(AF) 52—109

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FEASIBILITY STUDY ON FORESTRY DEVELOPMENT IN TOGIAN ISLANDS OF THE REPUBLIC OF INDONESIA

June 1978

Japan International Cooperation Agency

FOREWORD

Forestry development in under-developed regions of Southeast Asian countries, often plays a pioneering role in the economic and social development of those regions.

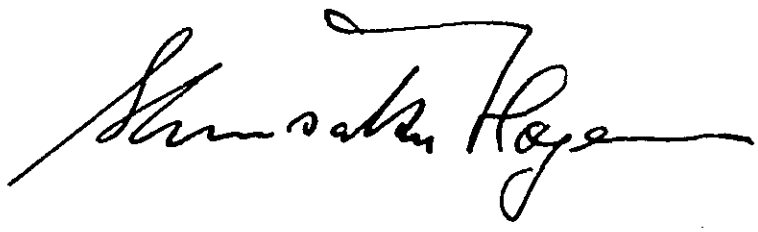
However, since forestry development in Southeast Asian countries has so far been conifined mainly to those areas abundant in Dipterocarpaceae species, known as lauan timber, its progress in other areas has been slow, thereby refunding their regional development.

Under such circumstances, the forestry development project in the Togian Islands of Central Sulawesi, Indonesia, which aims at the development of forests having many un-utilized species, other than Dipterocarpaceae species, is a note worthy project indicating what the future tropical forestry should be. In this connection, it is of great significance that the Japan International Cooperation Agency conducted the first and the second preliminary surveys for forest development in March, 1976, and in October, 1976, respectively, and has completed the present development project survey.

The forest development project under the present survey is viewed with hopes and interest by both the Indonesian and the Japanese sides as a project which will contribute not only to forest development but also to regional development by Indonesian-Japanese cooperation on a private sector level. We are confident that the success in this project will open new vistas to the forestry cooperation between our two countries and to the promotion of our mutual understanding regarding regional development

I wish to take this opportunity to express my deepest appreciation to the Directorate-General of Forestry, Provincial Government Authorities of Central Sulawesi and other Indonesian Authorities and other officials concerned for their unlimited assistance and cooperation.

June 1978



Shinsaku Hogen
President
Japan International Cooperation Agency

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I. Purpose and outline of survey.

1-1 Background

The Togian Islands, the area for the present survey, are located in Tomini Bay in Central Sulawesi. The islands are covered with approximately 70,000 ha of forests; the majority of them are tropical rain forests consisting of broad-leaved trees for which the method of tuilization has not been established. Thus, it is the strong wish of the Government of Indonesia to carry out regional development centering around forestry development utilizing untapped resources, which may lead to higher level of living of the people of the region with increased employment opportunities and improved social environment.

Against this background, Mr. Gobel, Chairman of the Indonesian-Japanese Joint Ventures Association and a member of the Indonesian Diet, visited Japan in 1975 and requested Japan's cooperation in the regional developemnt through forestry.

In response to the request, the Japan International Cooperation Agency conducted the first feasibility study for forestry development in March, 1976, to study the possibility of Japanese cooperation and the conception of the development project, which was followed by the second feasibility study carried out in October of the same year. At the same time, aerial photographing and mapping indispensable for the formation of the development project were also carried out. Results of the surveys may be summarized as follows:-

a) Regional development through forestry development accompanied by processing and afforestation concurs with the scheme of regional development advocated by the Indonesian Government.

b) There are as many as 127 species identified in the survey area, and the volume of those of the diameter over 50 cm

is estimated to be 91m^3 ha. However, even those with the slightest marketability account for only 40% of the total.

c) With regard to those forests consisting of unutilized species, as forest management techniques such as regeneration have not been established, various tests will be necessary.

d) In order to proceed with the forestry development of the area, development of techniques for wood utilization will be necessary to assess the utility value of those species which have not so far been utilized.

e) In order that the forestry development may induce the regional development, attention should be paid to enrichment of social capital by extending farmland and by improving roads and harbor facilities.

In the light of the above findings, the second feasibility study team summarized the basic shceme of the development project as follows:-

a) Social development plan for the expansion of agriculture and enrichment of social capital.

b) Cutting and regeneration programs for developing techniques to be applied to unutilized species.

c) Processing and utilization programs for developing processing and utilization techniques to be applied to unutilized species.

These programs are to form the basis of the unified development project, each geared to the development of the Togian Islands.

1-2 Purpose of survey

The purpose of the survey is to plan various tests con-

cerning cutting, regeneration and processing necessary for the forestry development in the Togian Islands and also to plan the development project for the islands.

The objectives of the survey include: reporting to the Indonesian officials concerned on the results of the second feasibility study, exposition of the contents of the present survey, meetings on the various tests necessary for the development of the Togian Islands and planning processing and utilization programs and improvement of related facilities.

1-3 Members of the survey team

Leader:	Keizo Okamoto, Head, Division of Forestry Investment and Loan, JICA.
Cooperation planning:	Hiromi Haga, Planning Division, Forestry Agency.
Processing:	Takao Okanishi, Chief Research Officer, Japan Wood Technological Association.
Afforestation & infrastructure:	Shuji Ozaki, Head, Technology Division, Japan Overseas Afforesting Association.
Forest analysis:	Sadao Ban, Assistant Director, Guidance Department, Japan Forest Technical Association.

1-4 Survey itinerary

Date	Route	Activities
Sept. 27(Tues.)	Tokyo→Jakarta	
28(Wed.)		Meeting at JICA Office Meeting at Japanese Embassy

Date	Route	Activities
Sept. 29 (Thurs.)	Tokyo→Jakarta	Courtesy call on Director-General of Forestry
30 (Fri.)	Jakarta→Palu	Trip
Oct. 1 (Sat.)		Meeting with Palu Regional Forestry Office
		Meeting with Central Sulawesi Government
2 (Sun.)		Study of wood processing and distribution in Palu
3 (Mon.)	Palu→Poso	Trip (Leader, Okanishi, Ozaki, Ban)
		Meeting with Central Sulawesi Government (Haga)
4 (Tues.)		Meeting with Palu Regional Forestry Office
	Poso→Wakai	Trip (Ozaki, Ban)
	Palu→Poso	Trip (Haga)
5 (Wed.)		Inspection of afforestation in Poso (Leader, Okanishi, Haga) Field survey (Ozaki, Ban)
6 (Thurs.)	Poso→Wakai	Trip (Leader, Okanishi, Haga) (Team meets) Field survey (Ozakai, Ban)
7 (Fri.)		Field survey
8 (Sat.)		Field survey
9 (Sun.)		Field survey
10 (Mon.)		Field survey

Date	Route	Activities
11(Tues.)		Field survey
12(Wed.)	Wakai→Luwuk	Trip
13(Thurs.)		Study of wood processing and distribution
	Luwuk→Manado	Trip
14(Fri.)	Manado→Jakarta	Trip
15(Sat.)		Meeting with PADI Traktor
16(Sun.)		Arrangement of data
17(Mon.)		Meeting at JICA Office
18(Tues.)		Inspection of Forestry Experimental Station
19(Wed.)		Meeting at JICA Office Meeting at Japanese Embassy
20(Thurs.)	Jakarta→Singapore	
21(Fri.)	Singapore→Tokyo	

II. Development project

2-1 Basic approach to development

The Togian Islands are situated at the center of Tomini Bay in North Sulawesi. The islands have no air service, and are served only by ship. It takes 16 hours from Gorontalo of North Sulawesi to which the islands are most closely related economically, 14 hours from Poso, the county capital of Poso in Central Sulawesi and 6 hours from Pagimana, the nearest town. Thus, they have the strong characteristics of isolated islands with economically unfavorable conditions of location.

Under these conditions, 25,000 inhabitants of the islands earn their living mainly by producing copra. They are also engaged in a cash industry such as the collection of rotan to purchase daily necessities including rice, the staple food, and are self-supporting with marine products such as fish.

In view of the above situation, it is perhaps to be expected that land is utilized on a small scale with a small area of paddyfield and coconut plantation extending over 10,000 ha and forests cover the rest of the islands.

Though the islands are abundant in offshore waters represented by many wide inlets and land which are resources in a wide sense, material resources are limited to forest resources.

In view of these economically unfavorable conditions of location, the basic direction of the development of the Togian Islands should be to expand land-based industry utilizing effectively the natural conditions and to develop resource-based industry making use of forest resources.

For instance, it is possible to develop culture fishery such as pearl culture utilizing inlets.

With regard to agriculture as a land-based industry, it is difficult to expand the area of paddyfield by a large margin as water supply is limited because of the size of the islands.

As for coconut forests, since they occupy over 10,000 ha of land and consitute the only industry in the islands, it is clear that natural conditions are suitable for coconut cultivation. Accordingly, expansion of coconut plantation is to be planned. However, in view of the possible fluctuations in copra price, it is necessary to stabilize earnings by introducing crops suitable for the natural conditions such as spices, e.g., cloves, in stead of depending solely on coconut plantation.

With regard to forest resources, the only material resources in the islands, the forestry development is to be the support of the Togian Islands developemnt for some time to come. Though timber production by felling the existing trees will play the main role in the forestry developement, efforts should be made to increase added value by placing wood processing industry in the islands utilizing the timber produced.

As for the development procedure, it is appropriate to begin with forestry development which can work as a detonator extending the effects to other fields such as agriculture so that unified development will be achieved eventually.

Finally, in order to push forward the various development programs described above, it should be borne in mind that the improvement of social and public facilities such as transport system including shipping, pier and roads and the improvement of living environment including medical and educational facilities are indispensable for the development of the Togian Islands.

2-2 Forest development plan

2-2-1 Basic approach to forest development

Unlike the forests in other areas, which are mainly composed of Meranti (so-called lauan), so far the main target of development, the forests in the Togian Islands are mainly composed of the so-called unutilized species with no market value at present. Though there are some species such as Palapi and Tawan which have some marketability, development based on these species is not economically feasible because of the limited resources and their present condition. Accordingly, the forest development in the Togian Islands will be possible only by giving marketability to these unutilized species.

In order to give marketability to the unutilized species, it is necessary to conduct basic study for determining characteristics of each species and to push forward developemnt of utilization and processing system accordingly. Further, in parallel to the development of utilization and processing system, products should be put on the market on an experimental basis.

With regard to the development of utilization and processing system, judging from the forest area, composition of species, growing stock and water supply, it seems impossible to set up a pulp plant in the Togian Islands in future.

As for a plywood plant, it will be difficult to set up a full-scale plant which can compete with other areas in view of the composition of species. However, if the system of utilization and processing for unutilized species can be developed, it may be able to function as a supply base of logs for plywood for other areas.

A sawmill may be placed in the islands in the sense of promoting local processing enterprise and also in view of resources and conditions of the market around the islands. In order to push forward the development of utilization and processing of the unutilized species, an experimental sawmill is to be constructed for sawing and drying to deal with decay and deformation; it is to develop to a full-scale sawmill with the increasing demand in the neighboring area and the promotion of export both demestic and foreign.

Because of many unutilized species there are many technical problems yet to be solved for regeneration in cut-over areas. Basically it is appropriate to adopt selective cutting, and clearcutting is to be adopted only in those areas which will be diverted to farmland.

In order to increase future value of the forests in the Togian Islands, it is necessary to establish a system of artificial supplementary regeneration so that artificial supplementary regeneration work may be carried out.

Though it is difficult for the time being to expand forestry actively by means of man-made reforestation, it is desirable to set up an experimental forest for the establishment of reforestation techniques to deal with future forest economic conditions.

For the promotion of the above forest developemnt, coordination with agricultural development should be maintained. It is also to be borne in mind that for efficient development it is important to push forward the development from anuified point of view not disregarding such a factor as placement of roads.

2-2-2 Timber production plan

a) Forest areas for timber production

The islands of Batudaka, Togian and Talatakoh are 24,800 ha, 17,700 ha and 9,400 ha respectively, occupying the total area of 51,900 ha.

Table 1 shows the present situation in land utilization in these islands. According to the table, apart from forest area, most of the land is occupied by coconut plantation though there are some paddyfields and farmland.

Though the production of rice which is the staple food is important, the area of paddyfield is to be maintained at the present level in view of the amount of irrigation water available. Judging from the natural conditions, copra production seems to be the most suitable industry for the Togian Islands, and is expected to account for over 90% of the total industrial production of the islands. Accordingly, in the light of topographical conditions and transport conditions based on the road improvement plan, it is desirable to

expand the area of coconut forest from the present 7,360 ha to 10,000 ha by utilizing the grass land and forests along the coast line and the roads. As a result, the total area which should be classified as forest area will be 36,500 ha.

Further, out of these forests, those which should be reserved in view of the natural protection and the future resources for sight-seeing in the islands, and those which cannot be regarded as productive forests because of the natural conditions amount altogether to 6,000 ha, and finally the area of the forest for timber production is 30,000 ha.

Table 1: Present land utilization

(unit: ha)

Area	Farmland	Coconut plantation	Grass land	Forest	Mangrove forest	Others	Total
Batudaka	50	2,530	560	20,070	1,460	110	24,780
	(0)	(10)	(2)	(81)	(6)	(1)	(100)
Togian	-	3,560	740	11,410	1,950	80	17,740
	(0)	(20)	(4)	(64)	(11)	(1)	(100)
Talatakoh	-	1,270	610	6,650	850	40	9,420
	(0)	(14)	(6)	(71)	(9)	(0)	(100)
Total	50	7,360	1,910	38,130	4,260	230	51,940
	(0)	(14)	(4)	(73)	(8)	(1)	(100)

Note: Figures in brackets are percentages.

Final land utilization plan will be as below.

Table 2: Land utilization plan

(unit: ha)

Area	Farmland	Coconut plantation	Grass land	Forest	Mangrove forest	Others	Total
Batudaka	50	4,000	250	18,910	1,460	110	24,780
					(6)	(1)	(100)
Togian	-	4,300	340	11,070	1,950	80	17,740
					(11)	(1)	(100)
Talatakoh	-	1,700	310	6,520	850	40	9,420
					(9)	(0)	(100)
Total	50	10,000	900	36,500	4,260	230	51,940
					(8)	(1)	(100)

b) Species for timber production

The forests in the Togian Islands belong to tropical rain forests. These forests in this area are mainly composed of those unutilized species having no marketability at present. Thus they have not so far been considered for development. Therefore, it is necessary first to ascertain the composition of species in planning the development of the forests in this area.

