

# CHAPTER 7

## WATER RESOURCES

Relevant hydrologic data on the surface and ground water resources of the Jengka Triangle have been assembled and assessed in relation to agricultural development and water supply. Soil infiltration rates and soil moisture deficiencies have also been considered.

### STREAM DISCHARGES

The major streams of the Jengka Triangle are the Jengka, Jempol and Tekam, each having catchment areas of 200 square miles or more (Figure 7-1). The Sungai Pahang, one of the largest rivers in Malaya, which borders the Triangle on the west, is too far from the proposed villages for development as a water source.

Stage and discharge records were not available for any of the Jengka Triangle streams and it was necessary to derive stream flow data from external sources. Based on comparisons of rainfall patterns, the Jengka Triangle area is climatically similar to Selangor, most of Perak, and western Pahang, and the patterns of stream discharges (partly dependent on rainfall) within the Jengka Triangle will be similar to stream discharges in those areas. Accordingly, estimates of discharges for Jengka Triangle streams were based upon the analysis of 33 streams in Selangor, Perak and western Pahang for which the Drainage and Irrigation Department has maintained many years of stage and discharge records (Appendix 7-1).

### Annual and Monthly Discharges

Mean annual and monthly discharges of Jengka Triangle streams have been estimated at about 50 per cent of mean annual and mean monthly rainfall (Table 7-1). The manner in which the annual rainfall is distributed between evapo-transpiration and total run-off, consisting of stream base flow and surface run-off, is illustrated in Figure 7-2.

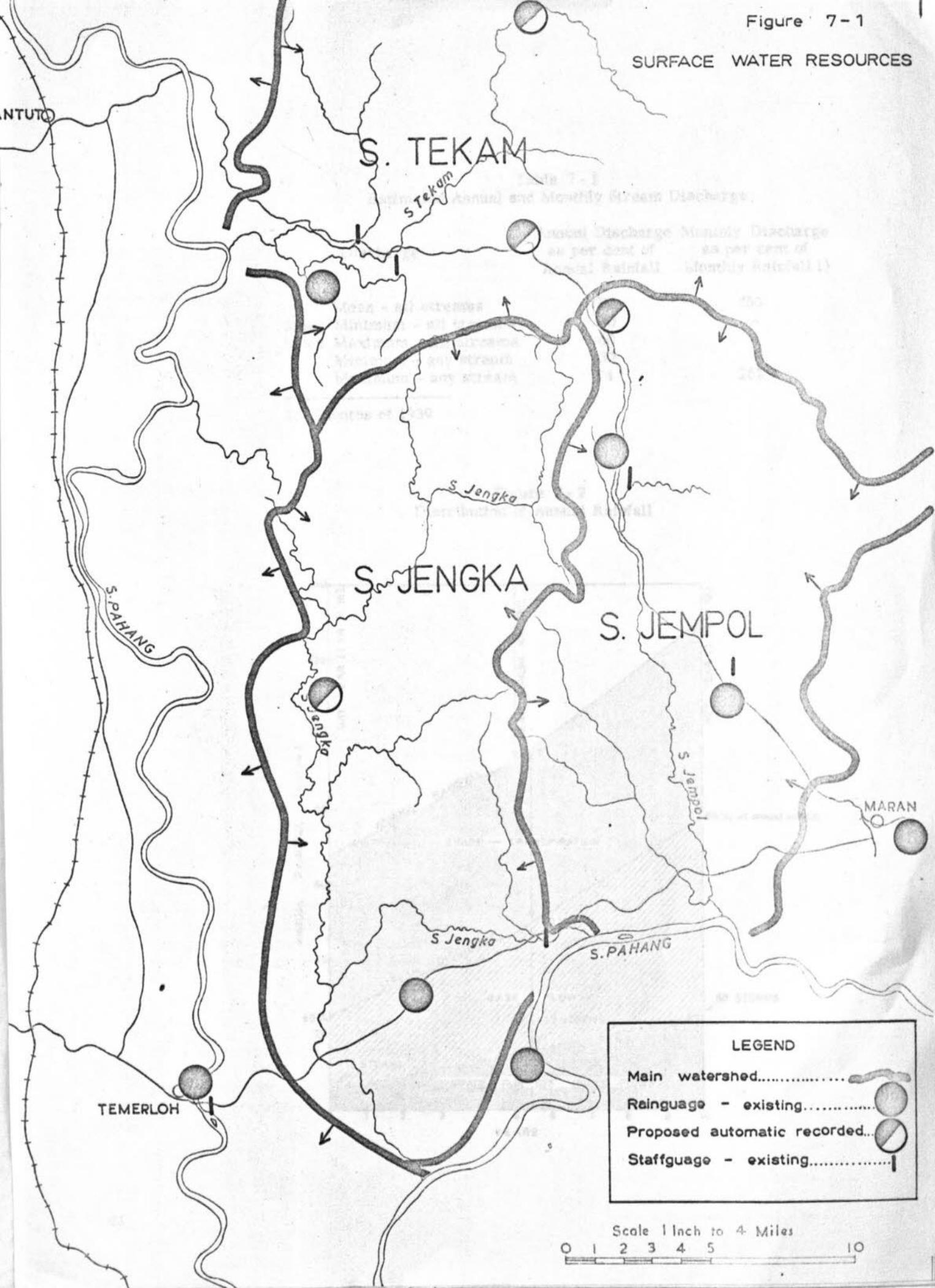
The surface run-off in the Jengka Triangle is probably almost all derived from rain storms of one inch or more, which occur 30 times in the average year, 10 times in dry years and 50 times in the wet years where the dry and wet years have a statistical probability of occurrence of about one year in ten. The mean run-off from such storms does not exceed about 0.5 inches per storm.

Estimated monthly stream discharges follow a considerably more variable rainfall-discharge relationship than do annual values. This is largely due to evapo-transpiration which is estimated to have a mean value of about four inches per month. Thus heavy monthly rainfall may be utilized in replenishing soil moisture deficiencies caused by evapo-transpiration losses occurring in previous dry months.

Proposed automatic recording  
Startpage - existing

Figure 7-1

SURFACE WATER RESOURCES



**LEGEND**

- Main watershed.....
- Rain gauge - existing.....
- Proposed automatic recorded.....
- Staffgauge - existing.....

Scale 1 Inch to 4 Miles  
0 1 2 3 4 5 10

Table 7-1  
Estimated Annual and Monthly Stream Discharge

Discharge	Annual Discharge as per cent of Annual Rainfall	Monthly Discharge as per cent of Monthly Rainfall 1)
Mean - all streams	50	50
Mean Minimum - all streams	40	-
Mean Maximum - all streams	60	-
Minimum - any stream	30	9
Maximum - any stream	74	265

1) Months of 1939

Figure 7-2  
Distribution of Annual Rainfall

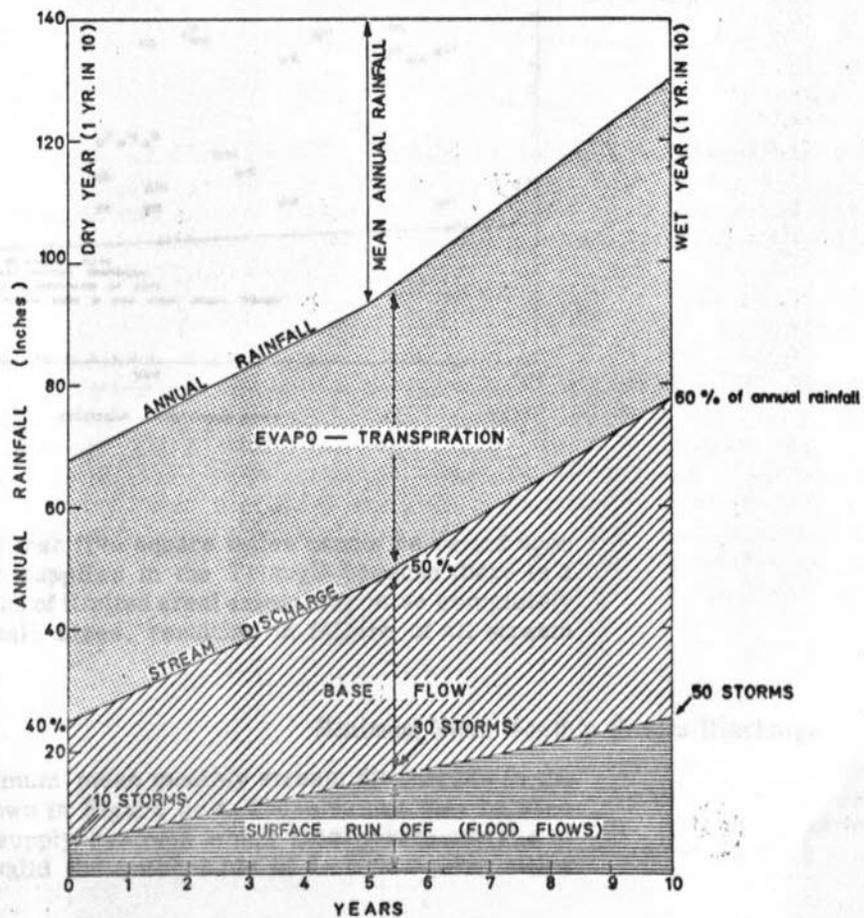
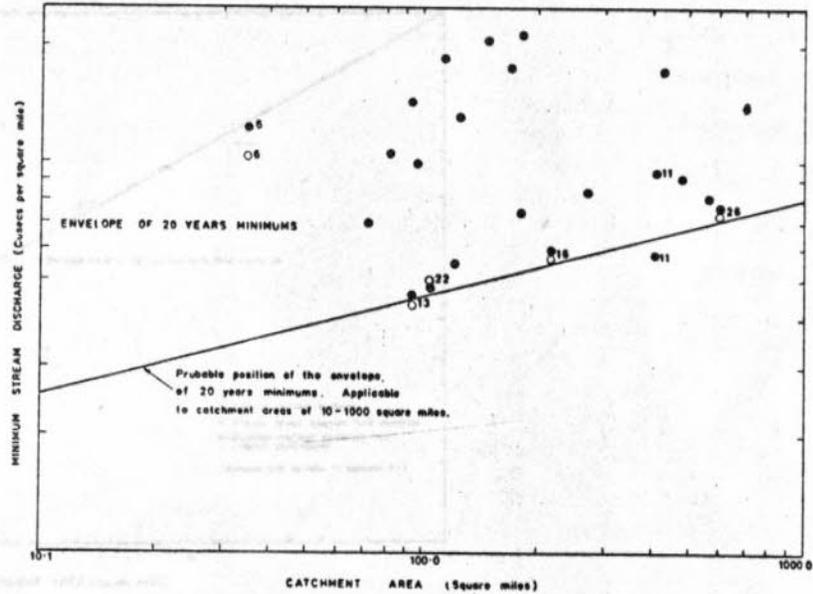




Figure 7-4  
Estimated Minimum Mean Monthly Discharges



The data of Figure 7-4 should not be extended to catchments of less than five square miles for the reasons given above. Where Jengka Triangle catchments of less than five square miles are proposed for water supply reservoirs, estimates of catchment yield should be based directly on rainfall data.

