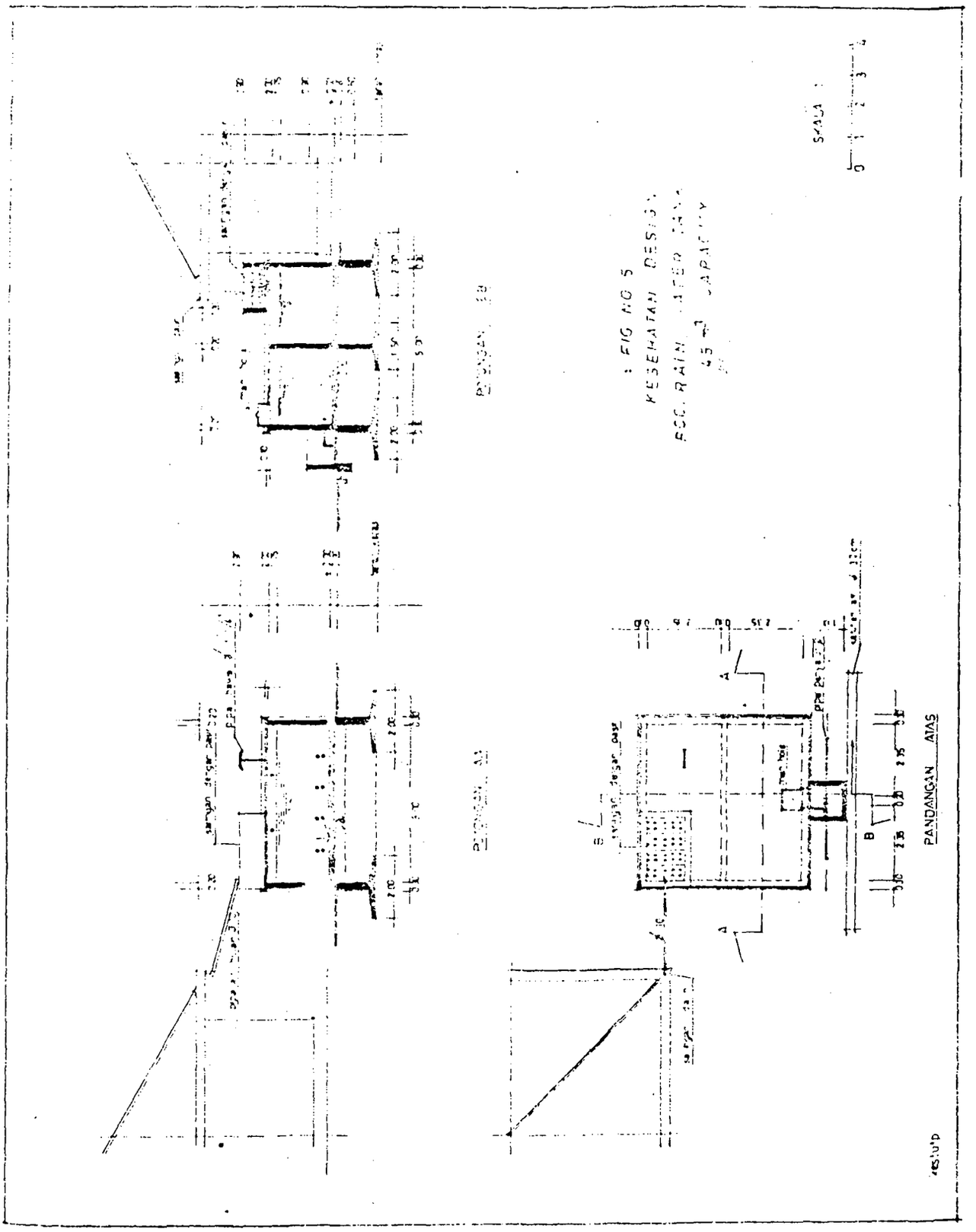


DENAH
BAK PENAMPUNGAN

FIG NO 4
KESEHATAN DESIGN OF
MASONRY RAIN WATER TANK
45 m^3 CAPACITY

skala 1 : 100.