According to the results of a field survey and of an aerial photographic survey, those species with high marketability such as Dipterocarpaceae are practically nonexistent, and there are only those species belonging to the low quality - broadlief species (M.L.H). Thus it is necessary to carry out the development by classifying these species into two groups: A) species with some marketability; and B) species with no marketability at present.

Table 3 gives the classification of these species. Those belonging to Group A are to be for export, both domestic and foreign. As for Group B, since these species have no marketability unless the utilization method is developed the development of the utilization is to be carried out either locally or in Japan.

Table 3: Species by the classification of marketability

Group	Local name	Scientific name
A	Palapi	Tarrietia javanica
	Kume	Palaquim obovatum
	Nantu	Palaquim obtusifolium
	Bintangoro	Calophyllum soulattri
	Tawan	Pometia spp.
	Kayu china	Padocarpus blumei
	Dama-dama	Canarium asperum
	Kenari	Canarium balsamiferum
	Makakata merah	Santiria spp.
	Makakata	Teriminalia microcarpa
	Sugimanai	Anthocephalus chinensis
	Siuri	Kourdersiodendron pinnatum
	Tea	Artocarpus sericicarpus
	Ula	Diospyros macrophylla
	Andolia	Cananga odorata
	Nane	Mimusops elengi
	Bone	Parinasi spp.
	Loyo	Dracontomelon mangiferum
	Bawan	Elaeocarpus sphaericus
	Benkele	Duabanga moluccana
	Polus	Celtis spp.
	Pia	Lauraceae spp.
	Bayu	Pterospermum celebicum
	Kayu besi	Metrosideros vera
	Lungulo	Heritiera littoratis
	Bakang	Lithocarpus celebicus
	Putat	Planchonia valida
	Benuang	Octomeles sumatrana

c) Growing stock

Table 4 gives growing stock of those standing trees with diameter over 50 cm calculated by means of field survey and aerial photographic survey.

Table 4: Growing stock

Area	Forest area		Growing stock			Standing stock per ha	
	All forests	Economic forests	A group	B group	Total standing stock	All forests	Economic forests
	ha				m^3		m^3
Batudaka	20,100	12,500	262,000	736,000	998,000	50	80
Togian	11,400	6,000	160,000	404,000	564,000	50	94
Talatakoh	6,600	4,400	95,000	238,000	333,000	50	76
Total	38,100	22,900	517,000	1,378,000	1,895,000	50	83

Note 1: Economic forests are those having trees of over 50 cm in diameter.

Note 2: Growing stock means the stock of marketable section under the first branch.

d) Timber production plan

For the future development of the Togian Islands, timber productionplan should be based on sustained forest resources.

Therefore, if

1) the forest area for timber production is .... 22,900 ha

2) the forest area diverted to coconut palantation .... 2,640 ha

3) rotation .... 35 years

4) diversion period .... 10 years

a) annual timber production after the diversion period will be:-

$$\frac{22,900 \text{ ha}}{35 \text{ years}} \times 85 \text{ m}^3 + \frac{2,640 \text{ ha}}{10 \text{ years}} \times 50 \text{ m}^3 \doteqdot 67,000 \text{ m}^3$$

b) annual timber production after the diversion period will be:-

$$\frac{22{,}900 \text{ ha}}{35 \text{ years}} \times 83 \text{ m}^3 \fallingdotseq 54{,}000 \text{ m}^3$$

In view of the above results, the annual timber production plan is to be as shown by Table 5 with the first three years for interim measures and with consideration given to the groups.

Table 5: Annual timber production plan

(unit: m^3)

Year	Monthly production			Annual production
	Total	A group	B group	
1	2,000	1,500	500	24,000
2	3,000	2,500	500	36,000
3	4,000	3,000	1,000	48,000
4	5,000	4,000	1,000	60,000
5	5,000	4,000	1,000	60,000
6	5,000	3,000	2,000	60,000
7	5,000	3,000	2,000	60,000
8	5,000	2,000	3,000	60,000
9	5,000	2,000	3,000	60,000
10	5,000	2,000	3,000	60,000
11	4,500	1,500	3,000	54,000
12	4,500	1,500	3,000	54,000
13	4,500	1,000	3,500	54,000
14	4,500	1,000	3,500	54,000
15	4,500	1,000	3,500	54,000
16	4,500			54,000
⋮	⋮			⋮

e) System of timber production

There are two methods of log-gathing which is the main part of a timber production system: yarder and tractor.

1) Since the terrain of the forest area as a whole is not so steep and there are many streams, the yarding range of the yarder may be limited and the machine may have to be moved many times.

2) Operation with yarder requires advanced techniques and experience such as the determination of the cabling method. It is, however, difficult to secure engineers qualified for this type of work. In the area where technical level are low, it is less difficult to find vehicle drivers. Therefore, skidding with tractor may be more familiar to the local population.

3) Distribution of standing stock is comparatively uneven

Because of the reasons given above, the method of stemlength skidding with tractor is to be adopted.

The necessary work to be carried out in stages may be outlined as follows:-

(1) Establishment of roads

Determination of the route (work in the forest area)

Based on topographical survey by aerial photographing and field survey, the road construction plan is to be formed. Cutting operation and marking operation for the center line of the route are to be carried out.

Cutting and formation of subgrade (work in the forst area)

Cutting is to be carried out on both sides of the route and the subgrade is to be formed.

Maintenance of the surface (work on the road)

Repair or restoration work is to be carried out on soft or damaged roads and good surface is to

be maintained by providing drainage ditches.

(2) Cutting, skidding and transportation

Survey of growing stock (work in the forest area)

Survey of growing stock of standing trees within the planned cutting section is to be conducted and recorded. Timber marking is also to be done.

Cutting (work in the forest area)

Those trees marked are to be cut with chain saw, trimmed and finished to stem length.

Skidding (work in the forest area)

Skidding is to be done with tractor to the timber yard in stem-length.

Logging (work in the forest area)

Bucking is to be done with chain saw to prescribed length. Defects are to be removed to produce logs.

Barking (work in the forest area)

Barking is to be completed and the log is to be sprayed with insecticide.

Inspection at timber yard (work in the forest area)

Logs to be weighed and recorded.

Loading (work in the forest area)

Finished logs to be loaded on trucks by crane truck and secured.

Transportation (work on the road)

Finished logs to be transported by truck to timber basin.

(3) Timber basin and classification

Unloading (work in the timber basin)

↓

Logs to be unloaded on the ground by log-loader in three groups: floater, sinker and specified.

Grading and weighing (work in the timber basin)

↓

Each log is to be graded and measured for diameter class and length, marked accordingly either in paint or by carving and entered in the field note.

Classification and selection (work in the timber basin)

↓

As for those graded and weighed, floaters and sinkers to be bound together are lowered to the water, and sinkers are piled up on the ground according to the instructions.

Rafting (work in the log pond)

Floaters and sinkers to be bound together are rafted with the help of a tug boat. After rafting, necessary marking should be done above the water level and particulars are to be recorded for each raft. Then rafts are secured to the bank.

(4) Shipping

Loading of sinkers (work in the timber basin)

↓

Those sinkers which have been kept on land are loaded by log loader on pontoons and secured according to the time of shipping.

Tugging (work at sea)

↓

Pontoons loaded with rafts and sinkers are towed by tug boat from the timber basin to the ship's side.

Loading (work at sea)

↓

Logs are lifted by the ship's derrick and loaded either in the hold or on the deck.

↓

Details of loading (work in the timber basin)

Based on the log details of each raft and pontoon, a check has to be made as to whether there is any missing, and an invoice has to be prepared.

Specifications and quantities of items required are as below.

Table 6: Equipment needed for timber production

Equipment	Specifications	Quantities
Passenger car		1
Jeep		1
Motorcycle	125 cc	2
Light truck	4 t	1
Tug boat		1
Shovel loader	D - 75	1
Truck crane	10 t	3
Bulldozer	D - 60	4
Chain saw	10 PS	13
Tractor	D80	4
logging truck	4-wheel transmission 8 t	4
Log loader	D - 75	1
Generator		1
Pontoons		2

f) Facilities

Necessary facilities and their specifications are as below.

Table 7: Facilities

Facility	Specifications	Quantities
Office	Wooden and brick 200 m^2	1
Staff quarters	Wooden and brick 60 m^2	20
Workers' quarters	Wooden 40 m^2	30
Accommodation quarters	Wooden and brick 200 m^2	1
Garage	Wooden 200 m^2	1
Warehouse	Wooden 100 m^2	2
Repair shop	Wooden 100 m^2	1
Timber basin	Set of equipment and machinery.	
	5,000 m^2	1
Fuel Tank	10 t	1
Bachelors' quarters	Wooden	3

2-2-3 Development plan for unutilized species

a) Results of the existing suitability test for processing

There is very little literature on tests or surveys carried out regarding the possibility of processing individual species found in the Togian Islands. The only literature available is a report on tests regarding the processing possibility of Togian timber forming part of the Project for promotion of utilization of unutilized species carried out by the Federation of Japan Plywood Manufacturers Association for the Forestry Agency in 1975. According to the report, logs supplied for the tests were of 16 species taken from the area 3 km to the south of Wakai Village, Batudaka Island, and the area of Togian

Island across the water from Wakai. Since these logs were cut manually, they were short (length about 2.5 m) in a small diameter class, and there was only one log for each species.

Under the survey, the appearance of the log was examined together with a plywood manufacturing test and a material test. The data obtained on material, efficiency and processing possibility were evaluated in three grades. The specimen logs were put in the actual production process and processed under the same conditions as Meranti, and evaluation was based on the experience of the operator at each stage of production. In particular, plywood was produced through the normal production process for producing 4 mm x 91 cm x 182 cm plywood.

Table 8: Results of processing suitability tests
(Project for promotion of utilization of unutilized species).

Names of species		Specific gravity in oven dry	Appearence				Plywood mfg. test									Physical properties test					
							Cutting			Drying speed			Suitability			Strength test			Processing test		
Local name	Popular name **		Crack	Core section	Color	Decay	Cutting	Surface quality	Yield percentage	Drying speed	Deformation	Crack	Light plywood	Heavy plywood	Overall	Young's modulus in bending	Breaking limit in bending	Breaking limit in compression	Sawing efficiency	Drying speed	Planing
Palapi	Teraling	0.49	o	Hard	Red	o	o	o	o	o	o	o	o	o	o	Δ	Δ	Δ	o	Δ	o
Nantu	Njatuh	0.41	×	Medi-um	Yel-low	×	o	×	×	Δ	×	×	×	×	×	Δ	Δ	Δ	o	Δ	o
Kume	Njatuh	0.56	o	Hard	Red	o	×	Δ	×	o	Δ	×	Δ	o	o	Δ	Δ	Δ	-	-	-
Dama-Dama	Canarium	0.49	o	Hard	White	o	o	o	o	Δ	Δ	o	o	o	o	Δ	Δ	Δ	o	Δ	o
Kenari	Canarium	0.48	o	Medi-um	White	o	o	Δ	×	×	o	×	×	o	Δ	Δ	Δ	Δ	-	-	-
Makakata Merah	Santiria	0.55	Δ	Medi-um	White	×	o	Δ	Δ	o	×	Δ	Δ	Δ	Δ	Δ	Δ	o	-	-	-
Tea	Artocarpus	0.25	o	Soft	Yel-low	×	×	×	×	×	×	o	×	×	×	×	×	×	-	-	-
Bintangoro	Bintangor	0.42	o	Soft	Brown	o	o	o	o	X	Δ	Δ	X	o	Δ	Δ	Δ	Δ	-	-	-
Tawan	Matoa	0.71	×	Medi-um	Pink	o	o	o	Δ	Δ	×	×	Δ	o	o	o	Δ	Δ	-	-	-
Ula	Ebony	0.62	×	Hard	Beige	o	o	Δ	×	Δ	×	×	×	×	×	o	o	o	-	-	-
Andolia	Cananga	0.37	o	Soft	White	×	Δ	o	×	o	o	o	Δ	×	Δ	Δ	Δ	Δ	-	-	-
Sugimanai	Biaun	0.45	o	Medi-um	Yel-low	o	Δ	o	Δ	Δ	o	×	o	×	Δ	Δ	Δ	Δ	-	-	-
Benuang	Biaun	0.28	o	Soft	Beige	o	o	o	×	Δ	o	o	×	Δ	Δ	×	×	×	-	-	-
Makakata	Terminalia	0.42	Δ	Hard	White	o	×	o	Δ	Δ	×	o	Δ	×	Δ	Δ	Δ	Δ	-	-	-
Nane	Nane	0.99	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	×	×	Δ
Bone	Parinari	0.82	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	Δ	×	Δ

* Names of species used in the present report.
** Names of species used in the report prepared by the F.J.P.M.A.
Marks: o: low or good. Δ: medium. ×: high or bad. However, in the case of strength test, o: value large. Δ: medium. ×: value small. -: no test.

This test was primarily for the production of plywood, and in terms of overall suitability Palapi, Dama-Dama, Kume and Tawan were found to be suitable for that purpose. Particularly, Palapi showed good results regarding appearance, cutting and aridity. Though it has not been accepted fully by the trade, it is one of the species with future.

Kenari, Makakata Merah, Bintangoro, Andolia, Sugimanai and Makakata ranked as of medium quality because of some unfavorable factors in processing. However, it may be possible to utilize them, depending on the type of plywood to be used, by improving the processing technique. Further study and testing are thus desirable.

Nantu, Tea, Ula, Nane and Bone were found to be unsuitable species for processing, because they were unsuitable for rotary cutting for being either heavy hardwood (Ula, Nane and Bone) or light softwood (Tea). It may be necessary to study the possibility of utilizing Ula as the surface of plywood with natural fancy wood.

With regard to the results of the strength test, high degree of correlation between strength and specific gravity was confirmed by the test. As for the processing suitability (sawing, aridity and planing), only a few species were tested because of the insufficent testing material. However, it is assumed to have the same degree of suitability as that for plywood.

b) Basic approach to the development plan for utilization of unutilized species

In order to give marketability to those unutilized species, it is necessary to conduct basic study for ascertaining the characteristics of each species, and, at the same time, to push forward the development of a utilization and processing system accordingly. Further, it is also necessary to try out the distribution of the products on the market.

As for the species found in the Togian Islands, however, only 16 out of 127 species have been tested with one specimen log each regarding plywood production and physical properties.