### Flood Discharges

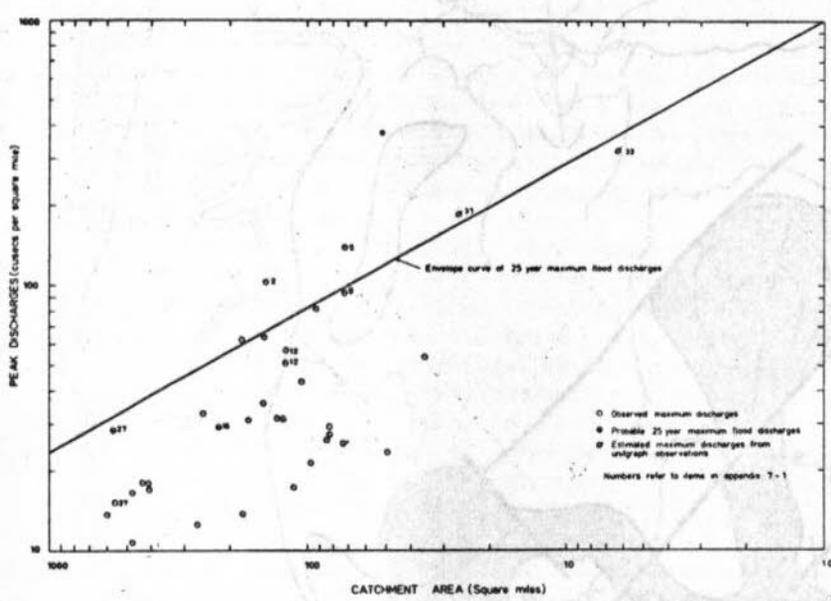
Estimates of flood discharges required for the design of hydraulic structures for the Jengka Triangle were based on comparisons of observed flood peaks and catchment areas of external streams (Appendix 7.1), with catchment areas of the streams of the Jengka Triangle. Flood frequency analyses were made for selected external streams having records of high discharges, using 25-year peak flood frequencies. The envelope of the computed 25-year peak discharges has been plotted as a straight line on Figure 7-5 expressing graphically the relationship.

Stream	Catchment Area in Square Miles	Peak Discharge (Cusecs per square mile)
Telant	270	59.0
Nam	19	3.6
Beta	5	0.8
Isang	19	3.6
Jempol	209	57.0
Kendak	44	11.1
Anak Jempol	25	5.7
Jengka	223	53.0
Lopak	25	5.7

$$Q^{1.85} = \frac{355000}{A}$$

where Q is the peak discharge in cubic feet per second per square mile of catchment, based on a 25-year peak flood probability, and A is the catchment area in square miles. Either the formula or the envelope curve on Figure 7-5 can be used to assess design peak flood discharges from catchments in the Jengka Triangle.

Figure 7-5  
Estimated Maximum Flood Discharges



**LEGEND**

- Mostly alluvium
- Mainly sandstones
- Possibly limestones
- Probable faults
- Trend lines
- Anticlines
- Synclines
- Blank areas undifferentiated volcanic and Sediments

For catchment areas of one square mile or less, the expression  $Q = 960A$  can be used, where Q is the total discharge in cubic feet per second and A is the catchment area in square miles.

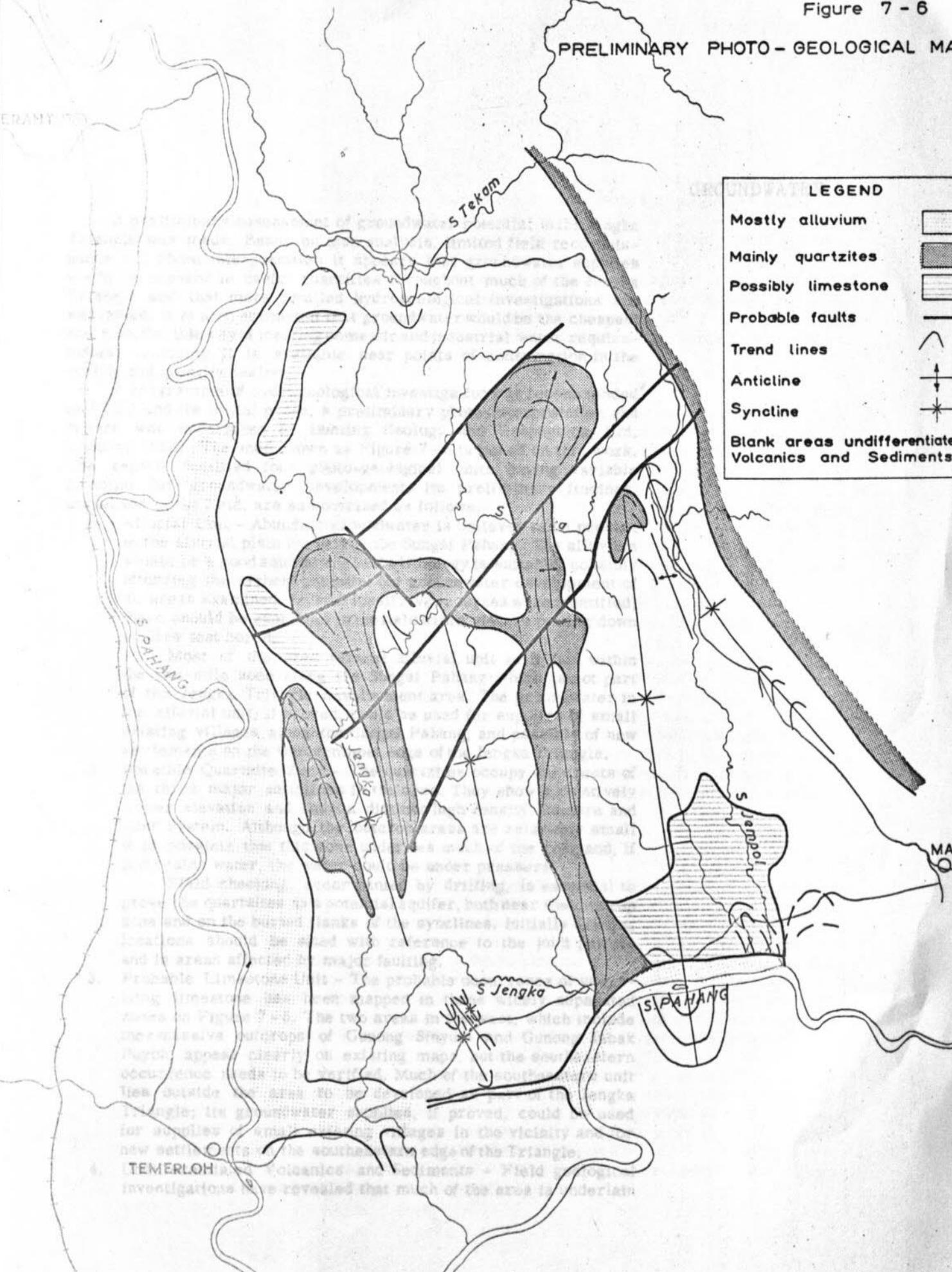
Summary of Estimated Stream Discharges

There is abundant surface water in the Jengka Triangle for development of domestic, industrial and irrigation water supplies. The estimated discharges of the main streams and their tributaries are shown in Table 7-2.

Table 7-2  
Summary of Estimated Stream Discharges

Stream	Catchment Area in square miles	Minimum discharge	Minimum Mean monthly discharge, cusecs	Maximum discharge
		cusecs	charge, cusecs	cusecs
		1 year in 20		1 year in 25
Tekam <sup>f</sup>	270	58.0	160.0	13,000
Siam	19	3.6	5.7	3,800
Batu	5	0.8	1.1	200
Galong	19	3.6	5.7	3,800
Jempol	209	44.0	115.0	11,400
Kundang	44	9.0	16.3	5,800
Anak Jempol	25	4.8	8.0	3,200
Jengka	222	47.0	124.0	11,700
Lopek	25	4.8	8.0	3,200

PRELIMINARY PHOTO - GEOLOGICAL MA



LEGEND	
Mostly alluvium	
Mainly quartzites	
Possibly limestone	
Probable faults	
Trend lines	
Anticline	
Syncline	
Blank areas undifferentiated Volcanics and Sediments	

Reduced from a preliminary photo-geological map produced by Hunting Geology and Geophysics

Scale 1 Inch to 4 Miles  
 0 1 2 3 4 5 10

A preliminary assessment of groundwater potential in the Jengka Triangle was made. Based on map analysis, limited field reconnaissance and photo-interpretation it appears that groundwater supplies would be present in useful quantities throughout much of the Jengka Triangle and that more detailed hydrogeological investigations are warranted. It is also estimated that groundwater would be the cheapest and most flexible way of meeting domestic and industrial water requirements, providing it is available near points of consumption in the quality and quantity desired.

A programme of hydrogeological investigation was recommended to FLDA and the initial phase, a preliminary photo-interpretation and report, was undertaken by Hunting Geology and Geophysics, Ltd. (Hunting 1966). The map shown as Figure 7-6 is based on this work. The report identified four photo-geological units having variable potential for groundwater development; its preliminary findings, unchecked in the field, are summarized as follows:

1. Alluvial Unit - Abundant groundwater is believed to be present in the alluvial plain bordering the Sungai Pahang. The alluvium should be a good aquifer where the lithology is suitable, possibly affording the highest potential for groundwater development of all areas examined. Several fossil river courses were identified; these should be examined in the field with a view to putting down shallow test bores.

Most of the area termed alluvial unit is in fact within the two-mile zone along the Sungai Pahang which is not part of the Jengka Triangle development area. The groundwater in the alluvial unit, if proved, could be used for supplies of small existing villages along the Sungai Pahang, and possibly of new settlements on the westernmost edge of the Jengka Triangle.

2. Possible Quartzite Zone - The quartzites occupy the crests of the three major anticlines in the area. They show a relatively higher elevation and have a distinct high density fracture and joint system. Although the outcrop areas are relatively small it is possible that this zone underlies much of the area and, if it contains water, the water could be under pressure.

Field checking, accompanied by drilling, is essential to prove the quartzites as a potential aquifer, both near the outcrop zone and on the buried flanks of the synclines. Initially drilling locations should be sited with reference to the joint pattern and in areas affected by major faulting.

3. Probable Limestone Unit - The probable occurrence of underlying limestone has been mapped in three widely separated zones on Figure 7-6. The two areas in the west, which include the massive outcrops of Gunung Sinyum and Gunung Jebak Puyoh, appear clearly on existing maps, but the southeastern occurrence needs to be verified. Much of the southeastern unit lies outside the area to be developed as part of the Jengka Triangle; its groundwater supplies, if proved, could be used for supplies of small existing villages in the vicinity and for new settlements on the southeastern edge of the Triangle.
4. Undifferentiated Volcanics and Sediments - Field geological investigations have revealed that much of the area is underlain

by an intimately associated series of mud-stones and impure sandstones, and this has been generally confirmed by the soil survey. In general, the limited evidence available suggests that this unit has a poor groundwater potential and should be given a low priority in future exploration.

The findings summarized above are based on an incomplete study; extensive field checking, additional final photo-interpretation in selected areas, and a programme of exploratory drilling are needed to assess definitively the location and extent of groundwater sources.

## WATER QUALITY

Water samples from six of the larger streams of the Jengka Triangle have been tested physically, chemically and biologically. The results of 39 analyses indicate that the surface waters are generally of good quality (Appendix 19-1), although in some streams the following deficiencies may need correction.

1. Turbidity - A range of 14 to 85 ppm was observed. This is 3 to 15 times as high as desirable for domestic use, and also exceeds certain industrial water standards.
2. Colour - A range of 5 to 40 Hazen units was observed, or up to eight times the desirable standard for domestic use.
3. Coliform Bacteria - All streams evidenced unacceptable levels ranging from 250 ppm to "countless" B.COLI (faecal types).
4. Chemical - The iron content (0.4-1.5 ppm) may have to be reduced and the pH range (6.5-9.0) may have to be raised. The total hardness (5-50 ppm) and the dissolved oxygen content (0.5-4.7 ppm) may require correction for industrial use.

Ground water supplies obtained within the Jengka Triangle will undoubtedly be of high physical and bacteriological quality. The chemical quality cannot be predicted since this is largely dependent on the sub-strata from which the water is derived. Based on experience elsewhere in Malaya, however, it is expected that adequate supplies will be located at about 200 feet.