kes tutp


PANDANGAN ATAS

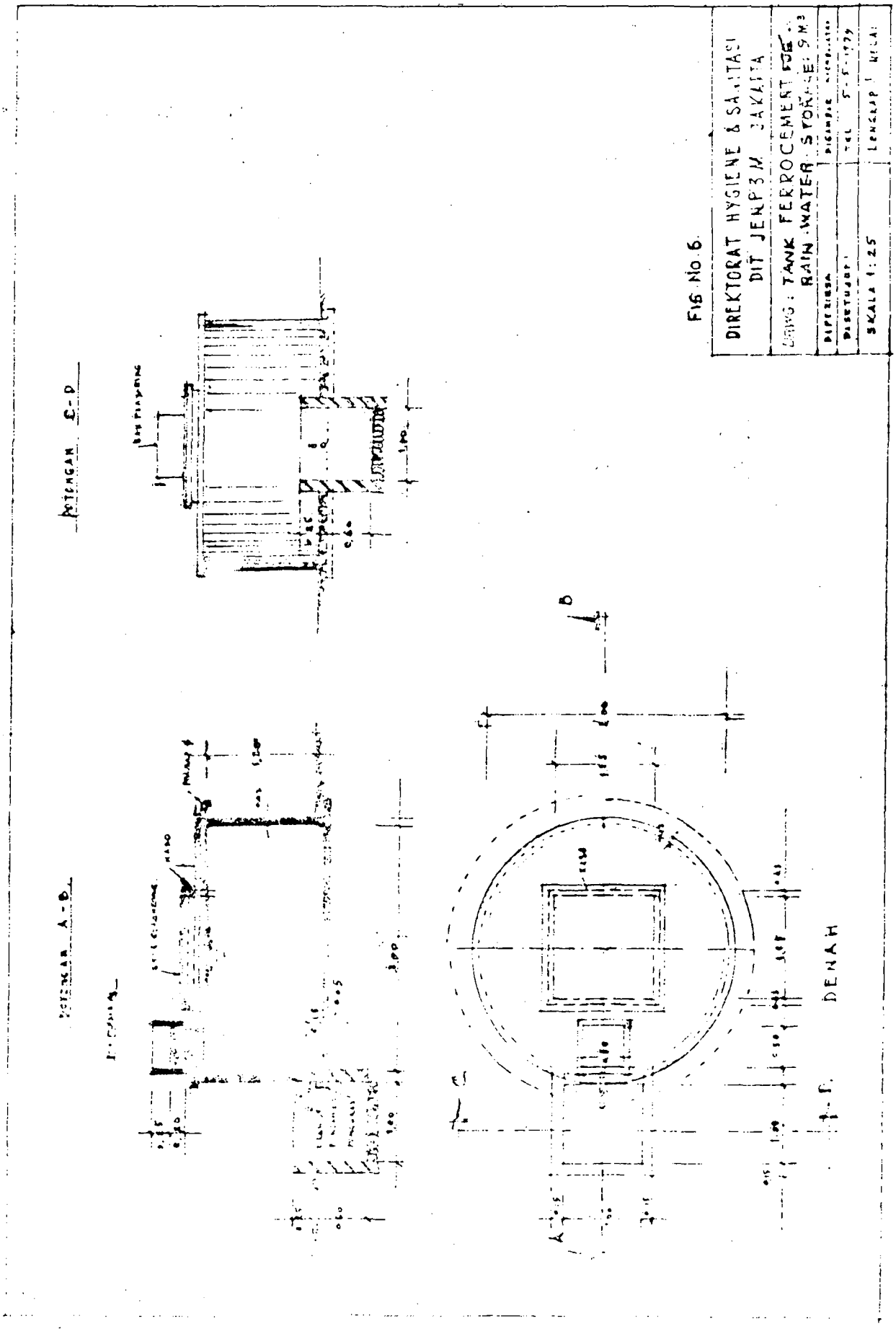