In order to utilize these species on a commercial basis, it is necessary to carry out various tests described in the previous report. Some of the tests may be conducted in Japan if logs are brought over to Japan, while some other tests such as aridity tests by air drying have to be carried out locally.

Further, even at an experimental stage, if it is intended to carry out experimental processing to the extent that effects of various mass production tests may be produced, it is advisable to construct an experimental plant locally to conduct these tests. Then it will not only contribute to the development of the region but also make processing extremely easy when utilization of those unutilized species has been developed. Further, considering that the utilization of these species should not be meant to be only for the Japanese market but for the domestic market as well, it is the most effective way of promoting the development of utilization of these species to carry out experimental processing locally with the capacity of mass production, while conducting various experimental tests both in Japan and in Indonesia. This method will undoubtedly respond move effectively to the idea of carrying out processing locally which is the basic policy of the Indonesian Government.

1. Selection of experimental processing field

Next, an appropriate experimental processing field has to be selected. In this case, though it is an experiment, it should be carried out with a minimum amount of loss to the organization during the operation. Further, after completion of the experiment, it should be able to

develop a wood processing enterprise on an economical basis.

In view of the fact that there are a variety of species in the Togian Islands ranging from hard to soft in wood quality or from dark to pale in color, experimental sawing and processing to develop sawing technique will the most appropriate and necessary enterprise for the islands for the reasons: 1) products making the best of the characteristics of each species may be produced; and 2) those products produced at the experimental stage may be sold on the local market.

2. Scale of experimental sawmill

Next, the scale of the experimental sawmill has to be determined. Though it is an experiment, as long as it forms part of an enterprise, it should bring about maximum effects of the experiment with a minimum loss to the enterprise. It should, at the same time, have the possibility of developing to an economically rational enterprise after completion of the experiment.

In order to ascertain the results of the experiment, particularly those concerning mass production, a certain scale will be required of the experimental plant. On the other hand, it has to be of a minimum scale to minimize the possible loss by the experimental enterprise. However, if the plant is constructed on the minimum scale, it will be an extremely costly enterprise.

The most important test regarding timber production is the one concerning aridity. Since the Togian Islands are situated directly under the eqator, drying technique making use of the position of the islands and experiments making the best of the sunshine should be recommended. The experimental method will be described in detail, but it is to be conducted in a dry room similar to a hothouse boarded with plastic board, which is equipped with a

spray for adjuting humidity in the room and a fan for forced ventilation. It is to utilize solar heat for heat-source. This dry room has to be of a fairly large size, and, therefore, will be able to dry 500 m^3 of wood a month.

In view of the various conditions described above, the most rational capacity of the experimental sawmill is to be 20 m^3 per day or 500 m^3 per month.

c) Experimental sawmill

1. Approach to the design

1) The plant is to produce timber products making the best of the characteristics of various species found in the Togian Islands. Accordingly, a variety of products will have to be manufactured for trial at the experimental stage of the enterprise. Thus, the pilot plant has to be designed in such a way that it will be possible to produce various kinds of products.

2) The most improtant among the various tests regarding sawing concerns drying. In view of the unique location of the islands being under the euqator, the drying facilities should be designed with the view to develop new technology geared to future sawmills in Indonesia.

3) Another important factor to consider is the technical level of local workers. It is also to be remembered that it is difficult to obtain spare parts locally for repair work.

The purpose of the experiment is to develop utilization of hitherto unutilized species and not for efficient sawing. Therefore, most up-to-date energy saving equipment is not required for the plant.

Rather it should be designed on the basis of trouble-free equipment which is easy to handle.

2. Species to be tested

Out of 127 species found in the Togian Islands, all except Palapi, Nantu, Tawan, Bintangoro, Kayu China and Kume which already have some degree of marketability on the tropical wood market in Japan are to be tested.

3. Subjects of the test

1) Condition of sawn face.

2) Life time of tooth edge and sawing efficiency.

3) Condition of cut surface by rotating knife.

4) Life time of blade and cutting efficiency.

5) Drying days of saw timber, deformation, cracking and shrinkage percentage.

6) Overall marketability of timber.

4. Facilities at the pilot sawmill

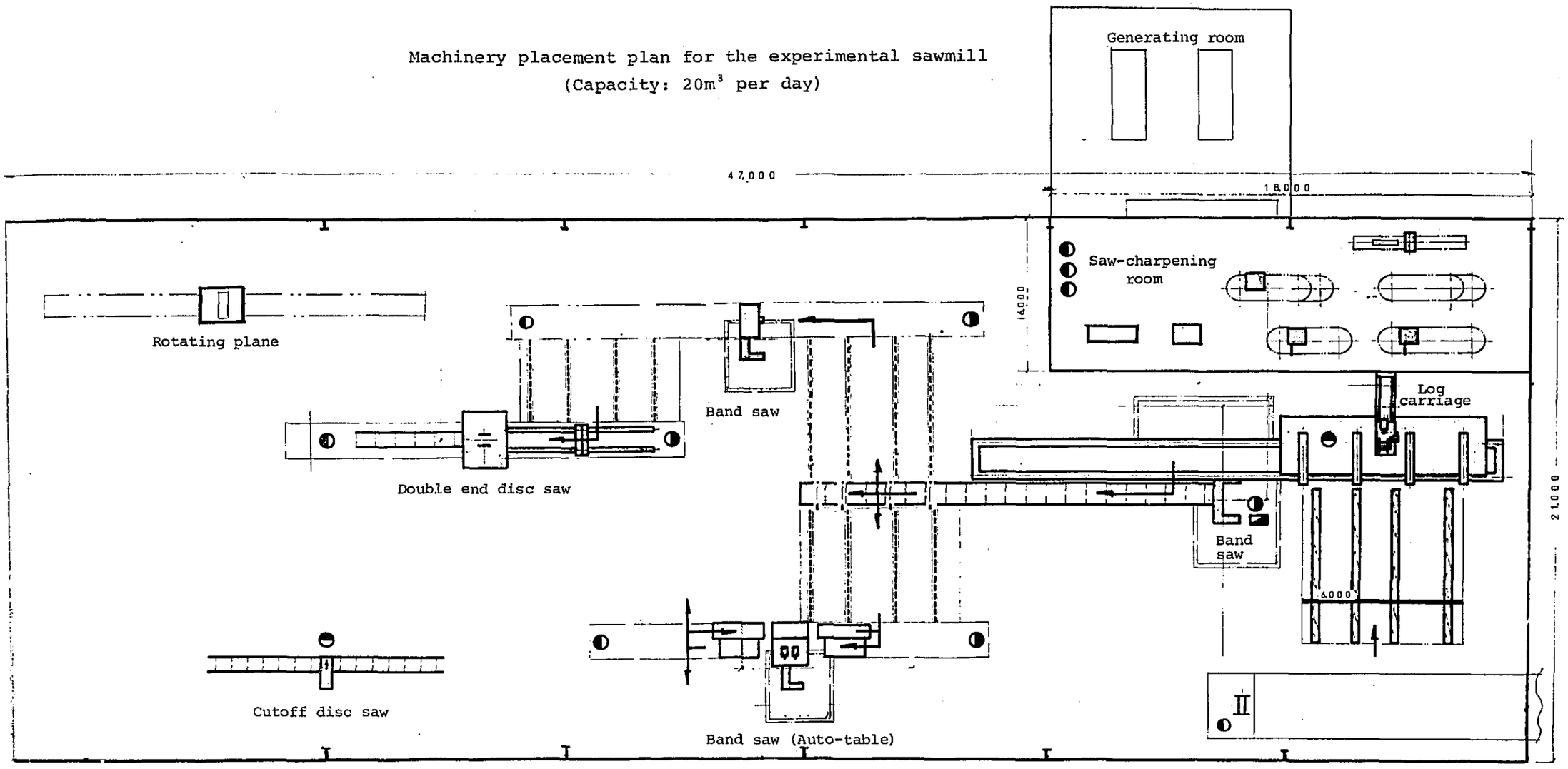
1) Sawing facilities

Table 9: Sawing facilities

Equipemnt	Quantity
Log winch (35 kW)	1
Log conveyor	1
Band saw with log carriage (1,200-type)	1
Auto-table band saw (1,100-type)	1
Table band saw (1,100-type)	1
Double end disc saw	1
Cutoff disc saw	1
Rotating single face saw	1

Equipment	Quantity
Saw-sharpener (band saw)	2
Saw-sharpener (disc saw)	1
Grinder (rotating plane)	1 set
Dust collector	2
Generator	1 set
Conveyor unit	1 set
Electrical wiring, piping and power control board	1 set
Lighting facilities	1 set
Foundation work	1 set
Installation work	
Supplementary material (teeth of various machines) Supply for 1 year.	
Repair tools (welding equipment, general tools)	

Machinery placement plan for the experimental sawmill
(Capacity: 20m^3 per day)



Grinding machines	
Saw-sharpener	0.75 kW
Saw-sharpener	0.75
Roller	0.75
Side grinder	0.4
Disc saw sharpener	0.4
Rotating plane sharpener	0.4
Total	3.45 kW

Conveyor	
Log conveyor	11.0 kW
Live roller	3.7
Chain stopper	3.0
Log winch	35.0
Total	52.7 kW

Grand Total 255.3 kW

Sawing machinery		
Band saw	(Wheel drive 5.5 kW Wheel lift 0.75 kW Guide lift 0.4 kW Dust collection 7.5 kW)	63.65 kW
Log carriage	(Drive 11 kW × 2 Setwork 7.5 kW)	29.5
Band saw	(Wheel drive 30 kW Wheel lift 0.4 kW Guide lift 0.4 kW Dust collection 5.5 kW)	36.3 36.3
Double end disc saw	(7.5 kW × 2 1.5 kW Dust collection 5.5 kW)	22.0
Cutoff disc saw	(3.7 kW)	3.7
Rotating plane	(2.2 kW Dust collection 5.5 kW)	7.7
Total		199.15 kW

5. Drying facilities

1) Introduction of drying facilities

Generally speaking, there are two methods of drying: air drying and artificial drying. With artificial drying it is possible to lower the moisture content to 6-8% in a short time. However, if the logs are transported to Japan the moisture content will unavoidably reverse to air-dried condition, necessitating to complete drying in Japan.

Though it is possible to lower the moisture content to 25-30%, a drying period of 2-3 months is necessary. In addition, distortion and cracking may occur, and it is technically impossible to prevent them. Further, it is difficult to obtain moisture content during the rain season. Thus it is difficult to supply dried logs regularly throughout the year.

For the pilot sawmill, therefore, the pre-dryer system is to be used on an experimental basis. The system utilizes solar heat making use of the geographical location of being directly under the equator and making the most of the merits of both air drying and artificial drying. Though this method has not been used on a commercial basis, pre-drying by solar heat has been experimented for some time in Japan and in the U.S.A., and there is a good deal of literature on the basic experiments and actual situation. The aim of the system is to shorten the initial drying period in a drying room similar to a hothouse, utilizing solar heat to reduce the high moisture content area. It is also provided with equipment to prevent artificially distortion, cracking and other damages unavoidable under air drying.

As for the equipment, in order to utilize solar heat to the maximum extent, the entire roof and the

upper portion of the wall will be made in double plastic boarding for easy absorption of radiant heat. The room will be equipped inside with a sprayer for temperature adjustment and a fan for forced ventilation. With these facilities, moisture content will be reduced to around 25% and the drying period will be shortened to 1/4 to 1/6 of the that required for air drying, preventing at the same time cracking and fungi.

By successful application of this system in the Togian Islands, the concept of utilizing solar heat to the maximum extent is expected to be adopted increasingly for timber drying in future in Southeast Asia.

Table 10: Drying facilities

Unit: Yen

Equipment		
Drying room	25.0×10.5=262.5m^2	25,000/m^2
Fan	3.7kW×12 ϕ1.2m	400,000/1
Aspirator/exhaust pipe	24	40,000/1
Humidifier	Spray nozzle	
Automatic control equipment	ON-OFF control	
Temperature recorder		
Compressor	5.5 kW	
Concrete work	500 m^2	
Water work	200 m^2	1,200/m
Generator	60 KVA	
Electrical wiring, piping, power control board		
Forklift	for 3.5 ton	

6. Technical guidance and training for local employees

For conducting experiments for the purpose of utilizing hitherto unutilized species, a considerable amount of study is necessary even for experienced specialists. Accordingly, for local employees to carry out the necessary tests, they should receive sufficient guidance and training to acquire the necessary knowledge about timber and machinery. In order that various tests on timber and drying and experimental run of the pilot plant may be carried out satisfactorily, basic knowledge of timber and training and guidance regarding the structure of machinery, assembly and function of machinery, sharpening technique, water extraction technique and log drying prior to the introduction of facilities.

2-2-4 Regeneration plan

a) Composition and characteristics of the forest area

The Togian Islands, situated under the equator and with the highest elevation of 542 m (Togian Island), may be described as tropical lowland. With regard to rainfall, since there is no observation station in the islands, the data obtained at Una-Una (Table 15), the nearest coastal town from the islands. According to the table, the annual rainfall exceeds 3,000 mm, and even during the period from December to February, when there are relatively fewer rainy days, over 100 mm of rainfall is to be expected.

Table 11: Rainfall

Monthly average of 25 years
(Una-Una Observation station.
Elevation 3 m above sea level.)

Month	Rainfall	Rainy days
January	133	7.6
February	111	7.3
March	250	12.0
April	335	14.8
May	440	17.3
June	504	18.1
July	376	14.7
August	270	11.5
September	295	11.9
October	246	11.4
November	258	12.5
December	154	7.8
Total	3,372	146.9

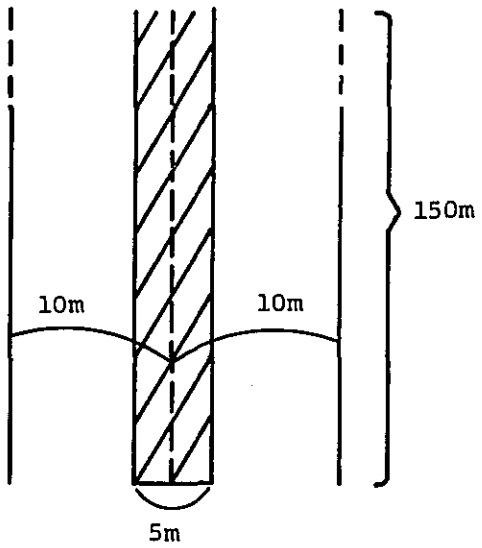
Source: Berlage, Verhandelingen No.37(1949)

Even if the amount of rainfall is less in the Togian Islands, the forests in the islands are so-called tropical rain forests which are composed of many species. Those of commercial size are above the upper-story and the lower-story is very dense, being covered with various ferns, shrubs, regeneration trees and rattans.