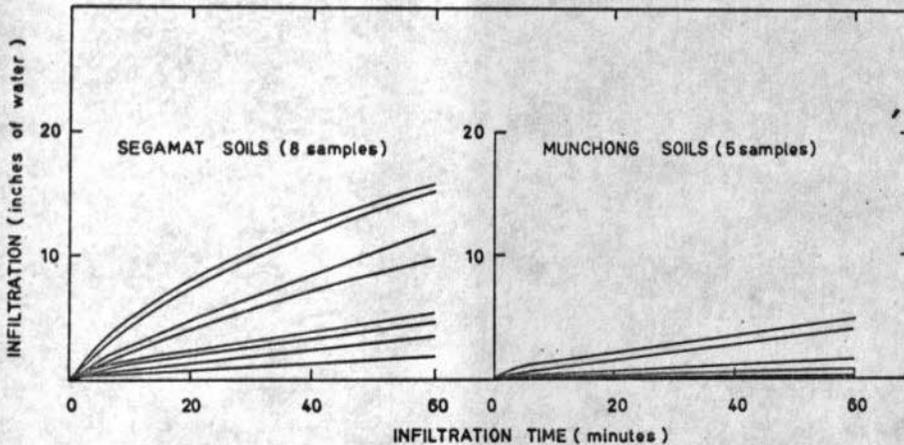
## INFILTRATION STUDIES

Preliminary soil infiltration studies were undertaken to provide quantitative data which could be used to determine the rate of recharge and availability of soil moisture to plant growth; to compile water balances, and to investigate certain aspects of flood run-off and drainage. The scope of the preliminary investigations described here has not been great enough to provide conclusive data for the soil parameters treated in the study, but the findings are indicative of the general ranges of infiltration values which may be expected. Typical curves of infiltration rates for two soil series are shown on Figure 7-7.

Infiltration studies of undisturbed soils were carried out on jungle covered areas of the Jengka Triangle; assessments were made on FLDA Ulu Jempol Scheme Phase II and the adjacent Chenor Estate for cultivated soils. Thirty two infiltration tests were made using nine-inch diameter infiltrometers (Appendix 7-2). Fifty samples were tested for soil moisture. Eight samples were tested for capillary, non-capillary and total voids ratios.

It was concluded that most of the soils series investigated may be expected to absorb almost all the rain from all but the most violent storms.

Figure 7-7  
Infiltration Rates



During the course of the infiltration studies estimates were made of the field capacities of the more important agricultural soils. No definitive studies appear to have been done in this country on this characteristic or on Permanent Wilting Points, but approximations of readily available moisture were made using fifty per cent of the field capacities (Israelsen 1965).

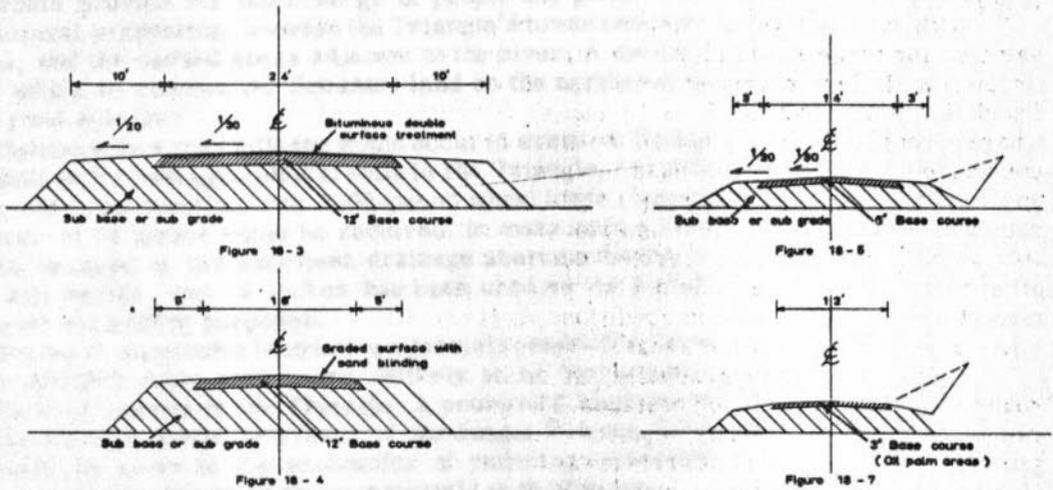
There is appreciable variability of available moisture content between soils. This variation was examined in relation to the rainfall deficit probabilities discussed in Chapter 2, and the general inference drawn that oil palm and rubber are unlikely to suffer from moisture deficiency on Segamat, Munchong and Malacca soils. On the other hand, deficiencies are likely to occur on the Durian, Bungor, Serdang series and on Colluvium. The effect of such deficiencies would depend upon their duration and severity.

From these preliminary studies it is evident that dry periods will occur with sufficient frequency to make their effect felt. The subject of soil, plant and moisture relationships requires considerably more detailed study.

#### CONTINUING HYDROLOGICAL INVESTIGATION

Additional hydrological investigations will be required to develop further the conclusions of this section, and to provide more precise information for future planning purposes. A network of automatic stream gauging stations, staff gauges and automatic and manual rainfall gauges should be established and arrangements made for continuous collection of data from them for an indefinite period. (Appendix 7-3).

Unsurfaced roads of Public Works Department rural road standard have been adopted for secondary roads (Figure 18 - 3). Roads of this standard would be suitable for village service as well, provided they do not become through routes attracting heavy volumes of large commercial vehicles such as timber lorries and palm oil tankers.



DESIGN CAPACITY	800 VPH (30% Commercial)	100 - 300 VPH	15 - 20 VPD	1 - 5 VPD
DESIGN SPEED	60 MPH	40 MPH	-	-
PAVEMENT WIDTH PER LANE	12 FT	8 FT	14 FT	12 FT
SHOULDER WIDTH	6 - 10 FT	5 - 7 FT	3 FT	-
RIGHT OF WAY	132 FT	88 FT	60 FT	30 FT
CAMBER	1 in 30 (Carriageway) 1 in 20 (Shoulder)	1 in 30 (Carriageway) 1 in 20 (Shoulder)	1 in 30 (Carriageway) 1 in 20 (Shoulder)	1 in 20
GRADIENT	3-33% (Max. 6.67%)	5% (Max. 10%)	5% (Max. 10%)	5% (Max. 10%)
SIGHT DISTANCE	800 FT (Stopping) 800 FT (Passing)	400 FT (Stopping) 800 FT (Passing)	-	-
HORIZONTAL CURVATURE	968 FT	480 FT	100 FT	-
CLEARANCE: HORIZ.	44 FT	20 FT	-	-
VERT.	18 FT 6 IN	-	-	-
BRIDGES	26 FT 6 IN	22 FT 6 IN	-	-
	Figure 18 - 3	Figure 18 - 4	Figure 18 - 5	Figure 18 - 7
	PRIMARY ROAD STANDARDS	SECONDARY ROAD STANDARDS	TERTIARY UNIMPROVED STANDARDS	TERTIARY ROAD STANDARDS

On two segments of the secondary road system where there is a possibility of somewhat higher traffic volumes, but not sufficiently great to warrant construction of primary roads, allowance was made in the estimates for addition of a bituminous double surface treatment, these are:

1. The secondary road connecting the palm oil mill of Project IV with the primary road system at the regional centre, and

2. The east-west secondary road serving the settlement units located between the proposed southeast and southwest towns.

Three secondary road links totalling about 7.5 miles were added on the west side of the Triangle to afford service to the development expected in the two-mile belt along the Sungai Pahang (Figure 18-2). These roads would provide for interchange of people and goods, and possibly agricultural production, between the Triangle's towns and processing centres, and the settled areas adjacent to the river. A similar road link was added to connect the Sultanate land on the northeast to the Triangle's road system.

Most of the secondary road mileage would occur in areas of Group I soils which include the best agricultural soils in the Triangle, but are the poorest for road construction. For 7000-pound wheel loads, foundation thicknesses of 14 inches would be required. In many areas, this can be reduced because of the excellent drainage characteristics of many of the soil series, and 12 inches has been used as the design thickness for cost estimating purposes.

The quantities of acceptable foundation materials needed for these roads, roughly 600,000 cubic yards, are unlikely to be conveniently found in the form of laterite in the Triangle. A promising alternative source would be the river sands and gravels of the Sungai Pahang. Consideration should be given to the economics of reducing foundation thickness by preparing mixtures of these materials with bitumen.

The secondary roads are estimated to cost about M\$68,000 per mile; the addition of bituminous surfacing would raise this to M\$89,000 per mile.

### Tertiary (Improved)

Within oil palm settlement units, a form of collector road would be needed to connect the tertiary harvest roads which would not link directly with the secondary roads, and to provide internal village service. It would be uneconomic to extend the secondary roads deeper into the settlement units for these purposes because of the relatively low daily traffic flow; instead, improved tertiary roads are proposed. These would be unsurfaced laterite roads, conforming generally to FLDA standards for internal (arterial) roads (Figure 18-5).

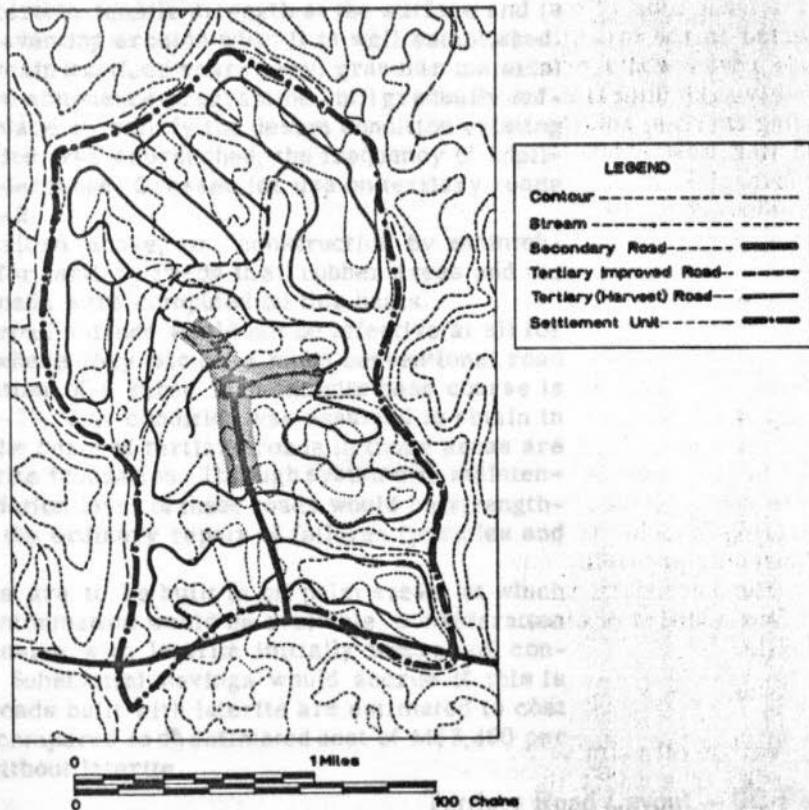
A total of about 94 miles of improved tertiary roads is proposed. The relationship between secondary roads, improved tertiary roads, and tertiary roads is illustrated in Figure 18-6. The tertiary (improved) roads are estimated to cost M\$22,000 per mile.

### Tertiary Roads

The layout and standards for tertiary or harvesting roads serving the main crop areas differ substantially as between oil palm and rubber areas.