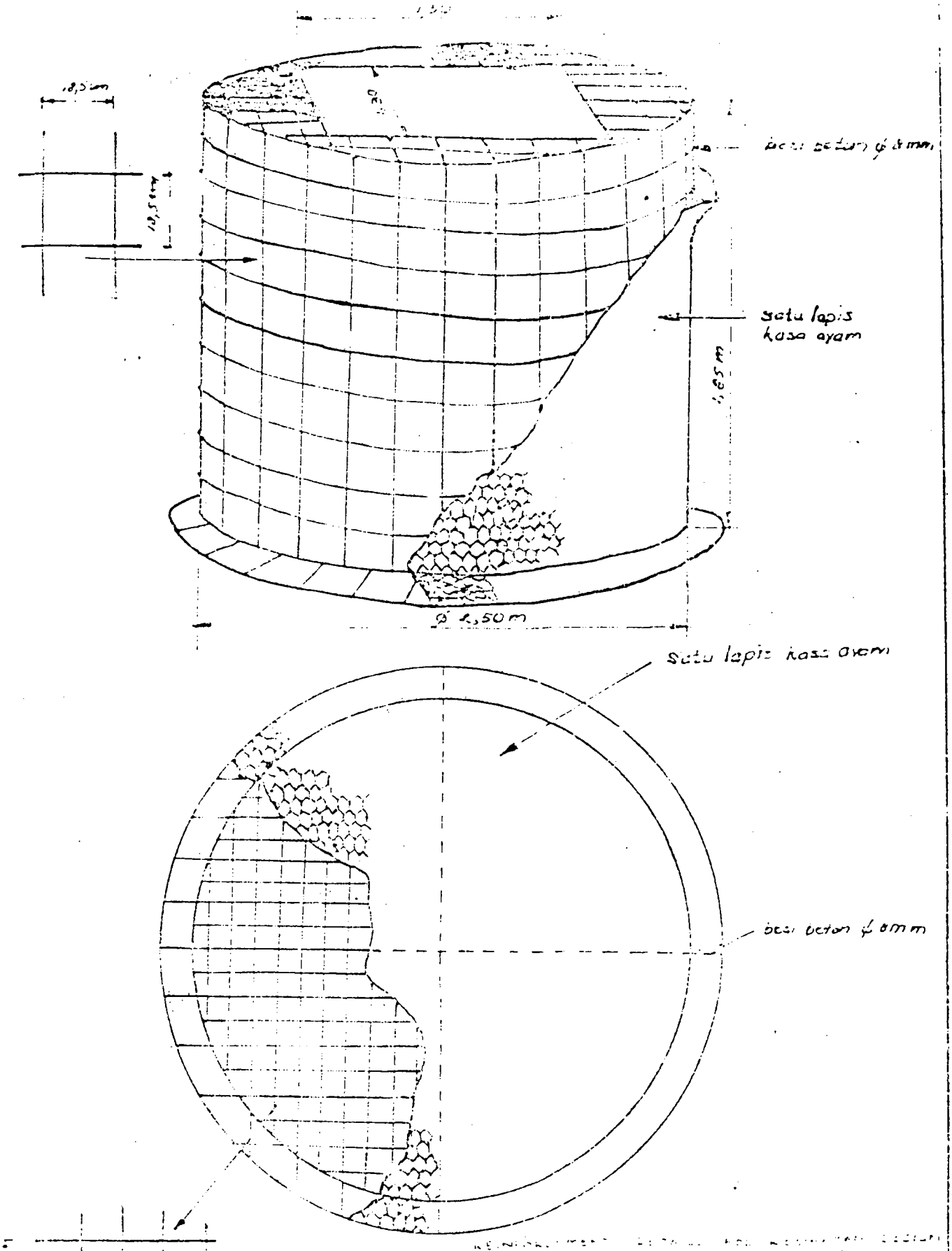