Under the present survey, the forests in the islands were divided into three topographical areas: 1) area centering around the ridge; 2) relatively flat area; and 3) undulating area. A belt-shaped survey area was set up for each of the topographical areas and regeneration conditions of young growth were examined. The results are given as Tables 12-1, 12-2 and 12-3.

In the survey area of 20 x 150m (0.3 ha), every tree over 5 cm was examined and classified according to the

Species and diameter class. Further, a sub-survey area of 5 x 150m was set up in the center to examine young growth of less than 5 cm in diameter.
(Table 12 gives per ha numbers converted from the data obtained in the survey.)



These are, however, sample surveys and do not show the composition of the entire forest area of the Togian Islands. They are intended to show variations in forest composition and young growth in different areas and are to serve for natural regeneration tests.

For the present survey 7 species were selected as utilized species for regeneration. Outline of the survey results is given below.

1) Ridge area

With regard to those large-sized utilized trees of over 50 cm in diameter at breast height, 17 of them, mainly Palapi and Dama-Dama, were found, and, with other species together, totalled 34.

As for those medium and small-sized trees of over 5 cm but less than 50 cm in diameter at breast height, there were 102 utilized trees for regeneration, and, with other species together, totalled 947. Their diameter class distribution was fairly balanced.

With regard to young growth of less then 5 cm in diameter, there were as many as 4,500 of which 2,300 were utilized species such as Palapi, Bintangoro and Dama-Dama.

2) Relatively flat area

With regard to the diameter class distribution in this topographical area, those of over 50 cm in diameter at breast height were 35, similar to the survey area 1); but the number of utilized trees was only 6.

Further, the number of medium and small-sized trees was 497, of which utilized trees accounted for only 7%, and only Nantu and Tawan were the main component species. However, there were about 2,400 belonging to young growth of less than 5 cm in diameter, and utilized young trees for regeneration accounted for 29% or 677.

3) Undulating area

The forest in this area can be regarded as a combination of the forests in the two previous categories. The number of those of over 50 cm in diameter at breast height was 39, of which 13 were utilized species.

The number of medium and small-sized trees was 632, of which 48 were utilized species such as Makakata, Tawan and Bintangoro. However, those young trees of less than 5 cm were 1,001, of which utilized species were only 252.

As has been described above, the present survey revealed that there was appreciable difference in forest composition and in habitation of young growth between the areas.

Table 12-1: Utilized Species for Regeneration in Forest Composition (Ridge area): per ha. (unit: numbers)

Diameter at breast height		Utilized species								Others	Total
		Palapi	Makakata	Nantu	Siuri	Tawan	Bintan-goro	Dama-Dama	Sub-total		
Less than 5cm	(Tree height) Less than 1m	462	185	224	92	79	383	634	2,059	Not surveyed	(2,059)
	1 ∿ 2m	17					119	3	139	1,380	1,519
	Over 2m	13					63	17	93	861	954
	Sub-total	492	185	224	92	79	565	654	2,291	2,241	4,532
5cm ∿ 19cm		17				3	10	50	80	693	773
20cm ∿ 29cm		3	3			3		3	12	86	98
30cm ∿										59	59
40cm ∿								10	10	7	17
Subtotal		20	3			6	10	63	102	845	947
Over 50cm		7	-	-	-	3	-	7	17	17	34
Total		519	188	224	92	88	575	724	2,410	3,103	5,513

Table 12-2: Utilized Species for Regeneration in Forest Composition (Relatively flat area): per ha. (unit: numbers)

Diameter at breast height		Utilized species								Others	Total
		Palapi	Makakata	Nantu	Siuri	Tawan	Bintan-goro	Dama-Dama	Sub-total		
Less than 5cm	(Tree height) Less than 1m	66	13	132	-	158	66	-	435	Not surveyed	(435)
	1 ∿ 2m	46	10	30	3	30		3	122	772	894
	Over 2m	66	-	30	-	17	7		120	924	1,044
	Subtotal	178	23	192	3	205	73	3	677	1,696	2,373
5cm ∿ 19cm				7		17			24	364	388
20cm ∿ 29cm						3			3	56	59
30cm ∿				3					3	20	23
40cm ∿						7			7	20	27
Subtotal				10		27			37	460	497
Over 50cm		3		3					6	29	35
Total		181	23	205	3	232	73	3	720	2,185	2,905

Table 12-3: Utilized Species for Regeneration in Forest Composition (Undulating area): per ha.

(unit: numbers)

Diameter at breast height		Utilized species								Others	Total
		Palapi	Makakata	Nantu	Siuri	Tawan	Bintan-goro	Dama-Dama	Sub-total		
Less than 5cm	(Tree height) Less than 1m	-	53	-	-	106	-	26	185	Not surveyed	(185)
	1 ∿ 2m	7	-			3			10	148	158
	Over 2m	17	7			23	7	3	57	601	658
	Subtotal	24	60			132	7	29	252	749	1,001
5cm ∿ 19cm		3	13			10	7		33	458	491
20cm ∿ 29cm						3		3	6	79	85
30cm ∿							3	3	6	27	33
40cm ∿							3		3	20	23
Subtotal		3	13			13	13	6	48	584	632
Over 50cm		7				3		3	13	26	39
Total		34	73	-	-	148	20	38	313	1,359	1,672

b) Natural regeneration method practiced in Southeast Asia

Regeneration technique resulting from the felling of tropical rain forests has been studied mainly for Dipterocarpacease species. Needless to say, these species called Lauan, Meranti (rather light and soft), Kapur, Mersawa and Keruing (medium hard) can be used for plywood, furniture and building, and have been developed since considerably old times. Thus, in those countries with a history of developing these species, study has been conducted regarding sustained production. The existing regeneration methods practiced in these countries, Malaya and the Philippines, may be summarized as follows:

1) Malayan Uniform System (Western Malaysia)

Under this system the proposed felling area is surveyed prior to felling, and those young trees of utilized species are allowed to develop, provided that they are in sufficient numbers. Further, immediately after felling utilized trees, remaining unnecessary trees are medically destroyed and climbing vines are removed to help the young trees grow.

If the number of young trees of utilized species is small, either the increase in the number is to be waited for or planting by means of line planting is to be carried out. In that case the number of young trees should be over 700 per ha and distributed evenly.

2) Modified Selection System (Philippines)

Forests of Dipterocarpaceae species in the Philippines are generally a mixture of large-sized (overmature), medium-sized (mature) and small-sized (young trees). Forest development under this system is to fell utilized trees of over 80 cm in diameter and felling is to be repeated after 35-45 years (to

wait for the growth of succeeding trees).

Since the composition of Dipterocarpaceae forests in the Philippines has a good diameter distribution of utilized species, if the damage on the succeeding trees caused by felling is small, the expected goal can be regarded as being achieved. However, because of the large diameter class of the trees for felling, large yield timber volume and the highlead yarding system, the damage on the succeeding trees is often large.

Therefore, in order to minimize the damage, those succeeding trees of 20-70 cm in diameter (about 60%) are to be marked, and in the case of the marked trees damaged, logging operators who are responsible for the damage are to be fined.

c) Basic approach to regeneration

It is the basic principle of forestry management to produce timber continuously. For the development of forests in the Togian Islands selective cutting is to be adopted to secure forest resources quantitatively.

However, it is important to increase the value of the forest through regeneration and is necessary to establish the technique accordingly. Therefore, an experimental area is to be provided in the Togian Islands for the establishment of the method of natural regeneration suitable for the forests of the islands, based on the method practiced elsewhere in Southeast Asia.

Further, in order to obtain forests of higher productivity utilizing selected species by reforestation, as there is no such record in the islands, an experimental area is to be provided so that reforestation can commence at any time in future.

d) Regeneration test program

i) Test items

Test items planned for the experimental area may be classified into two categories: 1) natural regeneration test; and 2) reforestation technique test. In the former, regeneration conditions will be tested by adopting the Malayan Uniform System and the Modified Selection System, using the forest composition of the planned felling area. These tests will be referred to hereafter as the application test of the Malayan regeneration method and the application test of the Philippine selection system.

The reforestation technique test in the latter may be divided into categories, line planting method and clear cutting reforestation method, depending on the method of planting. In the proposed experimental area, experiments are to be conducted on growth comparison of specimen trees and on planting numbers, which will be described later. Further, in the nursery, tests will be conducted on germination and the size of seedling pot.

The above test items may be outlined as below.

Natural regeneration test:

- Application test on the Malayan regeneration method
- Application test on the Philippine selection system

Reforestation technique test:

- Line planting method — Growth comparison
- Clear cutting reforestation — Planting numbers
- Nursery ..... Nursery practice

ii) Contents of tests and test details plan

Actual contents of the tests and test details plan are to be as follows:

1. Malayan regeneration method

a. Testing area: 20 ha (200 x 500 m at 2 locations)

b. Proposed areas: M-1 and M-2

Testing areas are to be selected in the area of the ridge with many young trees of utilized species as shown by Table 18-1.

c. Species for regeneration:

Based on the utility of the timer and frequency of the young tree, the following 5 species are to be used.

Palapi	(Tarrieitia javanica)
Nantu	(Palaquim obtusifolium)
Bintangoro	(Calophyllum soulattri)
Tawan	(Pometia sp.)
Kayu China	(Podocarpus blumei)

d. Work standards:

1) After final cutting, the above 5 species are to be left intact.

2) All other species of more than 15 cm in diameter at breast height are to be girdled.

3) Unnecessary trees of more than 5 cm in diameter at breast height are to be cleared from where there are young utilized trees.

4) Vines are to be either cleared or destroyed medically.

Work to be carried out 5 years later:

1) A belt-transect method of 5 m in width is to be carried out.

2) If the number of young trees (larger than 5 years previously) is more than 200 per ha, regeneration should be considered satisfactory.

3) Vines and unnecessary trees are to be removed.

2. Philippine selection system

a. Testing area: 20 ha (200 x 500 m at 2 locations)

b. Proposed areas: F-1 and F-2

Testing areas are to be selected in the area where utilized young trees such as Palapi are few.

c. Species for regeneration:

In addition to those listed for the Malayan method, the following are to be used.

Makakata Merah	(Santiria sp.)
Kenari	(Canarium balsamiferum)
Makakata	(Terminaliz microcarpa)
Dama-Dama	(Canarium asperum)
Sugimanai	(Anthocephalus chinensis)
Siuli	(Kourdersiodendron pinnatum)

d. Work standards:

1) Trees for final cutting are to be of over 50 cm in diameter.

2) Before cutting, those species of over 15 cm in diameter, selected for regeneration, are to be marked to minimize the damage which may be caused final cutting and skidding.

Work to be carried out 5 years later:

1) Vines covering the crown of the utilized young growth are to be cleared.

2) All other species of less than 15 cm in diameter are to be cleared.

3) Those regeneration trees which are wolf trees are to be girdled.

4) During the testing period, conditions of forest composition are to be observed.

3. Reforestation technique

3-1 Species for the test

Those species to be used for testing reforestation technique were selected from among the utilized species growing strongly in a natural distribution area with similar conditions to those of the islands or in a transplanted area.

Selection was also made from among those species peculiar to the Togian Islands providing utilized timber with a high rate of growth.

These species may be classified as below according to the purpose of management. Main characteristics of the species will be given in the section iv).

Division	Species	Scientific name	Line planting test			Reforesta-tion test by clear cutting	Remarks
			General wood group	Special wood group	Pulp wood group		
General and pulp wood group	Merkusii pine	Pinus merkusii Tungh. et Dere.				o	
	Caribaean pine	Pinus Caribaea Mor.				o	
	Kamerere	Eucalyptus deglupta Bl.	o			o	
	Albizzia falcata	Albizzia falcata(L) Back.	o			o	
	Jabon	Anthocephalus chinensis (Lank) Rick	o			o	Local species
	Palapi	Tarrietia javanica	o			o	"
	Makakata	Terminalia microcarpa	o			o	"
Special wood group	Mahogany	Swietenia macriphylla King		o		o	
	Canalete	Cordia alliodora		o		o	
	Teak	Tectona grandis				o	
	Cedro	Cedrela odorata L.				o	
Pulp wood group	Gmelina arborea	Gmelina arborea L.			o	o	
	Giant Ipil-Ipil	Leucaena purverulenta			o	o	

3-2 Line planting test

Line planting method is a regeneration method devised in the tropical rain forests of West Africa where commercial species are relatively few. First, a lane (Layon) is cut open in the forest to plant seedlings of utilized species so that the forest will contain more utilized trees. In the second stage of development, natural regeneration will also be used to increase the number of utilized species. This method is known as La Methode des Layons.

This method will be applied to the present experimental area to determine proper species and the distance between the lines.

1) Testing area: 45 ha

2) Proposed area: L-A

3) Species for regeneration: refer to the previous section.

4) Line distance and planting width:

   General and special wood groups:

   Line distance 13 m x planting width 4.5 m

   Pulp wood group: 4.5 m x 3.5 m

5) Plan of the test: Shown later

   In designing the test, 10 lines are to be provided for 1 species.

6) Work standards:

   i. The proposed area for reforestation (cut-over area of utilized trees) is to be surveyed and the base line should be determined after ascertaining the topography.

ii. Lines should be positioned in parallel to the base line and at a prescribed distance.

iii. Those trees of over 5 cm in diameter in the proposed area are to be cleared.

iv. According to the lining plan, lines of about 1.8 m in width each are to be formed by clearing trees and bushes.

v. Those branches covering the lines are to be cleared so that the lines will be in the sun.

vi. Those seedlings in pots are to be planted within 1 week afte rthe opening of the lines.

vii. Care should be taken so that seedlings will not be covered by weeds.