For oil palm areas, where based on topographic consideration, the maximum feasible hand carry of fresh fruit bunches is estimated to be six chains, the average tertiary road spacing would be theoretically 12 chains (0.15 miles). These roads would have to accommodate highway type lorries of 5-ton capacity hauling FFB to the mills. Furthermore, since the best oil palm growing areas in the main include the poor road building soils of Group I, foundation construction procedures would also differ.

Figure 18-6  
Typical Settlement Unit Roads



For rubber areas, tertiary roads can be spaced further apart, and an estimate of 20 chains (0.25 miles) has been used as the theoretical desirable distance between them. Since latex would be transported on settlers' bicycles to village collecting stations, the vehicular traffic served by these roads would be very light and would include only occasional lorry or tractor and trailer movements of fertilizer and other materials, as well as FLDA supervisory staff traffic. Finally, rubber areas generally include the better road building soils of Group II and thus foundation construction procedures can be greatly simplified.

For the very light traffic to which tertiary roads would be subjected, normal design procedures which are empirical and relate to large numbers of vehicle passes, cannot be rationally applied. The recommended procedure is to minimize initial construction, where possible by building the earthworks only, and to adopt a system of gradual improvement by a well-organised system of maintenance. This would be possible on the sandy alluvial soils of Group II which will compact well and form a surface having good frictional properties. Where advisable,

river sand, gravel, or laterite can be rolled into the surface of roads built in this way to improve their performance under traffic and to avoid slipping. Initially, however, these roads could be seeded to grass, since grass provides a certain tensile strength at the surface and is capable of reducing or preventing erosion when it is well established. Where grass will not maintain itself, or wears away, granular material would be added under the maintenance programme until gradually sufficient material was in place to satisfy the design condition existing there, and as this condition was approached, the frequency of application of material would decrease. Grasses for use on tertiary roads are listed in Appendix 18-2.

The approach described above, or "construction by maintenance", is recommended for tertiary roads in all rubber areas and the estimated costs of such roads were computed on this basis.

Untreated soil as a road surface would not be effective at all for the Group I soils, and where they occur, a more conventional road design based on application of a three inch laterite base course is recommended (Figure 18-7). This condition was assumed to obtain in all oil palm areas, and the costs of tertiary roads in those areas are based on this type of laterite foundation. Through systematic maintenance, the thin initial foundation layer of these roads would be strengthened where necessary in the ordinary repair of failures (potholes and ruts) as they occurred.

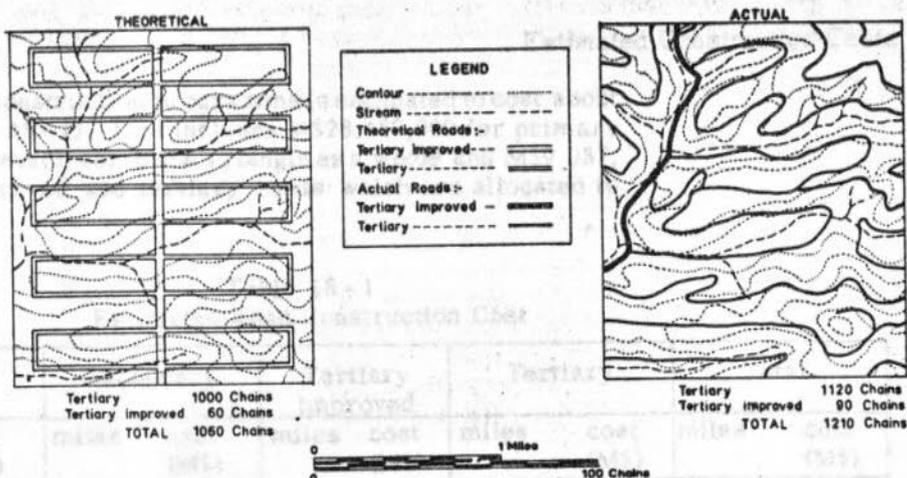
When tertiary roads are to be built in oil palm areas, at which time more detailed site information would be available, consideration should be given to dispensing with laterite initially where soil conditions are satisfactory. Substantial savings would accrue if this is possible, since tertiary roads built with laterite are estimated to cost about M\$7,650 per mile, compared to an estimated cost of M\$3,400 per mile for tertiary roads without laterite.

#### Tertiary Road Layout - Oil Palms

The great density of tertiary roads needed to support oil palm harvesting operations necessitates careful planning to ensure both minimum length of road and minimum numbers of passes by collecting vehicles. Minimum road length is achieved by arranging that the tertiary road serves the maximum carry distance (6 chains) on both sides. Minimum travel can be achieved by basing tertiary road layout on a grid system as much as possible, connecting parallel segments in loops. The length of individual loops should be closely related to the carrying capacity of a single transport vehicle (5-ton lorry) under peak harvest conditions. A layout on this basis would require only 100 chains of tertiary road per 120 acres, or 0.833 chains per acre (Figure 18-8). For such a system, the theoretical number of passes would never exceed one per day. If in practice more vehicles were to use these roads, they would tend to be carrying reduced loads and thus causing less road damage.

A detailed analysis of tertiary road layout on land similar to that of most of the oil palm areas of the Triangle, using an absolute maximum gradient of 1 in 10 (10%) and a desirable maximum of 1 in 20 (5%), indicated that the extra length due to physical relief alone would be 1.11 of the basic grid (Figure 18-8). This would result in an average requirement of about one chain per acre; the total system required is estimated to be about 815 miles.

Figure 18 - 8  
Tertiary Road Layout



### Tertiary Road Layout - Rubber

The average road spacing assumed for rubber areas is 20 chains; the virtual absence of highway-type transport vehicles on these roads greatly simplifies their layout. As for oil palms, the objective should be a grid network, with variations from it as dictated by topography and the need to maintain acceptable grades. Individual segments of tertiary roads should be interconnected to afford settlers the most direct route practicable between their smallholdings and the village latex collecting stations. Because of the extremely light traffic loads, improved tertiary roads would not be built in rubber areas.

For average conditions in the Triangle, tertiary roads in rubber areas would be required at a rate of about 0.6 chains per acre; the total system required is estimated to be about 211 miles.

### Drainage and Bridges

The numbers of cross drainage structures were estimated from analyses of actual conditions on the Ulu Jempol FLDA scheme where suitable topographic mapping was available, assuming rainfall intensity of five inches per hour and runoff of about 25 per cent. Minimum pipe size was taken to be 15 inches. Allowances for cross drainage structures are given in Appendix 18 - 3.

Estimated bridge construction for primary roads was based on an assumed 16 bridge ranging in length from 30 to 180 feet, or about 18 feet of bridge construction per mile (Appendix 18 - 3). Secondary road bridge construction was estimated to be about 11 feet per mile, or at approximately the same density as obtains on the existing Maran-

Jerantut road.

The Sungai Pahang bridge was assumed to have a crossing length of 400 feet at the site indicated on Figure 18-2.

### Estimated Construction Costs

The total road construction programme is estimated to cost about M\$37,496,000 (Table 18-1). This includes M\$28,459,000 for primary and secondary roads which serve the Triangle as a whole and M\$9,037,000 for tertiary-improved and tertiary roads which are allocated to individual projects.

Table 18-1  
Estimated Road Construction Cost

Project	Primary		Secondary		Tertiary improved		Tertiary		Total				
	miles	cost (M\$)	miles	cost (M\$)	miles	cost (M\$)	miles	cost (M\$)	miles	cost (M\$)			
I					12	270,000	149	1,105,000					
II					16	357,000	171	1,159,000					
III	not distributed to individual projects		not distributed to individual projects		21	467,000	223	1,635,000	not distributed to individual projects				
IV					17	360,000	169	1,295,000					
V					14	311,000	164	924,000					
VI					14	300,000	150	854,000					
Total		64		14,207,000	202	14,252,000	94	2,065,000		1026	6,972,000	1386	37,496,000

Estimated construction costs are based on a number of approximate assumptions and simplifications. They have been developed from study of available 50-foot contour base maps at 1:25,000 scale and from air photograph interpretation. As such they indicate the magnitude of investment required in each of the proposed road classes. Accurate engineering cost estimates cannot be developed until adequate soils and materials investigations are carried out and centre-line surveys are made.

Unit costs used in the estimates were obtained from the Public Works Department (PWD), FLDA, and contractors and represent contractors' prices including an allowance of 20 per cent for contractors' overhead and profit. An allowance of 25 per cent for contract administration, engineering and supervision of construction, and contingencies has been added to all estimates.

No costs for land acquisition are anticipated, therefore no allowance has been made for them in the estimates.

Summaries of quantities and the main elements of cost for each road class are given in Appendix 18-4.

## Maintenance

It was assumed that the PWD would be responsible for maintaining primary and secondary roads in accordance with present policy. The PWD, Pahang, estimate that the cost of maintenance of any type of road is M\$4,500 per mile per year, because the larger amount of maintenance required for roads of lower standard with low-cost materials is offset by the less frequent maintenance of better roads using more expensive materials. This maintenance factor has been adopted for the purpose of this report.

For improved tertiary and tertiary roads maintenance could be provided by FLDA with its own forces, or preferably by contract. For laterite roads in oil palm areas, annual grading and replacement of five per cent of the laterite is assumed, at an annual cost per mile of M\$1,000 for improved tertiary roads, and M\$750 for tertiary roads.

Tertiary roads in rubber areas are assumed to be built initially with untreated soil, and systematic "construction by maintenance" is recommended. It was assumed that one half the cost of construction of a laterite road would be finally incurred over a period of ten years, and that the annual cost of maintenance would be M\$400 per mile.

## Coordination with Logging Roads

The proposed Jengka logging industry has been planned on the basis of modern log hauling and logging equipment which would require an extensive system of well built logging roads (Chapter 10). These would be built to a heavier foundation standard than needed for agricultural development and would include 18-inch crushed stone base courses to support the heavy log hauling vehicles (200,000 GVW) planned (Table 18-2). Logging roads would be built in three classes (main, secondary, and spur) corresponding approximately to the first three classes of permanent roads proposed for the Triangle. Their temporary nature would facilitate economies in design and construction. Construction of permanent cross drainage and bridges would largely be avoided and alignment, grade and width would be sacrificed in favour of simpler road building conditions.

Table 18-2  
Logging Road Standards

	Main Logging	Secondary Logging	Spur Logging
Carriage Width (feet)	20	16	12
Shoulder Width (feet)	5	5	3
Base Course	18 inches crushed stone	18 inches crushed stone	18 inches crushed stone
Maximum grade (per cent)	4 (adverse) 6 (favourable)	6 (adverse) 10 (favourable)	6 (adverse) 10 (favourable)
Minimum Radius of horiz. curvature (feet)	500	250	100

Logging would precede agricultural development, and the logging roads could adequately serve the agricultural development operation, on completion of log hauling. Their layout has been coordinated therefore with that of the permanent road system of the Triangle to avoid

construction of a duplicate system. Main, secondary and spur logging roads would be built initially on more than half of the Triangle's permanent primary and secondary road system (Table 18 - 3).

Table 18 - 3  
Coordination of Logging Roads

Permanent Road Classification	Total Required	Built initially for logging		
		Main Logging Roads	Secondary Logging Roads	Spur Logging Roads
Primary	64	16	9	-
Secondary (outside settlement units)	81	10	25	-
Secondary (inside settlement units)	121	-	-	87
Tertiary - improved	94	-	-	19
Tertiary (oil palm)	815	-	-	-
Tertiary (rubber)	211	-	-	-

The advance construction of logging roads on alignments ultimately needed for the Triangle's permanent road system would afford an opportunity for substantial savings in the construction cost of that system. As logging operations are successively withdrawn from sections of the Triangle, the logging roads would be improved to desirable standards. The possible saving is estimated at approximately M\$ 7,000,000.