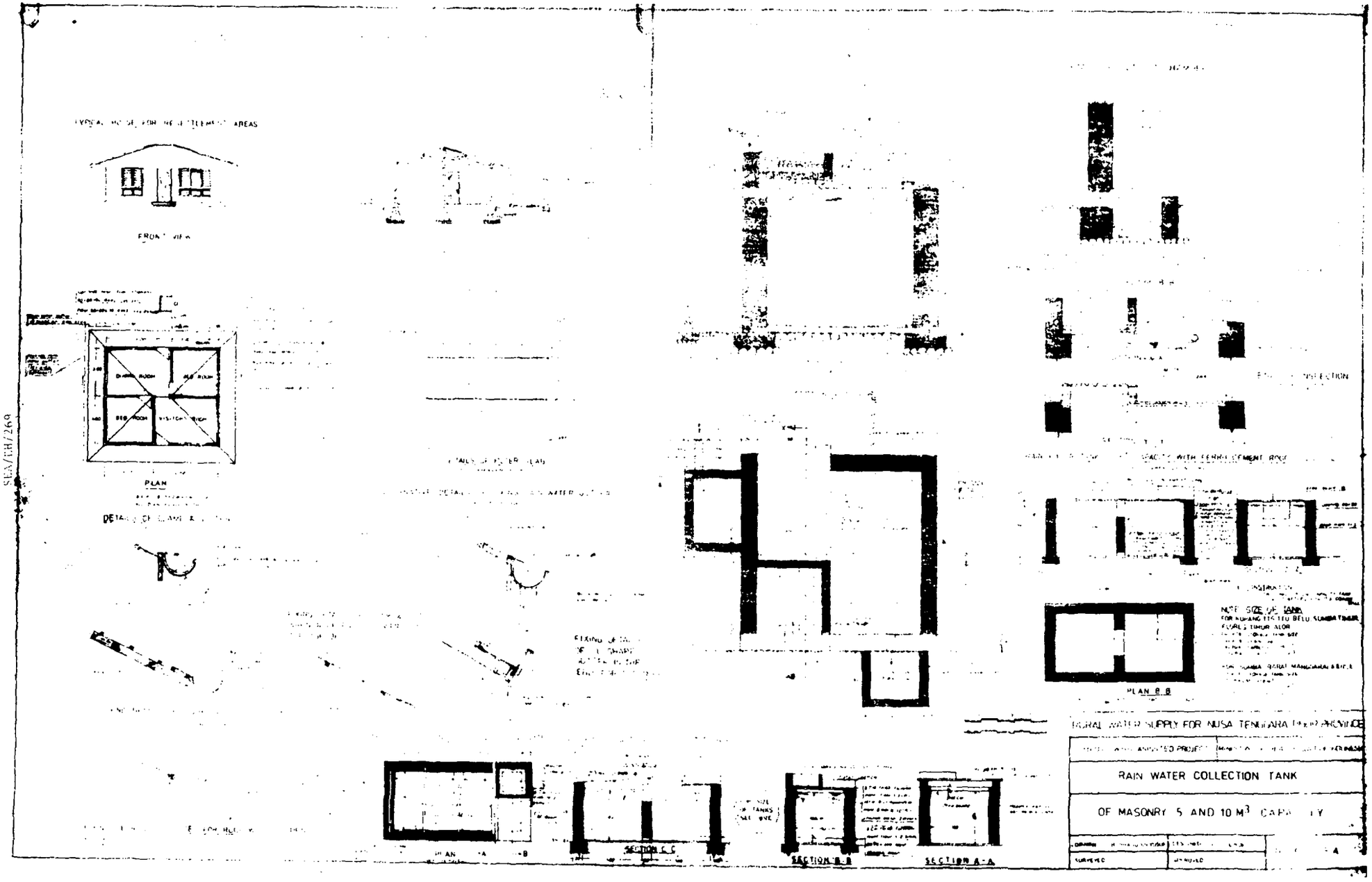