3-3 Reforestation by clear cutting

1) Testing area: 86 ha

2) Proposed area: P-1

3) Species for regeneration: refer to the previous section

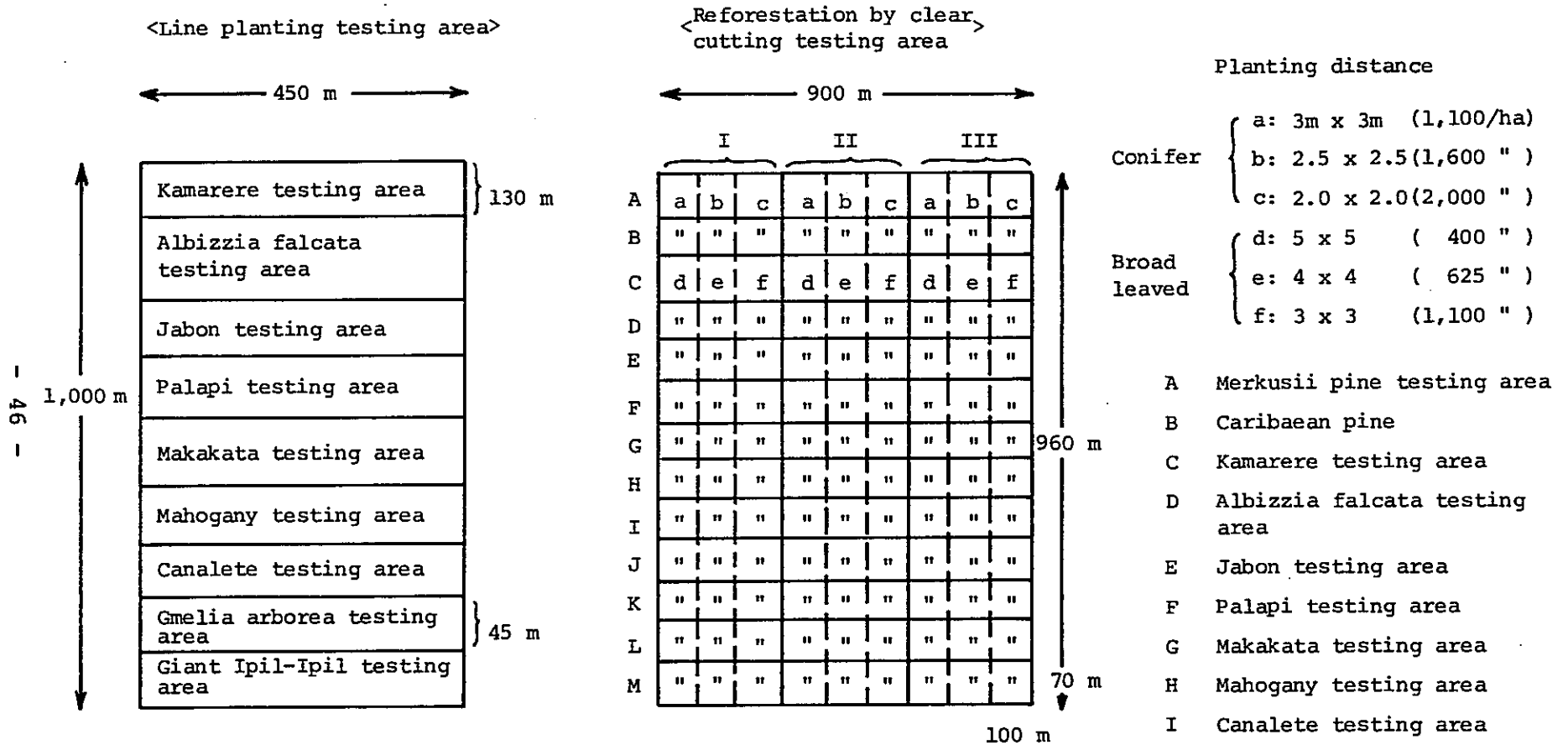
4) Planting distance:

Conifer	3 m x 3 m	(1,100/ha)
	2.5 m x 2.5 m	(1,600 ")
	2.5 m x 2 m	(2,000 ")
Broad leaved	5 m x 5 m	(400 ")
	4 m x 5 m	(625 ")
	3 m x 3 m	(1,100 ")

5) Plan of the test (planting positions): shown later

Standard area for the test are to be 0.7 ha (70 m x 100 m) for each species, and testing of 3 planting width is to be repeated three times.

Testing plan for reforestation



iii) Preparation of the nursery

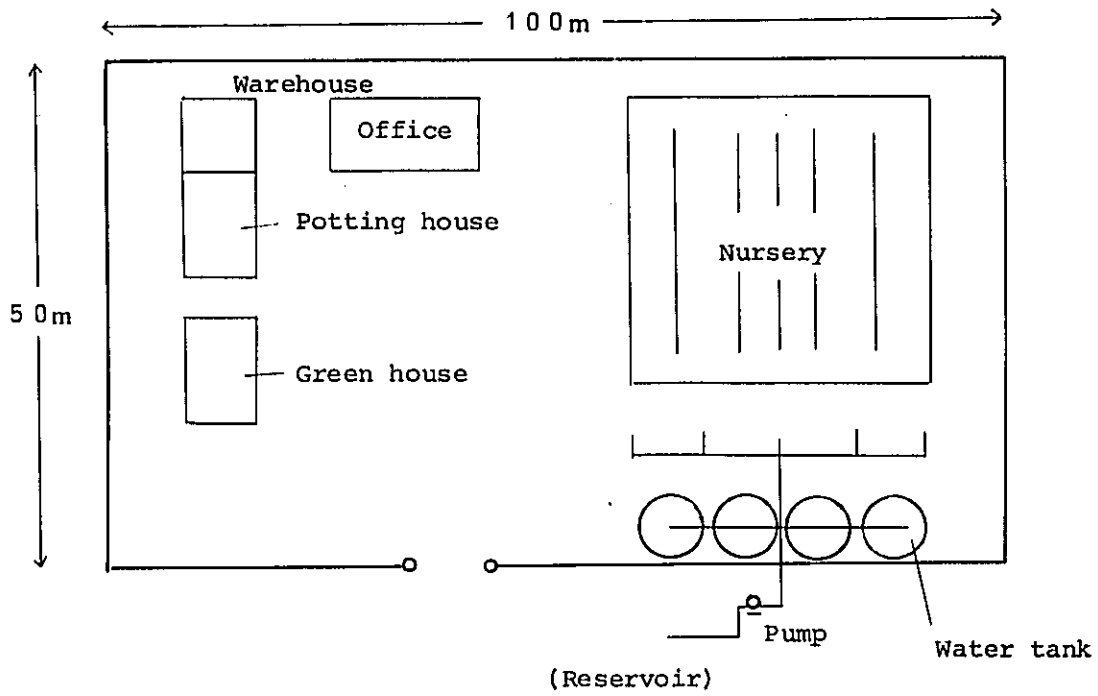
The reforestation test requires about 100,000 seedlings, and a nursery will be provided near the testing area.

1) Nursery area: 0.5 ha

2) Facilities for the nursery:

Item	Q'ty	Remarks
Office	1	
Potting house	1	
Green house	1	
Watering facilities	1 set	For watering
Generator	"	"
Concrete mixer	1	For soil preparation for pots
Sprayer	3	For disinfection
Leight truck	1	For transport seedlings
Tools and equipment	1 set	Refrigerator, equipment for meteorological observation

3) Plan of the nursery



iv) Characteristics of testing species

1) Merkusii pine

a. This species is widely distributed in the continental part of Southeast Asia such as Burma, Thai, Cambodia, Vietnam and Laos, and also in Sumatra of Indonesia, Mindoro and Luzon of the Philippines. In Sumatra the distribution is limited to the northern part (Latitude 2° S-5°30' N), and most of the forests are situated between 800 and 2,000 m in elevation, though they are seen sometimes in lowland of 200-300 m in elevation. Pure forests are normally located near the ridge or on steep mountains.

It is a double leaf pine, growing to the height of 60 m having the girth of 7 m, with straight stem. Sapwood is in light yellow, core in reddish brown, and the wood contains resin. It has air-dried specific

gravity of about 0.55, and is moderately soft and strong with considerable durability. The wood containing resin is extremely heavy (air-dried specific gravity 0.93). It has little cracking, contraction and warping, and is easy to work on. It is suitable for construction, board, furniture, plywood and matches. It is rather heavy for box material for transportation. It is also suitable for paper and pulp production.

b. In Indonesia, reforestation of Merkusii pine has been carried out for the last 50 years with substantial results. Apart from Sumatra, it was introduced to Java where good results were obtained. Thus the area was extended gradually and reached 188,000 ha in 1967, and is still being extended every year. Since ecological requirement of this species differ from place to place, for reforestation in the Togian Islands, it is advisable to select an Indonesian species.

Elevation range for this species in Java and Sumatra is from 0 to 2,000 m above sea level. It adapts itself well to various types of land with the annual rainfall ranging from 3,000-4,000 mm to 500 mm. It does not require fertile soils, and survives in barren land with little permeability. However, best growth may be obtained in wet land of the elevation between 500 and 2,000 m and the annual rainfall of over 1,500 mm with good drainage. It is regarded in Indonesia as the most important species for reforestation in barren and grass land.

c. Thinning, cutting period and yield volume

For the production of saw timber, cutting period is to be 25-30 years with 2 thinnings. With regard to yield volume, the total yield volume under favorable

conditions (volume after cutting off below 7 cm in diameter and after barking) is expected to be 814 m^3 per ha in 30 years. In the area of medium site class, expected results in 30 years will be: average height of 33.5 m, average diameter at breast height of 48.7 cm, per ha total yield volume of 643 m^3 and annual volume increment of 21.4 m^3. (Source: Stand volume table of Merkusii pine in Indonesia.)

2) Caribaean pine

a. It is maintained that there are three varieties of Caribaean pine. Pinus var. Caribaea hondurensis Barr & Golf is distributed, from lowland to the elevation of 1,000 m, in British Honduras, Guatemala, Honduras and Nicaragua of Central American continent (12°13'-18°00' N). Pinus caribala var. Bohamensis is distributed, from 0 to 12 m in elevation, in Bahama Islands and Caicos Islands. Pinus caribaea var. caribarea is distributed, from 0 to 280 m in elevation, in Cuba and the island of Pine. Pinus caribala var. Hondurensis grows particularly well in tropical lowland and is used in many tropical areas for a/reforestation and experiments. In the ideal habitat of British Honduras, it grows to 45 m in height and 1.35 m in diameter; in other habitats the height will be 25-30 m, diameter 30-60 cm with straight stem. The wood is light brown to brown, with resin canals running axial and horizontal. With air-dried specific gravity of 0.75 (0.53 with Japanese red pine), the wood is soft and rather light, but has strength. It is used for general construction, internal fixture, public work, boxing material and pulp.

b. Though Pinus caribaea var. Hondurensis has been used for the last 50 years in tropical areas of the

world for a/reforestation and experiments, actual results are still few with the total area of less than 27,000 ha in 1970. Judging from the experience gained so far, it seems that the ideal place for this species is the area of gentle slope with soils of acid reaction and good ventilation. It is not necessary to have soils of high fertility, but necessary water should be secured in the very dry season.

c. Thinning, cutting period and yield volume

Though thinning has been attempted in many countries, sufficient results have not been obtained because of the young age. However, a few tables of expected yield volume have been prepared from the limited data. For instance, in Malaya, if the purpose is saw timber, per ha total yield volume of those over 7.5 cm in diameter is expected to be 397 m^3 in the cutting period of 25 years. It is also estimated that 20% will be for plywood, 30% for saw timber and 50% for pulp and that the main tree height will be 29.6 m. The average annual volume increment will be largest at about 20 m^3 around the 15th year (with relatively good site class).

In the case of production for pulp wood, per ha yield volume will be 243-362 m^3 in 15 years with planting distance of 2.4 x 2.4 m and without thinning. With medium site class, average tree height will be 25.3 m, producing yield volume of 299 m^3 (diameter over 7.5 cm).

In Fiji, if the purpose is saw timber, total yield volume in 26 eyars will be 722.9 m^3 with the average height of 30.5 m and diameter 50.8 cm. These figures are, however, based on the data obtained from the area of relatively good site class, and the figures for other areas are about 15% lower.

3) Leda (Indonesian name)

Also known as Kamarere (Papua-New Guinea name) or Bagras (Philippino name).

a. This species is distributed in Papua-New Guinea, southern part of Mindanao of the Philippines, Western Sulawesi, Celam and West Irian of Indonesia. In Papua-New Guinea, natural forests of this species seem to be confined to natural bare land or sites of shifting cultivation, with the annual rainfall of 2,500-5,000 mm averaging 3,000 mm and without a long period of dry season. It grows to the height of 73 m and the diameter of 2.44 m. Sapwood is in white to pinkish, core in red-brown to pink-brown. Grain is normally straight, though it is interlocked sometimes. Ribbon figure appears occasionally on the sawn face. Texture is rather coarse, but is balanced with slight luster. Though it does not have durability when in contact with the ground, it has considerable durability in the open air. Thus it is suitable for internal fixtures. Processing is easy, and it can be used for practical furniture, internal structure and flooring with suitability for pulp.

b. Afforestation in Papua-New Guinea began in 1951, and planted land was extended to 736 ha by 1973 (concentrated in Keravat district of New Britain Island).

In the Philippines afforestation by a large cutting firm is in progress; but the history is short and the results are still few. This species is suitable for deep and fertile land with the annual non-seasonal rainfall of 3,000 mm and with good drainage. Though afforestation with this species has not been sufficiently analysed technically, it is being carried out in the countries mentioned above.

c. Yield volume

According to the data obtained from the afforestation area in Keravat (Papua-New Guinea), the average upper-story tree height is 30.5-29.6 m (annual average of 4.7-4.5 m) and per ha volume 262.5-198.2 m^3 (average annual volume increment 40.4-30.5 m^3) after 6.5 years, 48.8-45.7 m (3.1-2.9 m) and 504.3-397.8 m^3 (32.5-25.7 m^3) after 15.5 years, and 52.4-51.5 m (2.5-2.4 m) and 640.1-504.8 m^3 (30.6-24.1 m^3) after 20.9 years respectively.

4) Albizzia falcata

Also known as Sengon Laut (Indonesian name).

a. The habitat is in the Mark Island, north of Indonesia, and is distributed between 0 and 1,500 m in elevation. It is reported to have been observed also in West Irian.

It grows to the height of 45 m. When it is young, the fast growth of the stem checks the growth of branches, thus growing rapidly upward. When the height is sufficiently tall, growth of the stem slows down with the result that branches grow faster. Finally the crown develops in the shape of flat umbrella. Both sapwood and core are white to pale yellow in color and cannot be distinguished from each other. It is light and soft wood of a good range with air-dried specific gravity of 0.24-0.49, the average being 0.37. Grain is slightly interlocked. Though texture is rather coarse, it has very little resistence against diseases and can easily be affected by pests such as termites. Since it is easy to dry and process, it is suitable for veneer. In the producing countries (Philippines and Indonesia), it is used for pulp and

packing material; it is planned to use it for matches and match boxes. In Japan it is used for furniture and fixtures inside cabinets.

b. This species was introduced to Java in 1871, and was used for sheltering at tea plantations. However, because of its fast rate of growth and light wood which is easy to handle, farmers began to plant it. Thus, the timber produced is playing a role in supplying timber to the local area. The Indonesian Government included afforestation with this species in the forestry development project and has been encouraging the forestry by farmers.