A deduction has not been made in the estimates of this report for the possible savings indicated, since their realization would depend on the implementation of the logging programme in the manner and within the time schedule recommended. Were the savings deducted from the Triangle's budget funds and were the logging programme not implemented as recommended, then capital costs of the permanent road system would be understated.

The advance construction of logging roads, however, has been assumed for purposes of developing a construction schedule for roads, and for phasing of their required capital investment.

### Road Construction Schedule

The proposed road construction schedule, based on the assumed advance construction of logging roads in many areas is illustrated in Figure 18 - 9 for primary roads and for the sections of secondary roads located outside individual settlement units and is summarized in Table 18 - 4. A complete construction schedule, indicating the anticipated responsibility for initial construction is given in Appendix 18 - 5. The phasing of capital investment in roads appears in Appendices 18 - 6 and 18 - 7.

## APPENDIX 5

## FORESTS

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## APPENDIX 5-1

## LIST AND DESCRIPTION OF SPECIES WITH SUGGESTED USES

GROUP	VERSACULAR NAME	SCIENTIFIC NAME	DESCRIPTION	SUGGESTED USES
1.	Merbau	<u>Intsia palembanica</u>	Large tree - a good heavy hardwood	Heavy construction, flooring.
2.	Buey	<u>Diospyros</u> spp.	Rare and of small size	Furniture.
	Kayu Arang	" "	Small tree of no present commercial significance	Turnery
	Kekotong	<u>Cynometra inaequifolia</u>	Medium size. Not presently popular	Sleepers, heavy construction.
	Keranji	<u>Dialium</u> spp.	Medium size. Not presently popular	Flooring, panelling, tool handles.
	Membatu	<u>Shorea guiso</u>	Large tree	Flooring, heavy construction.
	Merbatu	<u>Parinari</u> spp.	Medium size. Rarely taken	General construction.
	Pelawan	<u>Tristania</u> spp.	Medium to large tree. Rarely taken	Flooring, construction, tool handles.
	Penaga	<u>Mesua ferrea</u>	Small to medium size	Heavy construction, tool handles.
	Resak	<u>Vatica</u> spp.	Medium size. Larger trees are taken in fellings	Heavy construction, boat building.
	Tembusu Hutan	<u>Fragaria gigantea</u>	Large tree with very durable timber	Flooring, heavy construction.
4.	Balau	<u>Shorea</u> spp. )	With exception of Giam, trees of large size	Heavy construction, heavy duty flooring and in the case of Giam, suitable for boat building.
	Giam	<u>Hopea</u> spp. )		
	Sengkawang	<u>Shorea</u> spp. )		
5.	Kempas	<u>Koompassia malaccensis</u>	Large tree of good form. Not durable in contact with ground but takes preservatives easily	Sleepers, flooring, core veneer, panelling.
6.	Keruing	<u>Dipterocarpus</u> spp.	Large tree of good form. Commercially popular for timber. Eight species were recorded.	Sleepers, flooring, general construction.
7.	Mengkulang	<u>Heritiera</u> spp.	Medium to large size	Plywood, flooring, furniture, panelling.
8.	Kelat	<u>Eugenia</u> spp.	Small to medium size. Rarely taken	Sleepers, general construction.
9.	Berangan	<u>Castanopsis</u> spp.	Small to medium size. Rarely taken	General construction.
	Jelawai	<u>Terminalia</u> spp.	Medium to large size. Rarely taken	Veneer, furniture, general construction.
	Kamp	<u>Strombosia rotundifolia</u>	Small to medium size. Rarely taken	General construction.
	Kasai	<u>Pometia</u> spp.	Medium to large size. Rarely taken	Sleepers flooring, tool handles, general construction.
	Keladan	<u>Dryobalanops oblongifolia</u>	Medium to large tree, taken wherever found	Flooring and general construction.
	Keledang	<u>Artocarpus</u> spp.	Medium to large tree. Popular amongst Chinese coffin makers	Flooring, panelling, hewn coffins.
	Kulim	<u>Scorodocarpus borneensis</u>	Small to medium size. Seldom taken	Marine piling, general construction.

Cont'd

GROUP	VERNACULAR NAME	SCIENTIFIC NAME	DESCRIPTION	SUGGESTED USES
9.	Meranti	<u>Carallia</u> spp.	Small to medium size. Seldom taken.	Sliced veneer, cabinet making
	Meupening	<u>Lithocarpus</u> & <u>Quercus</u> spp.	Small to medium size. Seldom taken.	Sliced veneer, general construction.
	Minyak Berak	<u>Xanthophyllum</u> spp.	Medium to large size. Seldom taken.	General construction, joinery, tool handles.
	Pauh Kijang	<u>Iringia</u> <u>malayana</u>	Medium to large tree. Rarely taken.	General construction.
	Ferah	<u>Elateriospermum</u> <u>tapos</u>	Small to medium size. Of no present commercial significance.	Core veneer, general construction.
	Petaling	<u>Ochanostachya</u> <u>amentacea</u>	Small to medium size. Rarely taken.	General construction.
	Rengas	<u>Melanorrhoea</u> spp. <u>Gluta</u> spp.	Medium size tree, seldom taken because of an irritant sap in the tree.	Furniture, cabinet making, decorative panelling and veneer.
	Simpoh	<u>Dillenia</u> spp.	Medium to large tree normally taken in fellings.	Sleepers, general construction, sliced veneer.
	Temponok	<u>Artocarpus</u> <u>rigidus</u>	Medium to large size. Not very popular.	Furniture, cabinet making, veneer.
	Tualang	<u>Koompassia</u> <u>excolata</u>	Large buttressed tree of good form but seldom taken at present because of the susceptibility of the timber to splitting.	Sleepers, veneer, panelling, flooring.
10.	Bintangor	<u>Calophyllum</u> spp.	Medium to large tree. Larger trees are taken in fellings.	Light construction, flooring, panelling, core veneer.
11.	Durian	<u>Durio</u> spp.	Medium to large size. Larger trees are taken in fellings.	Core veneer and light construction.
	Punggai	<u>Coelocotyle</u> <u>griffithii</u>	Medium to large tree. Heavily buttressed. Un-common and rarely taken.	Core veneer and light construction.
12.	Jelutong	<u>Dyera</u> <u>costulata</u>	Large tree of good form. A popular timber but liable to serious defect in trees tapped for latex.	Plywood, moulding, pattern making.
13.	Meranti Melantai	<u>Shorea</u> <u>macroptera</u>	Large trees of good form in the Red Meranti group - the most important group of general utility timbers in the country.	Flywood, furniture, joinery, cabinet making, panelling, general construction.
14.	Meranti Rambai Daun	<u>Shorea</u> <u>acuminata</u>		
15.	Meranti Sarang Punai	<u>Shorea</u> <u>parvifolia</u>		
16.	Meranti Teabaga	<u>Shorea</u> <u>leprocula</u>		
17.	Seraya	<u>Shorea</u> <u>curtisi</u>		
18.	Meranti Batu	<u>Shorea</u> <u>desyphylla</u>		
	Meranti Kepong	<u>Shorea</u> <u>ovalis</u>		
	Meranti Langgong	<u>Shorea</u> <u>lepidota</u>		
	Naseu	<u>Shorea</u> <u>pauciflora</u>		
19.	Meranti Pa' ang	<u>Shorea</u> <u>bracteolata</u>		
20.	Meruava	<u>Anisoptera</u> spp.	Large tree.	Flywood, flooring, general construction.
21.	Meranti Kuning	<u>Shorea</u> spp.	Medium to large trees of the Yellow Meranti group, rather susceptible to defect especially in over-mature trees.	Flywood, joinery, general construction.
22.	Nyatch	<u>Falagium</u> spp.	Medium to large trees, some species of which are taken in fellings.	Flywood, furniture, joinery, panelling.

Cont'd

GROUP	VERNACULAR NAME	SCIENTIFIC NAME	DESCRIPTION	SUGGESTED USES
23.	Mepetir	<u>Sindora</u> spp.	Large tree of good form providing good figured heartwood	Furniture, decorative panelling, plywood.
24.	Kedondong	<u>Burseraceae</u> spp.	Medium to large tree not commonly taken in fellings	Plywood, general construction.
	Kata Ulat	<u>Lophopetalum</u> spp.	Medium to large tree not commonly taken in fellings	Veneer, general construction.
	Melumak	<u>Pentace</u> spp.	Medium to large tree with timber resembling Red Meranti. Larger trees are taken in fellings	Plywood, furniture, joinery.
25.	Medang	<u>Lauraceae</u> spp.	Medium to large tree some species of which are taken, but mostly not	Plywood, light construction.
	Pesarahan	<u>Myristica</u> spp.	Small to medium size trees not popular and only occasionally taken	Plywood, light construction.
	Becendok	<u>Endospermum malaccense</u>	Small to medium size and rarely taken. Timber is subject to mould during seasoning. Normally common in secondary forest	Plywood, light construction.
26.	Ara Berteh	<u>Paratocarpus</u> spp.	Medium to large size. Taken in fellings	Core veneer.
	Geronggang	<u>Cratogeomys arborescens</u>	Small to medium size tree normally found in wet situations. Larger trees are taken	Plywood, furniture, joinery.
	Karas	<u>Aquilaria malaccensis</u>	Trees of medium size and of no present commercial importance	Light construction.
	Kumbang Kemangkrak	<u>Scaphium</u> spp.	Medium size tree of poor form. Rarely taken in present fellings. The timber has a high silica content	Plywood.
	Kungkur	<u>Pithecellobium</u> spp.	Medium size and of sporadic occurrence. Rarely taken in fellings	Plywood, furniture, joinery.
	Mebang	<u>Mangifera</u> spp.	Medium to large size	Plywood, furniture, veneer cabinet work.
	Mempisang	<u>Anonaceae</u> spp.	Generally of small to medium size, of no present commercial significance	Sliced veneer, light construction.
	Moruan	<u>Hopea</u> spp.	Medium to large size trees, the larger stems being taken in present fellings	Plywood, furniture, light construction.
	Peleng	<u>Pentapadon</u> spp.	Medium size tree of good form and, though not popular is taken in growing quantities	Core veneer, flooring, light construction.
	Petal	<u>Parkia speciosa</u>	Medium size tree more prized for its edible fruit than for its timber	Plywood, light construction.
	Petal Kerayong	<u>Parkia javanica</u>	Large tree of good form but not commonly worked for timber although reputed to be easy to saw and to peel	Plywood, light construction.
	Palai	<u>Alstonia</u> spp.	Medium to large size with high buttresses, but little used for timber.	Core veneer, moulding, pattern making.
	Turutang	<u>Cammosperma</u> spp.	Medium to large tree of good form	Plywood, satch boxes, light construction.

1/ Certain Classes are of completed unit type entitled by lower limit of each class.

## APPENDIX 5-2

## JENGA SINGLE ENTRY VOLUME TABLE

Volumes in cubic feet based on height/girth data  
obtained from Jengka Forest Reserve

Species Groups	Girth Classes <sup>1/</sup>									
	4'	5'	6'	7'	8'	9'	10'	11'	12'	13' +
1	34	62	98	146	191	243	305	385	460	540
2	40	71	120	166	231	310	383	463	551	646
4	42	71	113	156	218	276	350	430	521	610
5	97	138	185	242	308	383	462	548	640	740
6	100	136	182	230	301	386	465	552	635	718
7	60	97	140	195	260	334	420	518	605	700
8 & 9	59	93	137	191	257	336	418	500	590	680
10 & 11	59	93	137	191	257	336	418	500	590	680
12	74	116	167	226	296	370	448	540	636	732
13	76	110	154	207	269	330	405	487	570	658
14	72	111	158	213	277	342	418	492	574	662
15	88	115	170	229	302	393	499	593	696	807
16	87	126	175	230	300	370	450	545	645	750
17	70	110	162	228	300	376	475	590	700	814
18	97	125	166	220	286	348	441	550	646	747
19	60	97	140	195	260	334	420	518	605	700
20 - 23	74	116	167	226	296	370	448	540	636	732
24	60	97	140	195	260	336	420	518	605	700
25 & 26	59	93	137	191	257	334	418	500	590	680

<sup>1/</sup> Girth Classes are of completed unit type entitled by lower  
limit of each class.