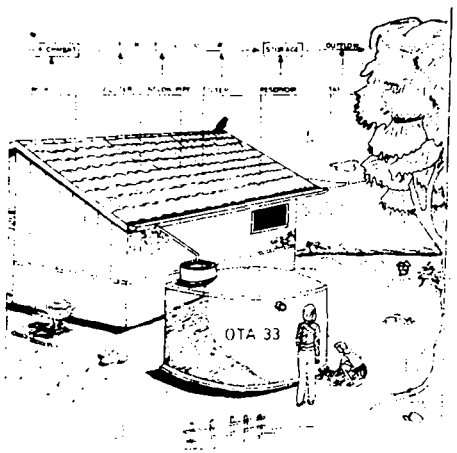
Fig No 6.
DIREKTORAT HYGIENE & SANITASI
DIT JENPAM JAKARTA
TANK FERROCEMENT
RAIN WATER STORAGE 9 M3
SKALA 1:25
POTONGAN C-D
POTONGAN A-B
DENAH



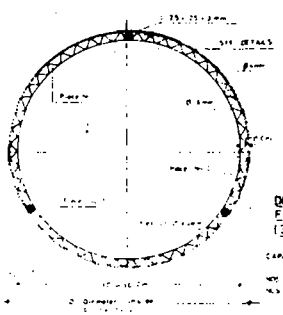
TULANGAN PENGGANTUNG V=9M


FRONT VIEW
PLAN
PLAN B-B
SECTION C-C
SECTION B-B
SECTION A-A
RAIN WATER COLLECTION TANK
OF MASONRY 5 AND 10 M3 CAPACITY

CONSTRUCTION DETAILS OF FERROCEMENT CIRCULAR TANK

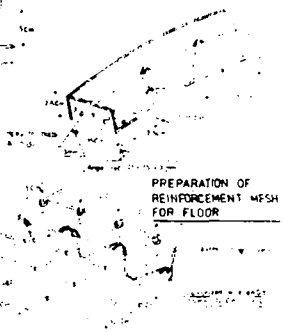


1 MILD STEEL RING FRAME FOR PLY – WOOD FORM – WORK

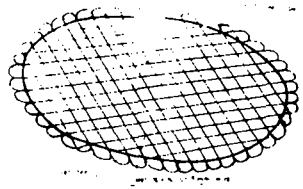


DETAILS OF RING FRAME WITH PINS FOR FLOOR & COVER (3 PIECES)

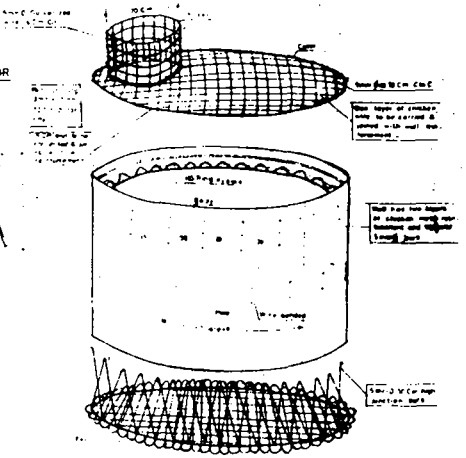
RING FRAME FOR THE TANK BODY (6 PIECES)



PREPARATION OF REINFORCEMENT MESH FOR FLOOR

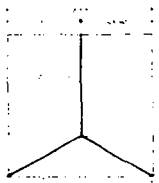


(NET FLOOR WITH FEET-NET COVER NO FEET)