In the Philippines, afforestation with fast growing species has been carried out by large cutting firms since the revision of the Forest Law in 1961, and this species is one of the most rpomising ones. The PICOP Company, the only paper-manufacturing company of the country located on the east coast of Mindanao, is encouraging the local farmers to plant this species in addition to those planted by the company for the purpose of securing the resources for the future. This sepcies does not require particularly fertile soils, and grows in dry, wet and saline soils. In the Philippines it is reported to grow well on undulating medium slopes because of the long distribution of annual rainfall. Since it is weak against winds, it is said to be advisable to plant it where it is sheltered from winds.

c. Growth and yield volume

With good soils and sufficient rainfall, it grows to the height of 15 m after 3 years, 21 m after 4 years and 30 m after 9-10 years, then the expansion of the crown begins.

According to the estimated yield volume table published in Indonesia, the average height after 8 years is 32.8 m and per ha total yield volume 488 m^3 (annual volume increment of 61.0 m^3). Even with the land of medium site class, the average height is 29.7 m with the total yield volume of 400 m^3. According to a report prepared in the Philippines, per ha total yield volume is 70-504 m^3, average being 245 m^3, after 8 years.

5) Kelampajan

Also known as Jabon (Indonesian name) and Sugimanai (Sulawesi, Togian).

a. This species is distributed in the countries of the continental Asia from India to China and in the island countries as far as Papua-New Guinea, and grows spontaneously between 0 and 900 m in elevation. It is an extremely intolerant tree, and appears as a pioneer species of the second growth, having strong resistance against weeds. Pure forests may be seen on both sides of a forest road, cut area by tractor skidding, cut area by shifting cultivation, slided land and river banks after flooding. It is one of the local species growing spontaneously in the Togian Islands. Normally it grows to the height of 25-30 m and the diameter of 40-60 cm or 1 m at a suitable location. The stem is straight and the height to the first main branch is large. Large branches extend sideways with the tips hanging down slightly. It has practically no buttress. For a few years after planting, it grows fast upward, then the growth shifts to the branches. As a rule, those branches which came out in youth come off. The wood is pale yellow-white, turning to cream later. There is no distinction between sapwood and core.

The grain is straight. The texture is moderate to rather fine and well balanced, having no scent or taste. The air-dried specific gravity ranges from 0.3 to 0.6. Processing is easy; but good finish may not be obtained. Veneer cutting is reported to be easy. It rots easily when exposed to wind and rain or in contact with the ground. It is suitable for matches of poor quality, tea chests, packing boxes, toys, wooden sandals and temporary light structures. It can also be used for pulping.

b. It is considered to be important in Indonesia and the Philippines as the species for afforestation. It is planted by many farmers in Indonesia. Since the wood is suitable for match sticks, it is one of the major species for afforestation in the forestry development project. In the Philippines it is planted by large cutting firms together with Albizzia falcata and Eucalyplus deglupta for afforestation. According to the experience gained so far, it is supposed to have more resistance than Albizzia falcata against strong winds.

This species generally prefers soils with good drainage and with the annual rainfall of 1,500-5,000 mm, and is reported to grow well in a climate with a dry season and also in a constantly wet climate. This species has a special characteristic of regeneration by sprout. In the Philippines, larvae of a moth harm the tree sometimes as they favor the leaves, but it is said to be preventable with medical spray.

c. It is reported that this species grows fast for a few years after planting but the growth slows down after that. It grows to the height of 9 m after 4 years and to 30-36 m after 22 years. In Indonesia

a tentative yield volume table has been prepared, though there is not sufficient amount of data. This table gives figures obtainable by the so-called standard operation which includes thinning of medium intensity. According to the explanations given, it grows, in the case of land of medium site class, to the average height of 11 m and the average diameter at breast height of 11.8 cm after 3 years. 5 years later the annual increment of 1.7 m will be obtained. After that, however, it will decrease gradually to 0.2 m in the 25th year. Accordingly, it will reach the period of maximum average annual volume increment 9-12 years after planting with the land of medium site class. At that point, per ha yield volume (final cutting and thinning together) will be 145-191 m^3, average height of final cutting 19.1-21.2 m and the average diameter at breast height 23.6-27.1 cm.

6) Mahogany

a. This species is widely distributed from the south of Mexico to Columbia along the Atlantic coast and also in the north of South America, Venezuela, Ecuador, Peru, Bolivia and Brazil. The habitat includes level land and mountain areas of low and medium elevation up to 1,500 m above sea level with the annual rainfall of over 1,500 mm.

This species grows to the height of 40-45 m with the diameter of 2 m. It is a leaf-shedding species, and the stem is normally cylindrical. Its sapwood is yellow-white and heartwood is in pale brown. The surface has beautiful yellow luster. The texture is fine to medium. The grain is straight to interlocked with wavy or eddy figure appearing sometimes. The wood is rather light but has strength with the air-dried

specific gravity of 0.5-0.6. It has good durability and resistance against bacteria, pests and termites. It is easy to process and finish is good with luster. It provides outstanding material for furniture, and is also suitable for quality cabinetwork, fittings and internal decorations of houses and ships, yachts, propellars of aircraft, lathework, sculpture and musical instruments (like piano), commanding good prices.

b. It is widely used as shade trees in Southeast Asia, and is used for substantial afforestation in Central and East Java. It is also used for afforestation and experiments in Fiji and other tropical areas.

c. Growth

It is a fast growing species, reaching the height of 5-6 m in 3 years and the average annual increment of 15-20 m^3 in 50-60 years.

7) Canalete

a. This species is distributed in the various areas of Central America to the south of central Mexico, various areas of South America as far as Ecuador, Peru, Bolivia and Brazil, and in the West Indies. It is an evergreen tree growing to the height of 45 m and the diameter of 70 cm, with straight stem. Its sapwood is in pale gray and heartwood in greenish coffee of dark greenish coffee, and attracts attention with many dark green figures. The distinction between sapwood and heartwood is not clear. Its air-dried specific gravity is 0.45-0.57 and is solid with medium hardness, wegiht and strength. The texture is fine to medium and the grain is normally straight. It has good durability and is strong against termites. Processing is easy with good finish. It is used for quality furniture, cabinetwork,

decorative sculpture, internal fittings of houses and ships, lathework and musical instruments.

b. Since the nursery practice is easy and growth is fast, it is planted in south Florida and other areas of the U.S.A. It is also used for shelter trees at coffee plantations and for garden trees. According to a report obtained in Puerto Rico, it grows to the diameter of 50 cm in 25 years, and is regarded as an outstanding species for line planting reforestation. In the experimental planting in New Hebrides, it reached the height of 10.8 m and the diameter at breast height of 11.7 cm after 3 years. In the Solomon Islands, it is reported to have grown to the height of 15.4 m and the diameter at breast height of 17 cm.

8) Teak or Djati (Indonesian name)

a. This species is distributed from the Indian Peninsular through the eastern part of India to Burma, Thai and Laos, and also in Java and Bhuton of Indonesia. In Java it grows in the lowland of central and eastern parts of the island with the elevation of less than 500 m, where the monthly rainfall is below 60 mm for 3-5 months of the year. The height is normally 25-30 m with the diameter of 1 m at breast height. It is a medium leaf-shedding tree and occasionally grows to the height of 50 m and the diameter of 2 m. Its wood is one of the most important woods in the world because of its superior physical properties. The wood is in gold-brown and turns to brown-black after a lapse of time. It is rather hard and rather heavy with the air-dried specific gravity of 0.6-0.7. The grain is straight or interlocked. It is superior in strength and also has good durability. It is easy to process with beautiful finish. It is used for practically

everything, but of high quality. It is used for furniture, sculpture, cabinetwork and internal decorations. It is also used for shipbuilding because of its dimentional stability. It is also superior for decorative purposes and is used for the surface of furniture.

b. In Indonesia, it has been used since the end of the 19th century for afforestation, and has about 500,000 ha of afforestation area as of 1965. Since it is a well-known species, it has been used for afforestation in tropical areas of the world. Teak grows in well-ventilated land with good drainage, as long as the soils are deep; the best soils are said to be sandy loam and it does not have to be fertile.

c. Cutting and growth volume

The cutting period is 80 years with repeated thinning. When it is young it grows fast, reaching the hegiht of 3 m in 2 years and 5 m in 5 years. The growth slows down after that, and it grows only a little after 50 years. According to a table of yield volume prepared in Indonesia, it grows to the average diameter of 48 cm and the height of 33 m in 80 years on the land of medium site class. The growing stock of final cutting will be 228 m^3 (per ha) with the average annual growth of 5.9 m^3 (per ha), which is fairly small. As has been described above, the natural growth area of teak has a dry season and the afforestation area in Java is located in such environment. On the other hand, good results have been obtained in Papua-New Guinea by planting teak in tropical rain forests. Though the best growth was recorded under conditions different from those natural for teak, it may be inferior in physical properties. However, in

view of the superior physical properites of teak, afforestation of teak in such tropical rain forests for a shorter cutting period should be given full consideration.

9) Cedro

a. This species is distributed widely in Latin America from Missiones district of Argentine of 27° S to the slopes on the Pacific coast of Mexico of 24° N with a wide range of temperature at the habitat. It appears most often where the annual rainfall is 2,000-3,000 mm with a dry season of 2-3 months.

It is a leaf-shedding tree, growing to the height of 30-37 m and the diameter of over 1 m under suitable conditions. The stem is straight and cylindrical. Its wood is yellow-white to pale brown in sapwood and reddish brown in heartwood. Sapwood is thin and heartwood has the unique refreshing scent. With the air-dried specific gravity of around 0.5 the wood is soft and light, but thas considerable strength. It has medium durability and resistance against pests. The grain is normally straight and the texture is rather fine. Good grade wood has a good color tone, grain and a scent, and is attractive. It is used for many purposes such as ordinary structures, fittings, furniture and plywood. In the Western countries it has used for cigar boxes.

b. It has been used for afforestation and experiments in the provenance, Africa and Asia. Its fruits and seeds are small, though they are similar to those of Mahogany.

It bears 45,000-50,000 grains of seed per kg. They loose their vitality soon unless they are completly dry. According to a test report prepared in Puerto

Rico, after storing the seeds in a sealed container at 2-4°C for 4 months, 31-34% of them germinated. In a test carried out in the Philippines, storing them in a sealed container at room temperatures, 97.4% germinated after 21 days, 80% after 63 days, 27% after 119 days and 0% after 161 days. With regard to growth, the following report is available (Nigeria).

1)

Tree age	Average tree height	Average diameter at breast height	Per ha total yield	Average increment (final cutting)
25 years	32 m	42 cm	315 m^3	12.6 m^3
32 years	36 m	47 cm	317 m^3	11.8 m^3

2) It grows to the average diameter of 71 cm at breast height after 40 eyars, with per ha yield volume of 455 m^3. Afforestation of this species has often failed because of the damage caused by Hypsipyla sp., and, therefore, cannot be recommended at this stage.

10) Gmelina arborea. Yemane

a. This species is widely distributed in West Pakistan, Southeast and South India, Nepaul, Sikkim, Assam, East Pakistan, Sri Lanka, Burma, Thai, Laos, Cambodia, Vietnam and South China. The habitat with the best growth has the mean annual temperature of 18.3°C-35.0°C, a clear dry season but with the humidity of over 40%, and the rainfall of over 1,500 mm with the ideal amount being 1,800-2,300 mm. Under favorable conditions, it grows to the diameter of 60-80 cm. However, it has normally a short life span, and tends to die in a small size unless the environmental conditions are extremely favorable, with the growth slowing down rapidly

from about the 7th year. Accordingly, it should be regarded as unsuitable for rain forest areas. Single trees have many branches, and the stem is not straight with a great deal of taperness. However, at a suitable location with suitable thinning, it will form almost straight crown with little taperness. Its wood is in pale yellow-brown to cream in color, and there is no clear distinction between sapwood and heartwood. The texture is medium with the grain rather interloced. With the air-dried specific gravity of 0.40-0.54, heartwood medium durability. Sawing and veneer cutting are easy and the surface has luster. It is used in the producing areas for beams, bells for cattle (wooden), wooden shoes, boat deck and canoes. It is also suitable for pulp, linings of furniture, boxes and matches (both boxes and sticks).

b. It is used, as a fast growing species, for afforestation and experiments in tropical areas of Southeast Asia, Africa and Latin America. Favorable climatic conditions at the habitat are: temperatures 18°C-35°C, a clear dry season but the humidity of not less than 40%, average rainfall of more than 1,500 mm with the ideal amount being 1,800-2,300 mm, fertile and deep soils with sufficient moisture. Though it shows liverly growth in tropical rain forests having the annual rainfall of neraly 4,000 mm, growth falls off rapidly after 7-8 years.

c. Growth

This is a fast growing species, and the growth in the first 7-8 years is particularly lively. However, it tends to fall off thereafter. According to a report obtained in the Philippines, the 4th year stand showed the annual increment of 4.6 m in

height and the annual increment of 42.4 m^3 in volume, while the 6th year stand showed 3.37 m and 29.73 m^3 respectively. A report from Africa estimates the annual increment of 25.2 m^3 for the 8th year stand.

11) Giant Ipil-Ipil (Philippino name)

a. This species is distributed in the northern part of Mexico and the southwestern part of Texas, U.S.A. It is reported to be reaching the height of 20 m and the diameter of 50 cm at the habitat. Originally it belongs to the genus of Leucaena, and generally grows as a shrub. Since the leaves can be forage for cattle, it is imported into Hawaii for that purpose. Giant Ipil-Ipil in the Philippines was also introduced from Hawaii, and was classified as Leucaena Purverulenta; but this has not been established. It is sometimes regarded as a species of L. Leucocaphala.