APPENDIX 5-3

STAND TABLES - JENCKA FOREST RESERVE

Table 1 - Northeast Quadrant (No. of stems per 100 acres)

Girth Class	Heavy Hardwoods			Medium Hardwoods			Light Hardwoods					Total							
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18		19-20	21	22	23	24-26		
4'-6'	MS	20.2	58.7	78.9	34.1	70.3	20.5	575.4	700.3	14.2	11.0	150.0	21.0	12.3	28.1	7.1	517.2	760.9	
	E%	17	18	14	22	13	32	7	6	42	33	16	50	36	35	60	5	4	4
	RME	16.8	48.2	68.2	26.9	61.3	14.0	540.8	658.8	8.4	7.5	126.6	10.7	8.0	18.5	2.9	496.3	737.3	
7'-9'	MS	12.6	11.5	24.1	29.9	61.9	15.5	54.0	161.3	4.7	3.1	71.3	4.7	6.3	4.2	2.9	47.5	144.7	
	E%	54	34	29	24	22	36	20	12	58	53	14	55	41	83	88	26	15	15
	RME	5.8	7.7	17.3	23.0	48.8	10.0	43.7	143.3	2.0	1.5	61.6	2.1	3.7	0.8	0.4	35.2	123.8	
10'+	MS	2.9	2.4	5.3	11.0	22.0	1.3	26.2	60.5	1.3	4.7	19.1	2.9	3.1	0.8	0.5	4.5	36.9	
	E%	92	82	70	49	27	76	36	21	183	52	23	61	94	128	157	86	24	24
	RME	0.3	0.4	1.6	5.7	16.2	0.3	16.9	47.9	-1.1	2.3	14.9	1.1	0.2	-0.2	-0.3	0.6	28.2	
Total 7' and over	MS	15.5	13.9	29.4	40.9	83.9	16.8	80.2	221.8	6.0	7.8	90.4	7.6	9.4	5.0	3.4	52.0	181.6	
	E%	51	27	29	23	20	32	21	12	67	45	11	44	32	70	78	26	15	15
	RME	7.7	10.3	20.9	31.7	67.8	11.5	64.1	195.9	2.1	4.4	80.6	4.3	6.5	1.5	0.8	38.9	155.8	
Total 4' and over	MS	35.7	72.6	108.3	75.0	154.2	37.3	655.6	922.1	20.2	18.8	240.4	28.6	21.7	33.1	10.5	569.2	942.5	
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

MS denotes Mean Stand  
 E% denotes Error per cent  
 RME denotes Reliable Minimum Estimate  
 NA denotes Not Available

APPENDIX 5-3

STAND TABLES - JENCKA FOREST RESERVE

Table 2 - Southeast Quadrant (No. of stems per 100 acres)

Girth Class	Heavy Hardwoods				Medium Hardwoods				Light Hardwoods				Total					
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20		21	22	23	24-26	
4'-6'	MS	48.5	46.5	95.0	46.7	99.7	20.8	420.3	587.5	11.2	16.6	176.3	17.7	12.2	20.5	13.8	520.5	788.8
	Eq	30	18	19	22	14	11	8	37	16	13	67	41	30	20	8	8	8
	RME	34.4	38.4	77.3	36.6	86.4	18.6	389.8	545.5	7.1	14.1	155.1	6.0	7.2	14.6	11.1	481.1	750.1
7'-9'	MS	20.5	6.5	27.0	24.9	66.2	6.2	29.3	126.6	1.0	3.6	59.4	2.5	5.5	2.1	2.9	32.2	109.0
	Eq	44	38	35	29	23	35	15	83	45	17	59	63	82	98	17	17	10
	RME	11.5	4.1	17.7	17.8	51.0	4.1	20.5	107.7	0.2	2.1	49.8	1.0	2.1	0.4	0.1	26.8	99.0
10'+	MS	3.4	0.5	3.9	4.2	20.5	0.3	13.5	38.5	0.3	6.0	11.4	2.1	2.9	0.5	0.5	2.3	26.0
	Eq	86	159	62	66	23	225	11	230	41	21	41	41	115	160	156	105	19
	RME	0.5	-0.3	1.5	1.4	15.9	-0.3	10.6	34.3	-0.3	3.5	9.1	1.2	-0.4	-0.3	-0.3	-0.1	21.1
Total 7' and over	MS	23.9	7.0	30.9	29.1	86.7	6.5	42.8	165.1	1.3	9.6	70.8	4.4	8.4	2.6	3.4	34.5	135.0
	Eq	45	37	34	26	18	37	20	105	105	30	15	38	68	66	98	18	8
	RME	13.3	4.5	20.5	21.7	71.8	4.1	34.5	146.0	-0.1	6.8	60.8	2.8	2.7	0.9	0.1	28.6	125.4
Total 4' and over	MS	72.4	53.5	125.9	75.8	186.4	27.3	463.1	752.6	12.5	26.2	247.1	22.1	20.6	23.1	17.2	555.0	923.8
	Eq	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-3

STAND TABLES - JENKA FOREST RESERVE

Table 3 - Northwest Quadrant (No. of stems per 100 acres)

Cirth Class	Heavy Hardwoods			Medium Hardwoods					Light Hardwoods					Total					
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20	21		22	23	24-26		
4'-6'	MS	91.9	65.8	157.7	69.8	93.1	30.4	382.8	575.1	15.5	9.4	231.8	16.4	8.2	41.0	19.3	541.1	882.7	
	E%	19	30	16	10	40	25	12	12	47	42	11	27	59	30	35	13	9	9
	RME	74.8	46.6	134	62.1	56.1	23.1	339.4	510.7	8.3	5.5	206.8	12.0	3.4	28.8	13.0	472.6	804.8	
7'-9'	MS	26.6	5.9	32.5	33.7	49.5	8.5	30.7	122.4	1.2	3.2	63.2	6.7	2.3	4.4	4.4	30.7	116.1	
	E%	34	46	25	30	21	37	26	17	140	74	27	55	106	94	64	33	20	20
	RME	17.7	3.2	24.7	23.6	39.3	5.4	22.9	102.6	-0.5	0.9	46.3	3.1	-0.1	0.3	1.6	20.7	93.5	
10'+	MS	4.7	0.9	5.6	5.6	22.5	0.3	7.0	35.4	0.3	3.2	11.7	2.0	0.6	0.3	0.9	1.8	20.8	
	E%	102	134	92	31	37	236	42	32	222	77	74	109	163	230	77	104	54	
	RME	-0.1	-0.3	0.5	3.9	14.3	-0.4	4.1	24.1	-0.4	0.8	3.2	-0.2	-0.4	-0.4	0.2	-0.1	9.7	
Total 7' and over	MS	31.3	6.8	38.1	39.3	72.0	8.8	37.7	157.8	1.5	6.4	74.9	8.7	2.9	4.7	5.3	32.5	136.9	
	E%	28	46	23	23	20	38	25	13	118	68	29	56	108	88	57	31	22	
	RME	22.6	3.7	29.5	30.2	58.1	5.5	28.5	137.3	-0.3	2.1	53.6	3.9	-0.2	0.6	2.3	22.7	108.0	
Total 4' and over	MS	123.2	72.6	195.8	108.1	165.1	39.2	420.5	732.9	7.0	15.8	306.7	25.1	11.1	45.7	24.6	573.6	1019.6	
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	

APPENDIX 5-3

STAND TABLES - JENCKA FOREST RESERVE

Table 4 - Southwest Quadrant (No. of stems per 100 acres)

Girth Class	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods				Total						
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18		19-20	21	22	23	24-26	
4'-6'	MS	46.0	55.9	101.9	50.0	59.8	33.5	408.3	551.6	6.6	10.5	242.6	26.3	7.9	25.6	10.5	432.0	762.0
	E%	31	28	26	19	24	30	14	10	79	45	20	48	96	66	28	15	13
	RME	32.0	40.5	76.0	40.9	45.8	23.8	354.9	497.8	1.4	5.8	195.0	13.9	0.3	8.8	7.6	369.6	668.5
7'-9'	MS	19.1	2.6	21.7	32.2	34.2	9.9	36.2	112.5	0.7	3.3	88.8	3.3	2.6	3.3	2.6	28.3	132.9
	E%	52	83	41	33	26	70	32	22	245	55	17	139	146	74	93	26	13
	RME	9.3	0.5	13.0	21.7	25.6	3.0	24.8	88.7	-1.0	1.5	74.0	-1.3	-1.2	0.9	0.2	21.1	115.9
10'+	MS	4.6	0.7	5.3	4.6	7.2	0.7	10.5	23.0	-	2.0	18.4	0.7	1.3	-	1.3	0.7	24.4
	E%	63	225	60	104	56	245	44	26	-	84	59	242	150	-	196	225	50
	RME	1.7	-0.8	1.1	-0.2	3.2	-1.0	5.9	17.1	-	0.3	7.7	-0.9	-0.7	-	-1.3	-0.8	12.2
Total 7' and over	MS	23.7	3.3	27.0	36.8	41.4	10.6	46.7	135.5	0.7	5.3	107.2	4.0	3.9	3.3	3.9	29.0	157.3
	E%	43	71	33	39	30	78	31	21	245	49	15	93	116	74	101	29	9
	RME	13.7	1.0	18.1	22.8	29.2	2.4	32.5	107.3	-1.0	2.7	91.4	0.3	-0.6	0.9	-0.04	20.6	144.3
Total 4' and over	MS	69.7	59.2	128.9	86.8	101.2	44.1	455.0	687.1	7.3	15.8	349.8	30.3	11.8	28.9	14.4	461.0	919.3
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-3

STAND TABLES - JENGKA FOREST RESERVE

Table 5 - All Four Quadrants (No. of stems per 100 acres)

Girth Classes	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods						Total				
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20	21		22	23	24-26	
4'-6'	MS	51.4	56.6	108.0	49.3	84.2	24.8	455.6	613.9	12.7	12.2	141.4	19.4	10.6	29.0	12.9	514.4	802.6
	E%	15	11	8	9	12	11	4	4	22	13	7	24	22	17	17	5	4
	RME	44.9	50.6	99.4	45.2	74.1	22.1	438.2	590.9	10.0	10.6	179.9	14.8	8.4	24.3	10.8	492.7	774.8
7'-9'	MS	19.6	7.4	27.0	29.7	56.5	10.1	38.0	134.3	2.1	3.3	67.6	4.4	4.5	3.5	3.3	35.9	124.6
	E%	20.0	20	15	13	11	19	12	7	42	26	9	30	31	42	39	13	7
	RME	15.7	6.0	23.2	25.9	50.3	8.2	33.7	125.4	1.2	2.5	61.9	3.	3.1	2.0	2.0	31.5	116.0
10'+	MS	3.7	1.2	4.9	6.7	19.9	0.6	15.2	42.4	0.6	4.4	14.7	2.1	2.1	0.5	0.7	2.6	27.7
	E%	43	56	36	27	15	63	19	11	127	27	19	37	59	83	61	52	15
	RME	2.1	0.5	3.2	4.9	17.0	0.2	12.4	37.9	-0.1	3.2	12.0	1.4	0.9	0.1	0.3	1.3	23.6
Total 7' and over	MS	23.3	8.6	31.9	36.4	76.4	10.7	53.2	176.7	2.7	7.7	82.3	6.5	6.6	4.0	4.0	38.5	152.3
	E%	19	17	14	12	10	19	11	6	47	22	9	25	30	37	37	13	7
	RME	19.0	7.1	27.6	32.2	69.4	8.8	47.6	166.2	1.5	6.1	75.6	4.9	4.7	2.5	2.5	33.9	141.7
Total 4' and over	MS	74.7	65.2	139.9	85.7	160.6	35.5	508.8	790.6	15.4	19.9	273.7	25.9	17.2	33.0	16.9	552.9	954.9
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-4