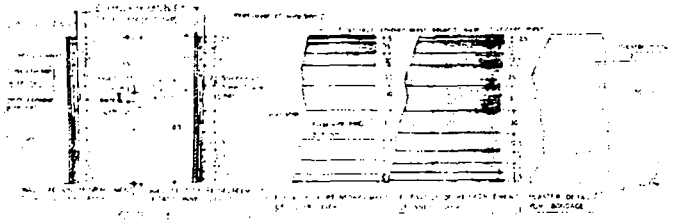


ASSEMBLY DETAILS OF FLOOR WALL & ROOF

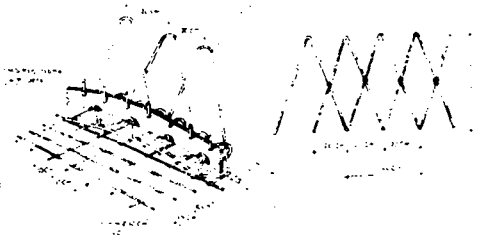
CHICKEN WIRE NET

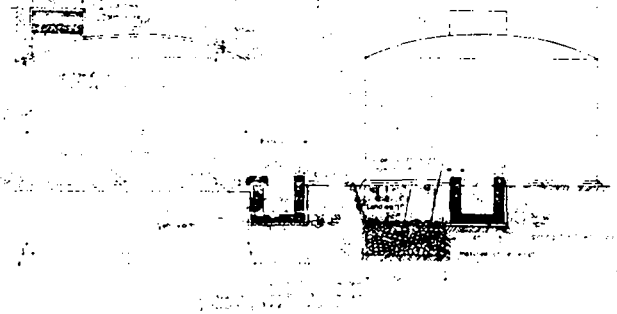


DETAILS OF WALL REINFORCEMENT AND PLASTER

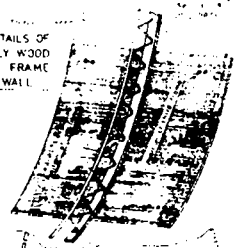


REINFORCEMENT DETAILS AT THE JUNCTION OF WALL AND FLOOR

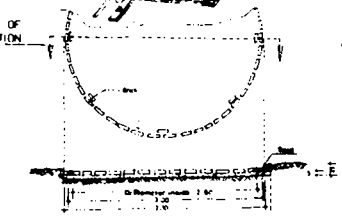




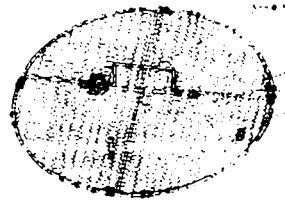
FIXING DETAILS OF TRIPLEX PLY WOOD WITH IRON FRAME FOR TANK WALL

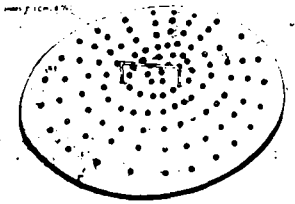


DETAILS OF FOUNDATION



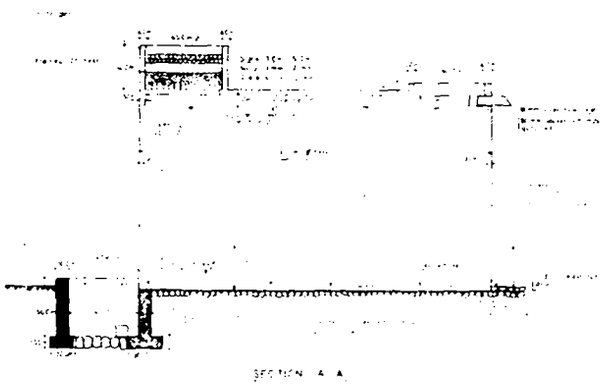
DETAILS OF RCC FILTER PLATE



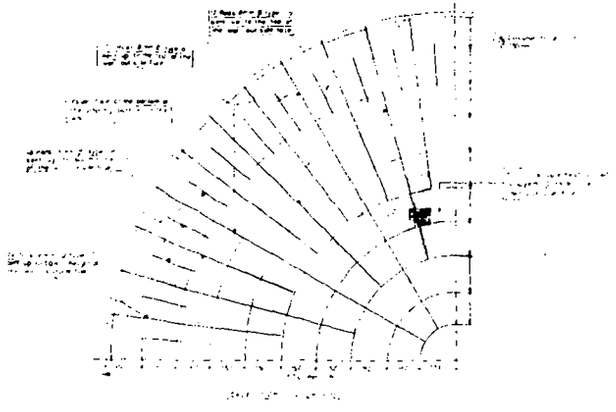


RURAL WATER SUPPLY FOR NUSA TENGGARA TIMUR PROVINCE	
UNDP - WHO ASISSTED PROJECT	MINISTRY OF HEALTH GOVT OF INDONESIA
RAIN WATER COLLECTION TANK	
FERROCEMENT 5 & 10 M^3 CAPACITY (BASSED ON WEST-JAVA PROJECT OTA-33)	
DRAWN: JUHAMUDIN YUSUF	DESIGNED: WHO/UNDP
SUPVD:	APPROVED:
DWG NO 005 B	