Giant Ipil-Ipil does not grow big enough to be used for sawing, but is showing satisfactory growth in the Philippines. Thus a cutting firm Agsan district of Mindanao is carrying out afforestation of this species to supply fuel for its plant. It is also used for supports at banana plantations, and is said to be suitable for pulp.

v) Annual plans

(Unit: ha)

Testing area	1st year	2nd year	3rd year	4th year	5th year	Total
Malayan regeneration method	10	10				20
Philippine selection system	10	10				20
Line planting test	Prepa-ration of nursery	10	10	10	15	45
Reforestation by clear cutting		14	28	28	20	90
Total	20	44	38	38	35	175

2-3 Plan for improvement of related facilities

2-3-1 Basic approach to improvement of related facilities

Before considering the basic approach to the improvement of related facilities, present situation regarding social capital of the Togian Islands may be summarized as below.

The means of transportation to the main island of celebes is a regular shipping service a few times a month. It takes 6 hours by ship to Pagimana, the nearest town. The only means of communication is radio broadcasting from Gorontalo across the waters.

With regard to roads, a few hundred meters of footway from the landing place are the only roads in every village in the islands. As for connecting roads between villages, the stretch of 4 km between Bangkagi and Benteng is the only one of its kind. In the field of medical service, there is a nurse acting also as a midwife in the village of Wakai, and those who require a surgical treatment have to go all the way to a hospital in Gorontalo or elsewhere.

In education, 17 elementary schools are scatterd in the 3 islands in the project area, and they are poorly equipped. There is an intermediate school in Unauna with its branch in Tobiru of Taratako Island; but those students from other villages have to find accommodation with their relations or elsewhere.

Local people have to obtain drinking water and washing water from a nearby river or a fountain, and, needless to say, there is no electricity supply.

Thus, living environment in the Togian Islands is extremely poor, and there are virtually no related facilities.

With regard to the population of the project area, which forms the basis of the plan for the improvement of related facilities, it is estimated that the total population of the 3 islands is about 12,200 as of 1977.

With the commencement of the development project in future, those connected with the project and merchants may

contribute together with a natural increase to a considerable increase in population, and population structure is expected to change markedly. With the improvement of the road network, local residents may move to different places and may change the positions of villages.

In order to increase social capital and improve living environment, the improvement plan is to place emphasis on Wakai Village and the following facilities are to be improved.

(1) Transport facilities
(2) Communication facilities
(3) Medical facilities
(4) Educational facilities
(5) Water supply
(6) Electricity supply
(7) Religious facilties

The basic approach to the improvement of facilities may be outlined as below.

(1) Transport facilities

1) Shipping: a speed boat is to be stationed at Wakai as a means of transportation in cases of emergency such as illness and official business.

2) Pier: the existing pier at Wakai is to be improved.

3) Road: the main objective is to connect major villages.

Eerries are to be deployed in channels for prompt connections.

(2) Communication facilities

It is technically difficult to install wire telephone. Therefore, radio telephone is to be installed.

(3) Medical facilities

A clinic is to be set up at Wakai with a resident doctor so that simple treatment and limited hospitalization may be possible.

(4) Educational facilties

Those elementary schools scattered in 17 villages are to be incorporated into a few schools to improve school facilities. For the present the elementary school at Waki is to have an additional building, and a new intermediate school is to be established.

(5) Water supply

A fountain which is located about 3 km from Wakai is to be the catchment area. Water is to be conducted from there to Wakai to be distributed to the project base and the village, which is to have a few outlets for communal use.

(6) Electricity supply

Power supply is to be designed mainly for the base and for the development of Wakai.

(7) Religious facilities

In order to ensure the stable basis for spiritual life of the residents, a mosque is to be constructed in Wakai.

2-3-2 Improvement programs for related facilities

a) Facilities relating to transportation

i. Shipping

A speed boat (capacity: 6 persons) is to be put into service for emergency.

ii. Pier

The existing pier is to be renovated to a wooden pier of 30 m in length and 6 m in width. (see Fig.)

iii. Road

In order to connect major villages in the island and to provide a circuit for the three islands, a graveled 6-meter road is to be constructed, and two ferries are to be deployed in the two channels.

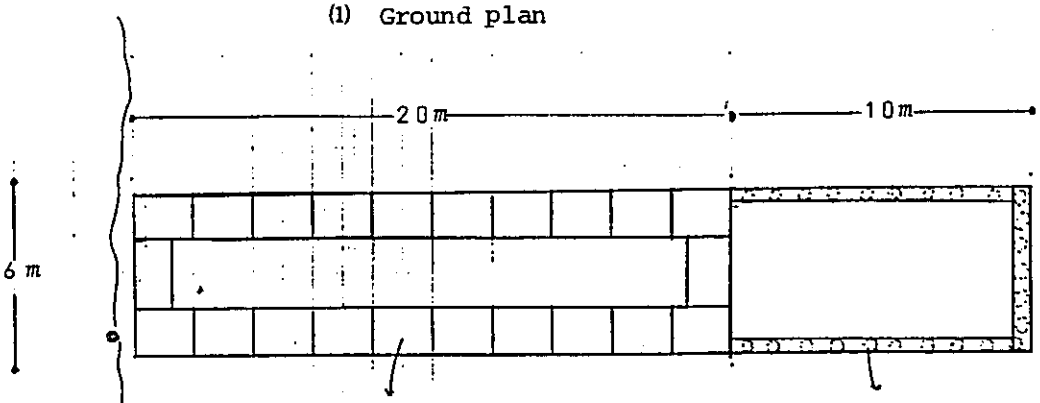
Road network:	see Fig.	
Total extension of road:	Togian	57 km
	Batudaka	50 km
	Talatakoh	21 km
	Total	128 km

o Equipment and machinery for road construction

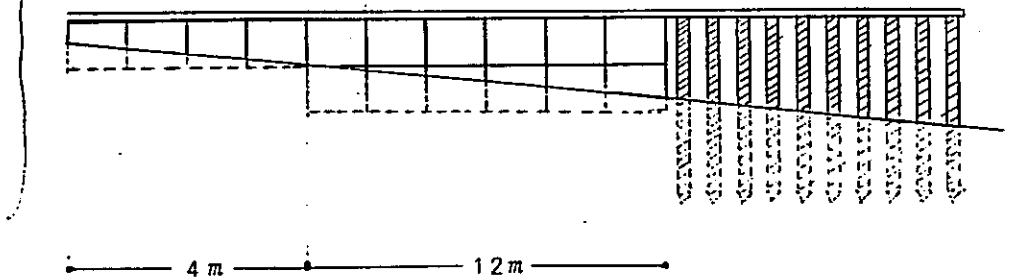
Name of machines	Quantity
Bulldozer	1
Dozer shovel	1
Grader	1
Dump truck	3
Crusher	1
Air compressor	1
Concrete mixer	1
Winch	1
Other equipment	1 set

Plan of the Pier

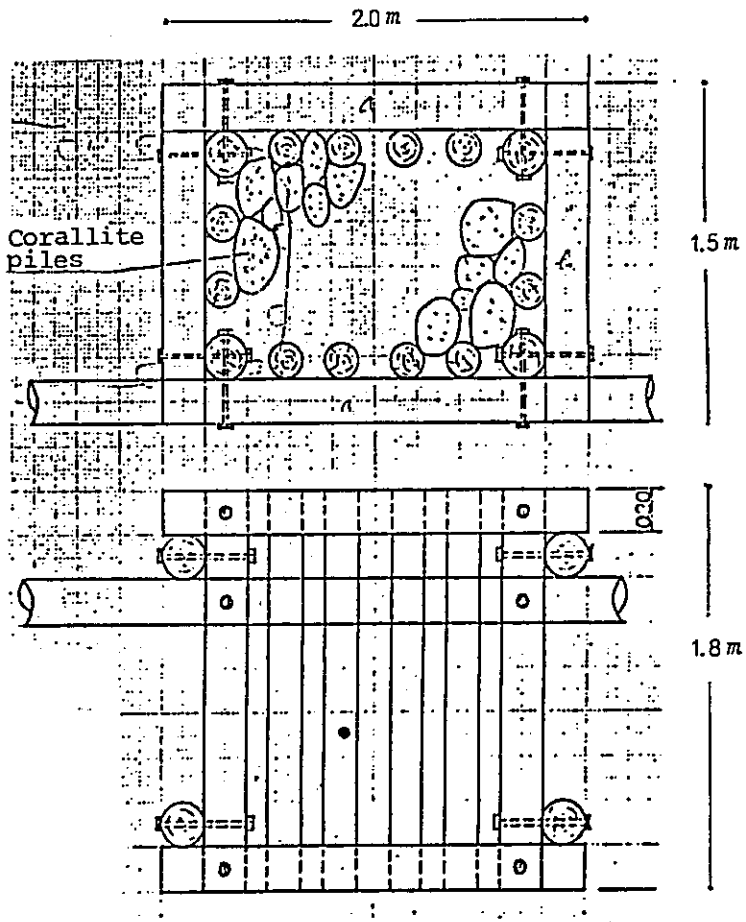
(1) Ground plan

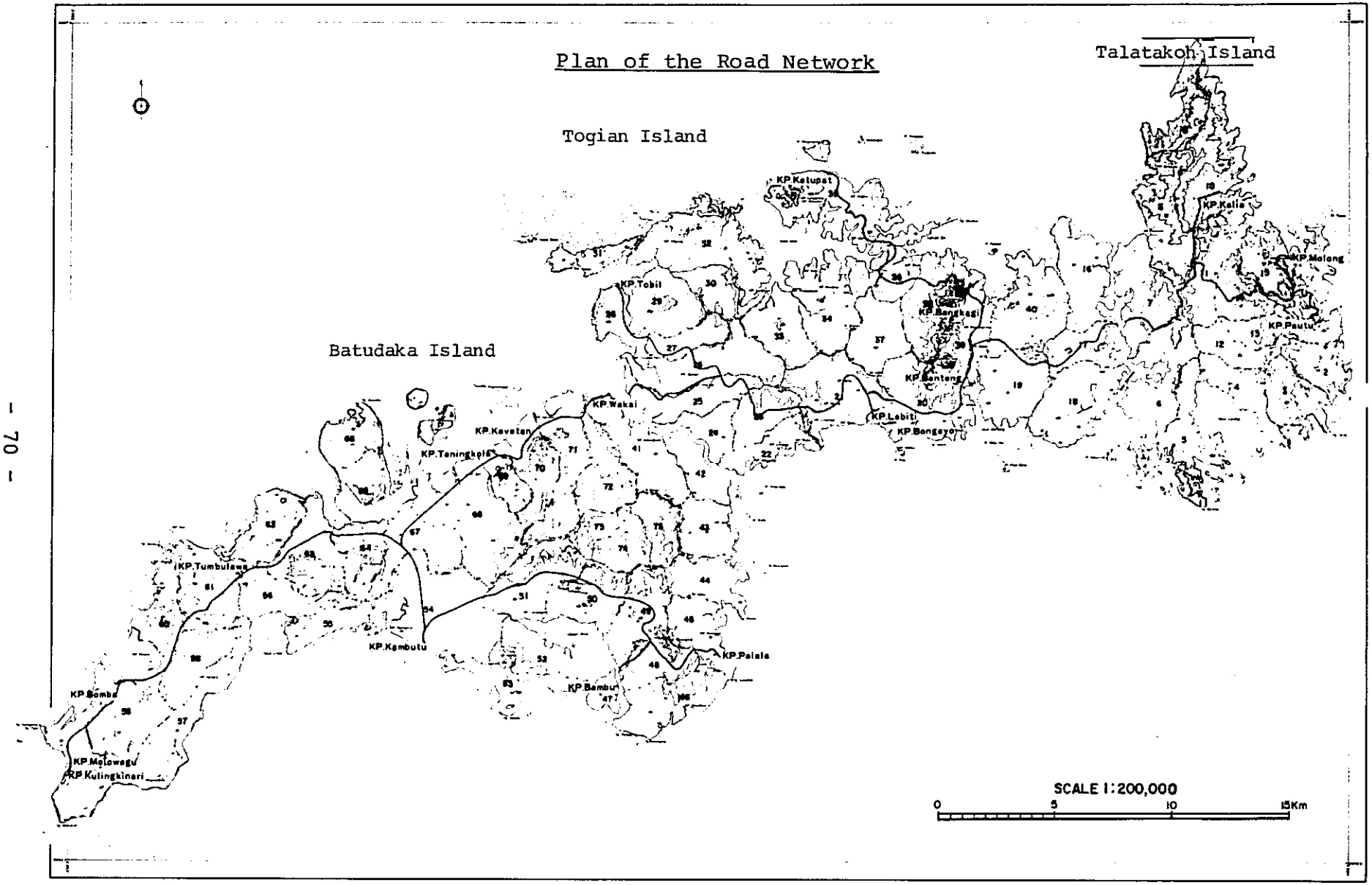


(2) Side view



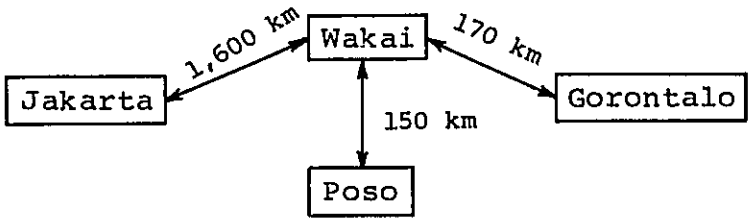
(3) Details of the box assembly




Plan of the Road Network
Talatakoh Island
Togian Island
Batudaka Island
KP.Ketupat
KP.Kalia
KP.Malang
KP.Tobil
KP.Bangkasi
KP.Pautu
KP.Bentang
KP.Wakai
KP.Kayetan
KP.Taningkola
KP.Labiti
KP.Bongoyo
KP.Tumbulawa
KP.Kambutu
KP.Palala
KP.Bambu
KP.Bomba
KP.Melawegu
KP.Kulingkinari
SCALE 1:200,000
0
5
10
15Km

b) Communication facilities

HF and SSB radio telephone are to be installed as shown below.



As for equipment, 125W SSB is to be installed at Wakai and Jakarta, and 10W SSB at Poso and Gorontalo.