VOLUME TABLES - JENCKA FOREST RESERVE

Table 1 - Northeast Quadrant (Cubic feet per acre)

Cirth Class	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods					24-26	Total				
	184	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20			21	22	23	
4'-6'	MV	14.4	38.6	53.0	49.8	96.6	20.9	459.5	626.8	12.0	11.0	179.7	21.3	15.1	25.6	7.9	412.6	685.2
	E%	22	20	16	24	13	34	7	7	46	31	16	49	41	34	65	5	4
	RME	11.4	30.9	44.8	38.0	84.1	13.9	430.9	588.8	6.5	7.7	152.2	10.9	9.0	17.1	2.8	395.2	660.8
7'-9'	MV	23.5	24.1	47.6	86.8	180.8	37.0	122.8	427.4	11.4	9.6	192.0	12.5	18.3	11.4	8.2	107.0	370.4
	E%	54	29	28	24	20	33	18	11	67	49	15	55	38	81	90	28	15
	RME	11.0	17.3	34.5	66.5	145.0	25.1	100.9	381.4	3.8	4.9	163.6	5.6	11.5	2.2	0.9	78.1	315.8
10'+	MV	12.7	11.1	23.8	60.8	121.5	5.8	145.6	333.7	7.0	25.6	109.3	16.5	17.3	4.3	2.8	24.6	207.4
	E%	97	82	71	50	27	79	36	22	186	55	24	63	93	132	160	84	25
	RME	0.5	2.0	7.0	30.8	89.5	1.3	94.2	260.7	-6.0	11.7	83.3	6.3	1.4	-1.3	-1.7	4.1	156.4
Total 7' and over	MV	36.2	35.2	71.4	147.6	302.3	42.8	268.4	761.1	18.4	35.2	301.3	29.0	35.6	15.7	11.0	131.6	577.8
	E%	54	29	33	27	18	27	23	14	91	46	12	45	39	67	78	29	16
	RME	16.8	25.3	47.8	108.5	248.7	31.5	206.8	657.7	1.8	19.1	266.6	16.2	21.8	5.2	2.4	93.9	486.3
Total 4' and over	MV	50.6	73.8	124.4	197.4	398.9	63.7	727.9	1387.9	30.4	46.2	481.0	50.3	50.7	41.3	18.9	544.2	1263.0
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

MV denotes Mean Volume  
 RME denotes Reliable Minimum Estimate  
 E% denotes Error percent  
 NA denotes Not Available

APPENDIX 5-4

VOLUME TABLES - JENCKA FOREST RESERVE

Table 2 - Southeast Quadrant (Cubic feet per acre)

Girth Class	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods					Total	24-26	Total		
	1&4	2	Total	5	6	7	8-9	10-11	12	13-18	19-20	21				22	23
4'-6'	MV	31.9	29.4	61.3	66.0	138.2	20.5	332.3	9.1	17.7	205.3	17.5	15.1	20.0	13.7	411.2	709.6
	E%	29	16	48	23	15	11	8	46	19	13	67	42	33	24	9	9
	RME	22.9	25.0	50.9	51.3	118.3	18.4	308.1	5.0	14.5	178.7	5.8	8.9	13.6	10.5	378.0	652.8
7'-9'	MV	40.3	13.1	53.4	71.7	192.7	15.3	66.8	2.3	10.9	155.0	5.6	14.1	5.6	8.5	69.3	271.3
	E%	43	37	33	30	24	39	31	95	53	17	61	62	75	106	19	11
	RME	23.2	8.4	36.1	50.5	147.4	9.4	46.4	0.1	5.2	128.9	2.2	5.4	1.4	-0.4	56.5	242.4
10'+	MV	15.9	2.6	18.5	23.9	120.7	1.1	78.8	1.1	36.5	63.7	12.5	17.7	2.8	3.6	10.9	148.8
	E%	82	160	58	58	25	225	22	230	46	19	40	124	162	157	21	21
	RME	3.0	-1.6	7.9	10.2	91.4	-1.4	62.3	-1.4	20.1	52.2	7.5	-4.2	-1.7	-2.0	-0.6	118.5
Total 7' and over	MV	56.2	15.7	71.9	95.6	313.4	16.4	145.6	3.4	47.4	218.7	18.1	31.8	8.4	12.1	80.2	420.1
	E%	46	47	32	25	17	40	15	128	34	13	37	85	68	110	22	9
	RME	30.7	8.5	49.5	72.2	261.7	9.9	124.2	-1.0	31.4	191.9	11.5	5.0	2.8	-1.1	63.1	383.3
Total 4' and over	MV	88.1	45.1	133.2	161.6	451.6	36.9	477.9	12.5	65.1	424.0	35.6	46.9	28.4	25.8	491.4	1129.7
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-4

VOLUME TABLES - JENGKA FOREST RESERVE

Table 3 - Northwest Quadrant (Cubic feet per acre)

Girth Class	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods					24-26	Total				
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20			21	22	23	
4'-6'	MV	59.0	39.5	98.5	95.3	126.4	30.3	295.7	547.7	11.7	9.5	263.8	17.7	9.2	38.6	19.8	420.7	791.0
	E%	19	27	15	10	40	27	13	14	53	41	12	29	61	30	35	12	8
	RME	48.3	28.9	84.1	85.8	76.5	22.2	260.0	473.7	5.5	5.7	322.5	12.6	3.6	27.1	13.0	370.3	732.3
7'-9'	MV	52.0	12.2	64.2	96.1	142.9	18.9	70.7	328.6	2.2	9.6	161.3	17.4	6.7	11.6	11.6	65.4	285.8
	E%	36	40	26	30	22	34	26	16	140	80	28	59	102	98	65	35	21
	RME	33.4	7.3	48.1	67.6	112.9	12.5	52.6	277.7	-0.9	2.0	117.4	7.3	-0.1	0.3	4.1	43.0	228.0
10'+	MV	19.4	3.4	22.8	30.7	128.7	2.0	37.4	198.8	1.2	17.4	65.5	13.6	3.2	1.6	4.5	8.2	115.2
	E%	101	134	91	34	38	236	39	32	222	82	73	108	165	230	96	104	54
	RME	-0.1	-1.1	2.3	20.5	81.1	-2.8	23.1	133.8	-1.5	3.6	18.3	-1.1	-2.1	-2.1	0.2	-0.3	53.2
Total 7' and over	MV	71.4	5.6	87.0	126.8	271.6	20.9	108.1	527.4	3.4	27.0	226.8	31.0	9.9	13.2	16.1	73.6	401.1
	E%	30	47	27	19	23	42	25	14	116	71	33	63	109	88	59	29	26
	RME	50.1	8.3	63.9	103.8	211.8	12.2	81.5	459.8	-0.5	7.9	152.9	11.6	-0.9	1.6	6.7	52.3	300.1
Total 4' and over	MV	130.4	55.1	185.5	222.1	398.0	51.2	403.8	1075.1	15.1	36.5	490.6	48.7	19.1	51.8	35.9	494.3	1192.0
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-4

VOLUME TABLES - JENGKA FOREST RESERVE

Table 4 - Southwest Quadrant (Cubic feet per acre)

Girth Class	Heavy Hardwoods			Medium Hardwoods				Light Hardwoods					Total						
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20		21	22	23	24-26		
4'-6'	MV	29.9	36.6	66.5	69.4	86.9	34.5	319.8	510.6	5.3	10.1	293.5	25.3	9.4	24.5	11.0	347.1	726.2	
	E%	34	28	28	20	25	42	17	13	93	60	20	54	92	79	39	15	14	14
	RME	19.8	26.5	48.0	55.9	65.3	20.1	265.7	448.5	0.4	4.1	236.4	11.8	0.8	5.2	6.8	298.5	631.7	631.7
7'-9'	MV	40.3	4.8	45.1	90.6	92.2	24.6	82.8	290.1	1.3	8.9	239.3	8.2	7.4	8.8	6.4	64.1	343.4	343.4
	E%	55	90	45	35	20	75	32	21	245	45	19	138	137	78	85	31	13	13
	RME	16.2	0.5	24.9	59.2	74.1	6.2	56.8	231.3	-1.8	5.0	194.9	-3.1	-2.7	2.0	1.0	44.5	300.5	300.5
10'+	MV	23.0	3.6	26.6	23.7	39.3	2.8	52.4	118.1	-	10.0	98.7	2.9	7.1	-	9.0	3.3	131.0	131.0
	E%	67	225	83	108	53	245	42	24	-	74	60	242	152	-	197	225	50	50
	RME	7.7	-4.5	4.6	-1.8	16.7	-4.0	30.6	90.3	-	2.6	39.7	-4.2	-3.7	-	-8.6	-4.1	65.7	65.7
Total 7' and over	MV	63.3	8.4	71.7	114.3	131.5	27.4	135.2	408.2	1.3	18.9	337.0	11.1	14.5	8.8	15.4	67.4	474.4	474.4
	E%	37	98	35	46	27	88	32	20	245	47	19	88	111	78	125	39	12	12
	RME	40.3	0.2	46.8	62.7	96.7	3.5	92.5	329.9	-1.8	10.1	273.8	1.4	-1.5	2.0	-3.7	41.3	421.6	421.6
Total 4' and over	MV	93.2	45.0	138.2	183.7	218.4	61.9	455.0	918.8	6.6	29.0	630.5	36.4	23.9	33.3	26.4	414.5	1200.6	1200.6
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-4

VOLUME TABLES - JENGA FOREST RESERVE

Table 5 - All Four Quadrants (Cubic feet per acre)

Girth Class	Heavy Hardwoods		Medium Hardwoods			Total	Light Hardwoods			22	23	24-26	Total			
	1&4	2	5	6	7		8-9	10-11	12					13-18	19-20	21
4'-6'	MV	33.7	35.8	69.5	116.2	25.0	359.3	570.0	10.2	12.6	19.6	12.8	27.3	13.3	406.5	726.4
	E%	13	11	8	12	13.00	5	5	24	14	24	23	17	18	5	4
	RME	29.5	32.2	64.0	63.5	102.4	21.9	344.8	545.5	7.8	10.9	15.0	9.9	22.8	10.9	389.7
7'-9'	MV	38.4	15.2	53.6	163.5	23.9	86.7	359.3	4.9	9.9	178.0	12.6	9.4	9.0	79.0	314.0
	E%	20	18	14	11	19	12	7	48	29	9	30	42	42	14	8
	RME	30.7	12.6	46.1	74.2	145.7	19.6	77.1	335.1	2.6	7.1	162.3	8.9	5.4	68.6	291.1
10'+	MV	16.7	5.5	22.2	36.8	3.0	84.6	237.7	2.8	24.8	82.2	12.9	2.6	4.2	13.4	155.3
	E%	42	56	35	27	67	19	12	134	28	19	38	85	66	52	16
	RME	9.8	2.4	14.5	27.1	96.6	1.0	69.1	211.4	-0.9	18.0	67.2	8.1	0.4	6.5	132.0
Total 7' and over	MV	55.1	20.7	75.8	122.0	26.9	171.3	597.0	7.7	34.7	260.2	24.1	25.0	13.2	92.4	469.3
	E%	19	19	15	14	18	12	7	63	23	9	36	37	40	14	9
	RME	44.7	16.8	65.0	107.4	251.4	22.2	151.9	559.5	2.9	26.9	237.5	17.8	7.6	79.6	431.6
Total 4' and over	MV	88.8	56.5	145.3	191.5	51.9	530.6	1167.0	17.9	47.3	484.3	43.7	39.3	26.5	498.9	1195.7
	E%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	RME	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