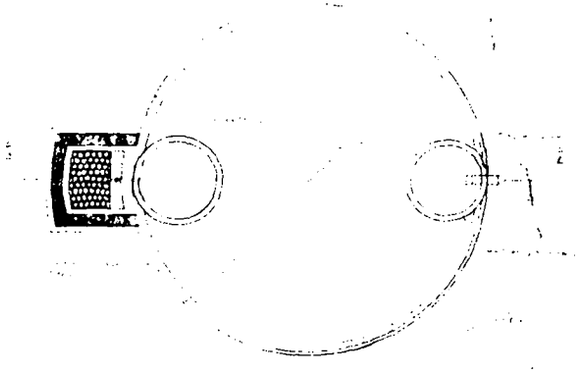
REINFORCEMENT DETAILS OF BASE SLAB



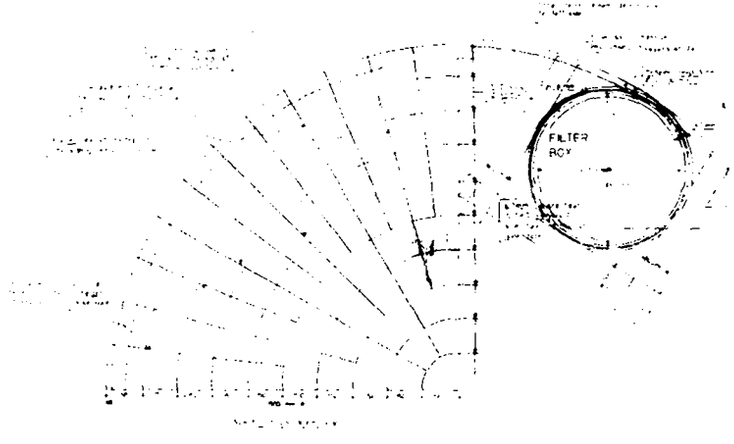
SECTION A-A



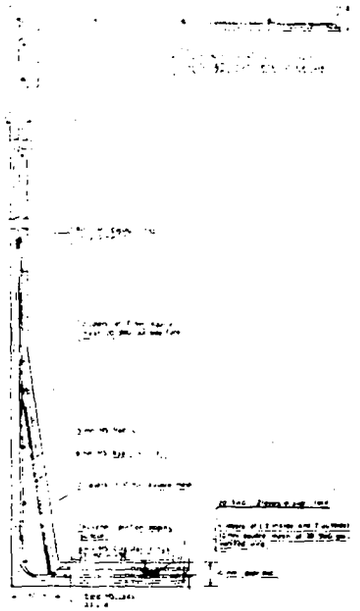
REINFORCEMENT DETAILS OF ROOF SLAB



PLAN



NOTE FOR DETAILS OF GUTTER, RAINWATER PIPE AND LAY OUT ETC REFER TO DRAWING NO 004



DETAILS OF WALL REINFORCEMENT

RURAL WATER SUPPLY FOR NUSA TENGGARA TIMUR PROVINCE

U.N.D.P. W.H.O ASSISTED PROJECT | MINISTRY OF HEALTH GOVT OF INDONESIA

RAIN WATER COLLECTION TANK

OF FERROCEMENT 5 AND 10M^3 CAPACITY

DRAWN	DESIGNED WHO/UNDP	DWG No 005 C
SURVEYED	APPROVED	

G L O S S A R Y

Abbreviations

Km	Kilometer
m	Metre
Cm	Centimeter
Mm	Millimeter
L	Litre
Km^2	Kilometer square = 100 hectares
m^2	Square meter
Lpcd	Litre Per Capita Per Day
F.S.L.	Full Supply Level
%	Per Cent
$	U.S. Dollar
Rp	Indonesian Rupiah
Ø	Diameter (dia)
No.	Number
CDC	Communicable Diseases Control
AC	Asbestos Cement
PVC	Poly Vinyl Chloride
C/C	Centre to Centre
O.D.	Outer Diameter
I.D.	Internal Diameter
M.S.	Mild Steel
G.I.	Galvanized Iron

Organizations

BAPPEDA	Badan Perancang Pembangunan Daerah; Provincial Planning Board
UNDP	United Nations Development Programme
WHO	World Health Organization
UNICEF	United Nations Children's Fund
D.G.	Director-General

Organizations

CIPTA KARYA	Director General Housing, Building Planning and Urban Development
P.U.	Public Works (Perkerjaan Umum)
KESEHATAN	Department of Health
P2AT	Proyek Pengembangan Air dan Tanah; Water Resource Development Department
P3M	Percegah dan Pemberantas Penyakit Menular; CDC

Other Indonesian Terms

KEPALA DESA	Village Head
DESA	Village
KECAMATAN	Sub Regency
KABUPATEN	Regency
BUPATI	Regency Chief
INPRESS	Special Funding Programmes Under Presidential Instructions
UDKP	Village Development Areas
PUSKESMAS	Pusat Kesehatan Masyarakat; Health Centre at Sub-regency Level