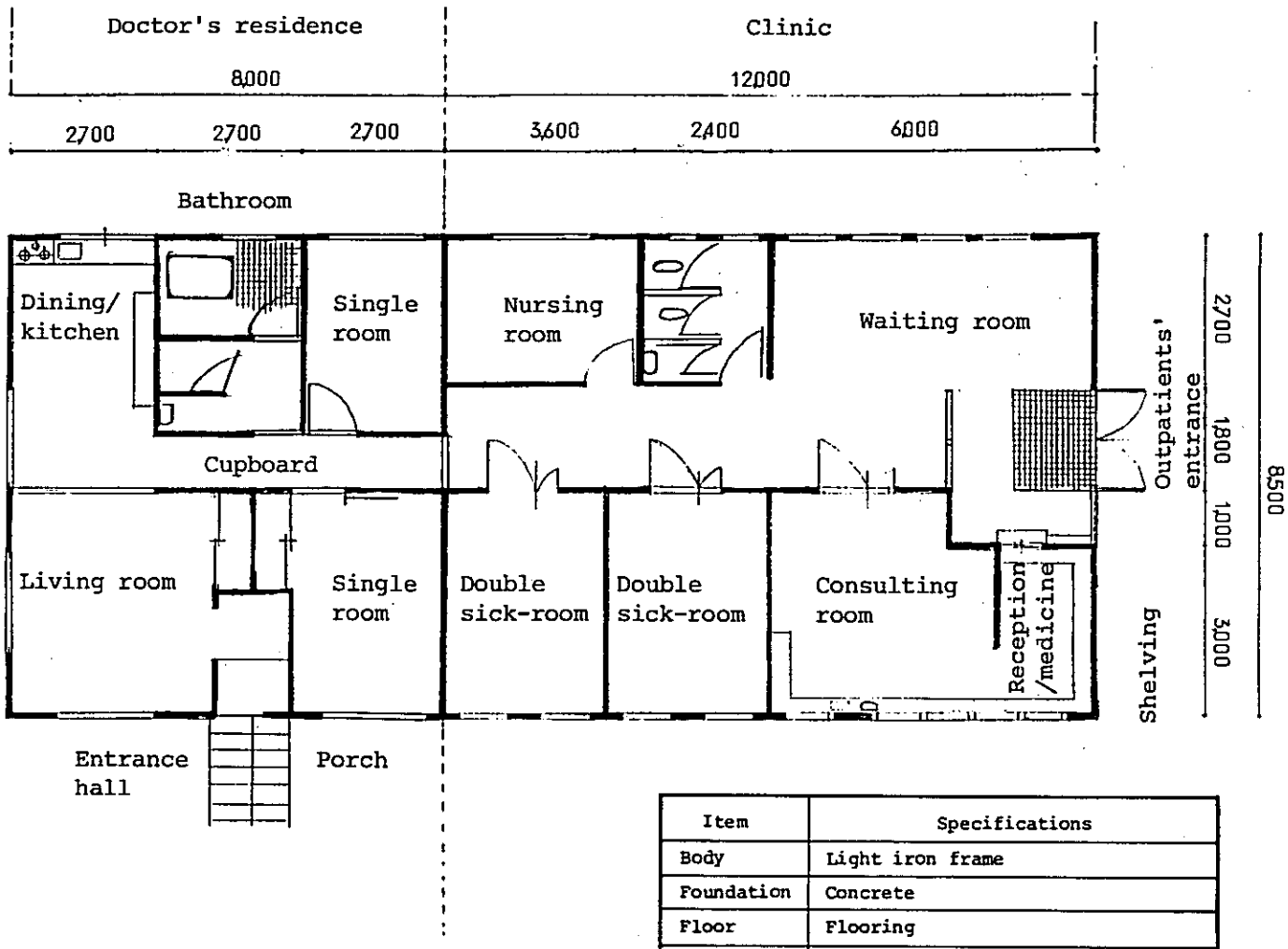
c) Medical facilities

A clinic with consultation room and sick-rooms is to be constructed. A residence for a resident doctor is also to be constructed. (see Fig.)

d) Educational facilities

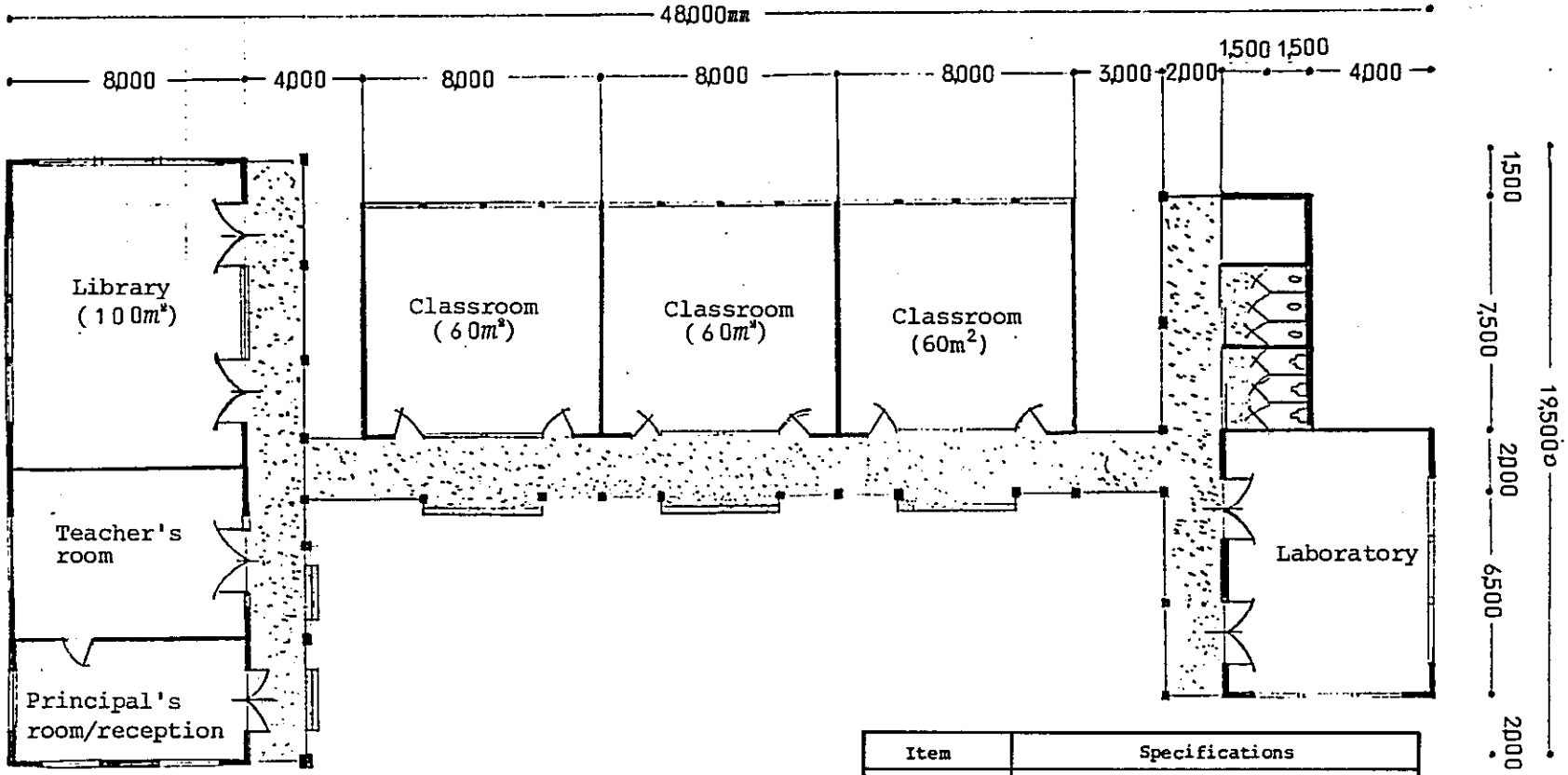
A new intermediate school (3 class rooms x laboratory, etc.) providing 1 class for each grade is to be constructed. An additional building (2 class rooms x spare room) is to be constructed for the elementary school.

Plan of the Clinic



Item	Specifications
Body	Light iron frame
Foundation	Concrete
Floor	Flooring
Wall	Asbestos cement (outside)
"	Print plywood and board (inside)
Roof	Panelling, Long sheet colored zinc
Ceiling	Fancy plywood
Window	Steel sash

Plan of the Intermediate School 2



Item	Specifications
Body	Light iron frame
Foundation	Concrete
Floor	Plastic tiles
Wall	Asbestos cement board (outside)
"	Print plywood (inside)
Roof	Roofing panels
Ceiling	Sound absorbing material
Floor (passage)	Concrete mortar
Window	Steel sash

e) Water supply

The fountain which is located 2.5 km to the southwest of Wakai is to be the catchment area. Water is to be conducted from there, through the 1st water tank (equipped with simple water purification unit), to the natural flow tank (see Fig.).

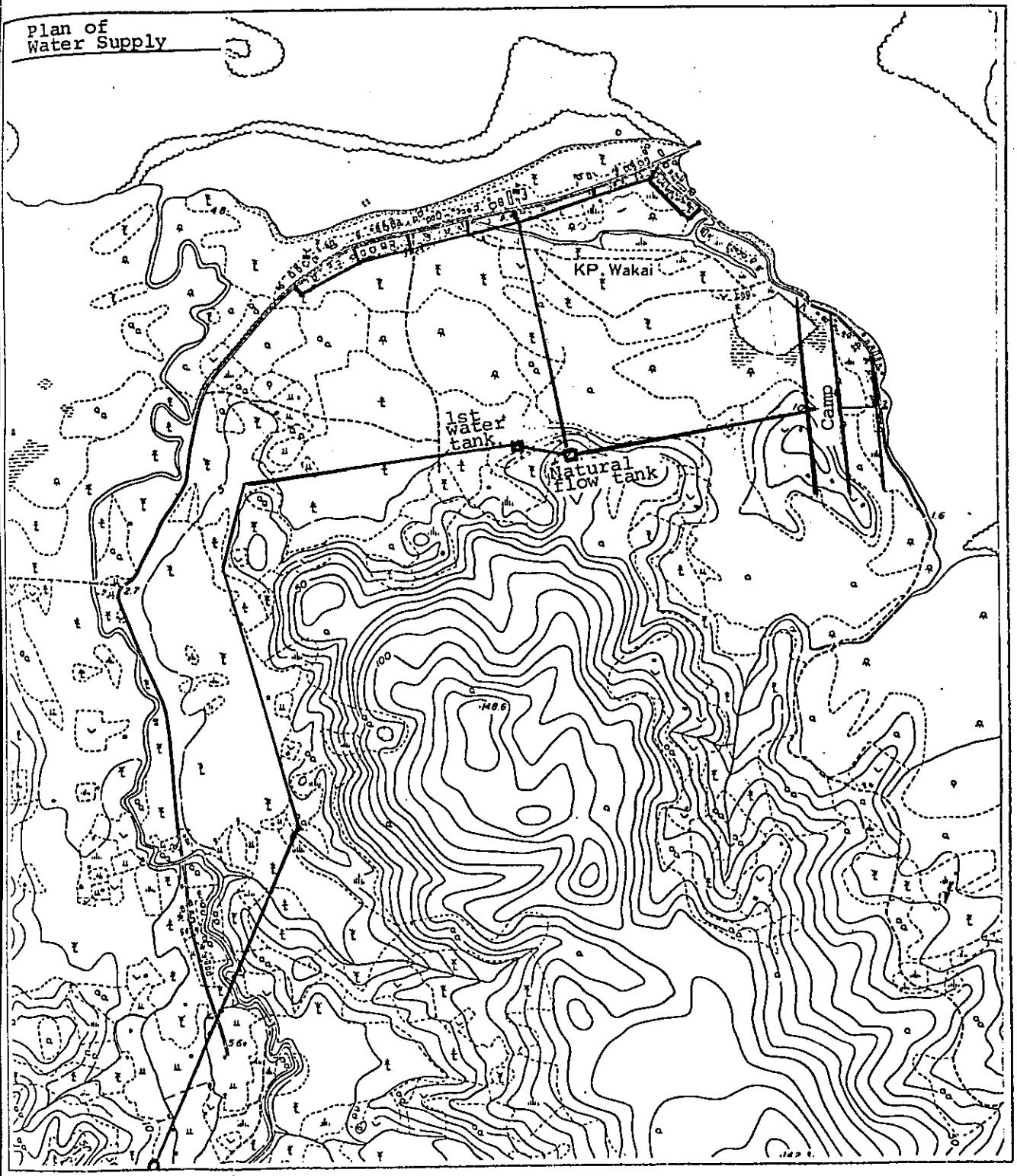
Wakai Village is to have 8 outlets for communal use.

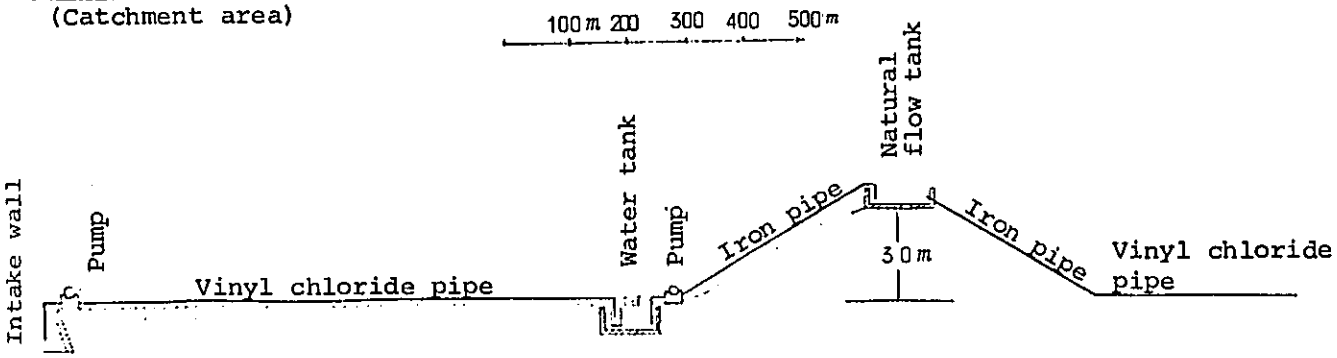
f) Electricity supply

Generator (50 Hz, 100 KVA) is to be installed at Wakai base to supply power to the base and to the village. (see Fig.)

g) Religious facilities

A mosque which can accommodate about 200 persons is to be constructed at Wakai. The mosque is to have a central plaza surrounded by a cloister apart from the chapel.


Plan of
Water Supply
KP. Wakai
1st
water
tank
Natural
flow tank
Camp
(Catchment area)
100m 200 300 400 500m


Intake wall
Pump
Vinyl chloride pipe
Water tank
Pump
Iron pipe
Natural
flow tank
30m
Iron pipe
Vinyl chloride
pipe

Plan of Electricity Supply