## JENGA FOREST RESERVE

Percentage composition of Groups by species  
exclusive of all defective trees

BLOCKS FROM WHICH DATA OBTAINED	GROUP	SPECIES	GROUPED GIRTH CLASSES				
			4'-6'	7'-9'	10% & over	Total	
N. E. QUADRANT = BLOCKS 1, 2, 3, 4, 9 & 10. S. E. " " " " 13 & 14. N. W. " " " " 22, 23, 26 & 27. S. W. " " " " 32 & 33.	1 & 4	<u>HEAVY HARDWOODS</u>					
		Balau	56.5	51.6	54.5	55.2	
		Merbau	22.4	25.3	36.4	23.5	
		Giam	18.0	20.9	9.1	18.5	
		Sengkawang	3.1	2.2	-	2.8	
			%	100.0	100.0	100.0	100.0
	2	KerANJI Merbatu Kekatang Membatu Kayu Arang & Buey Tembusu Resak Penaga Pelawan		42.2	43.5	14.3	41.9
				25.2	13.0	-	23.4
				10.7	19.6	-	11.5
				6.3	19.6	85.7	9.1
				6.6	-	-	5.7
				3.8	4.3	-	3.8
				2.5	-	-	2.2
				2.2	-	-	1.9
				0.5	-	-	0.5
				%	100.0	100.0	100.0
	8 & 9	<u>MEDIUM HARDWOODS</u> Kelat Perah Minyak Berok Tualang Kasai Temponek Meransi Petaling Keladan Pauh Kijang Mempening Siapoh Berangan Keledang Rengas Jelawai Kamap Kulim Others		30.0	15.4	-	28.0
				26.3	8.4	-	24.2
				7.7	6.6	3.9	7.5
				2.9	22.4	71.4	6.3
				6.3	5.1	-	6.0
				2.9	6.5	2.6	3.2
				3.3	0.9	-	3.0
				2.6	0.5	-	2.4
				1.8	6.1	9.1	2.4
				1.5	6.5	2.6	1.9
				2.1	-	-	1.9
				1.6	6.1	1.3	1.9
				1.6	1.4	1.3	1.6
				1.0	5.2	3.9	1.4
				1.1	0.9	2.6	1.1
				0.7	4.2	-	1.0
				0.1	-	-	0.1
			0.1	-	-	0.1	
			6.4	3.8	1.3	6.0	
			%	100.0	100.0	100.0	100.0

(Contd.)

## JENGA FOREST RESERVE

Percentage composition of Groups by species  
exclusive of all defective trees (Contd.)

BLOCKS FROM WHICH DATA OBTAINED	GROUP	SPECIES	GROUPED GIRTH CLASSES				
			4'-6'	7'-9'	10' & over	Total	
N. E. QUADRANT : BLOCKS 1, 2, 3, 4, 9 & 10. S. E. " " " " " 13 & 14. N. W. " " " " " 22, 23, 26 & 27. S. W. " " " " " 32 & 33.	10 & 11	<u>LIGHT HARDWOODS</u>					
		Durian	47.0	66.7	100.0	54.1	
		Bintangor	51.5	33.3	-	44.7	
		Punggai	1.5	-	-	1.2	
		%	100.0	100.0	100.0	100.0	
		13 - 18	Meranti Tembaga	21.9	23.3	10.2	21.6
		" Melantai	20.7	10.5	2.3	17.1	
		" Sarang Punai	18.2	10.3	4.5	15.4	
		" Kepong	10.7	11.8	20.4	11.6	
		" Rambai Daun	10.3	14.3	17.1	11.6	
		Nemesu	8.7	16.5	18.2	11.2	
		Meranti Langgong	7.3	9.3	13.6	8.2	
		Seraya	2.0	3.8	11.4	3.0	
		Meranti Batu	0.2	0.2	2.3	0.3	
		%	100.0	100.0	100.0	100.0	
		19 & 20	Nereawa	51.4	71.4	90.0	57.2
		Meranti Pa'ang	36.4	14.3	10.0	31.2	
		" Pipit	12.2	14.3	-	11.6	
		%	100.0	100.0	100.0	100.0	
	24 - 26	Kedondong	32.3	38.9	-	32.7	
	Merawan	8.9	5.2	-	8.6		
	Fenarahan	7.6	5.2	-	7.4		
	Kembang Semangkok	7.3	8.8	-	7.4		
	Medang	7.5	4.1	11.1	7.3		
	Nemrisang	6.4	4.2	11.1	6.3		
	Mata Ulat	4.7	7.3	11.1	4.9		
	Pelong	3.6	7.8	11.1	3.9		
	Machang	2.4	3.1	11.1	2.5		
	Terap	2.0	1.6	11.1	2.0		
	Sesendok	2.1	1.6	-	2.0		
	Kungkur	1.2	0.5	-	1.2		
	Karas	0.9	1.0	-	0.9		
	Petai & Petai kerayong	0.9	0.5	22..	0.9		
	ara Berteh	0.5	1.0	-	0.5		
	Terentang	0.4	1.5	-	0.5		
	Pulai	0.3	3.6	11.1	0.5		
	Melunak	0.4	1.0	-	0.4		
	Geronggang	0.3	-	-	0.3		
	Others	10.3	3.1	-	9.8		
	%	100.0	100.0	100.0	100.0		

STATISTICAL RESULTS OF JENGA FOREST INVENTORY SAMPLINGArea Sampled

Approximately 146 square miles (39,000 ha.) of "productive" lowland dipterocarp forest in the "Jengka triangle" development area.

Design

Stratified random 2-per-block with a systematic constraint, employing chain-wide strips running parallel east and west from a central north-south base-line. Contiguous blocks were first defined, separately east and west of the base-line, each 2 miles (160 chains) wide north-south and from half to four miles long east-west depending on the extent of the forest, covering the whole unexploited area. There were 33 blocks in all, subdivided for analysis into four quadrants, NE with 10 blocks, SE with 9, SW with 6 and NW with 8 blocks.

Strips were randomised along the north-south base-line two in each block, but with the constraint that only six positions were possible in each block, but with the constraint that only six positions were possible in each block, namely the six previously cleared soil-survey rentis lines which had been laid out at one-third mile intervals.

The theoretical effect of this restriction will be to over-estimate sampling errors and therefore to depress the lower confidence limit and to create the possibility of bias if coincident systematic variation should occur in the forest. In practice these effects can be ignored firstly because there was no evidence that wider spacing led to greater deviations and secondly because strip length averaged  $7\frac{1}{2}$  times minimum spacing. Since the strips always extended to the east and west limits of each block, the sampling fraction was constant at 1.25% over the whole area.

Observations in each strip consisted of the numbers of stems of 26 different species-groups separately in each of ten girth-classes running from 4' up to 13', the latter including all larger sizes. For analysis, observations were converted to the two parameters stems per acre and volume per acre. The latter was obtained from single-entry volume tables derived from standard Malayan dual-entry tables by the inventory authority, using height-girth curves obtained from the Jengka area itself.

Sampling errors at 95% probability were calculated for stems and volume per acre of the 26 species groups or combinations of them, separately by four major size-classes, in all a total of 72 "populations". Because the required parameters were ratios and sample units differed greatly in size, the "combined ratio estimate" (Cochran 1964, p.169) was used.

Results: The relation between population density and sampling errors.

As expected, sampling errors were inversely proportional to population density, as is clearly shown in the attached graph. What was expected was the very clear logarithmic relation between the two and the small variation in slope between the four sectors.

The function:  $\text{Log. E} = k - b \times \text{Log. N}$

where E = sampling error percent

and N = number of stems per acre

was clearly applicable to all quadrants, with b varying non-significantly from .36 to .50, and the value .42 applying to both westerly quadrants and to the combined analysis. K was inversely related to the number of strips employed, but with only four samples the relation could not be quantified. The two most reliable equations were:

$$\text{Log. E} = 8.8 - .42 \times \text{Log. N} \text{ for 66 strips}$$

$$\text{Log. E} = 23 - .42 \times \text{Log. N} \text{ for 14 strips}$$

The first of these should be widely applicable to lowland dipterocarp forest sampled in the way described, with any number of strips from

about 50 to 100. The percentage of the sample is almost immaterial, the critical factor being the number and size of sample units and the nature of variation in the forest.

The range of sampling errors rather than their trend is set out in the attached table. It brings out clearly the dependence of sampling errors on the regularity or otherwise of a species' occurrence. Thus an evenly distributed species or group averaging 1 stem per acre may be safely quantified by a sample of less than 20 strips to within 20% but a more irregularly grouped species may cause sampling errors up to 40%.

Also clear is the fact that even exceptionally ill-distributed species averaging over 0.3 stems per acre were quantified within  $\pm 20\%$  by a sufficiently large sample - in this case of 66 strips. The results of the latter sample are considerably superior to those of Guyana, Sierra Leone, Uganda and elsewhere inventories of forest of 100 to 200 square miles at around 1% were found to estimate timber tree populations to within 20% only if mean stocking exceeded 2 per acre; in the present case success by the 20% criterion has been achieved over the whole area for populations down to 0.3/acre (though individual sectors only for those exceeding 3/acre). The better performance can probably be attributed to the well-known greater uniformity of the lowland Malayan forests.

As indicated before, under these conditions and dimensions of forest and sample, the estimate of approximately  $\text{Log. } E\% = 9 - 0.4$   $\text{Log. } N$  is likely to provide safe predictions for the future.

JENGA SAMPLE OF 1965 - 1966

TABLE OF STATISTICAL RESULTS

<u>Population frequency in number of stems per acre</u>	<u>No. of strips</u>	<u>Range of sampling errors found and size of sample concerned</u>		
		<u>% according to species distribution</u>		
		<u>Least variable</u>	<u>Mean</u>	<u>Most variable</u>
0.1	12 - 20 66	15 - 30 15	46 20	70 - 90 30
0.3	12 - 20 66	10 - 25 10	32 13	40 - 60 17
1.0	12 - 20 66	9 - 20 7	20 9	20 - 40 11
3.0	12 - 20 66	7 - 12 5	12 5.5	12 - 30 6
10.0	12 - 20 66	4 - 8 3	8 3.5	8 - 14 4

H. C. DAWKINS  
Oxford  
July 4, 1966



## APPENDIX 5-7

## TEKAM SINGLE ENTRY VOLUME TABLE

Volumes in cubic feet based on combined height/girth data obtained from Jengka and Tekam areas.

Species Groups	Girth Classes <sup>1/</sup>										
	4'	5'	6'	7'	8'	9'	10'	11'	12'	13' +	
1	37	66	106	146	191	260	320	388	461	540	
2	40	71	120	166	231	294	383	463	551	646	
4	42	71	113	166	218	276	362	438	521	610	
5	90	138	190	255	316	386	462	548	640	740	
6	100	136	182	242	316	386	465	552	635	718	
7	60	97	146	206	266	353	432	518	614	700	
8 & 9	59	93	137	191	257	336	408	510	590	680	
10 & 11	59	93	137	191	257	336	408	510	590	680	
12	74	116	167	226	296	376	448	548	636	732	
13	76	110	154	207	258	330	395	468	548	632	
14	72	111	158	213	264	336	402	476	554	640	
15	83	122	170	229	302	372	473	562	659	764	
16	87	126	175	230	296	374	448	534	620	723	
17	62	107	162	228	306	380	481	574	676	786	
18	94	125	166	220	286	348	441	522	611	706	
19	60	97	146	206	266	353	432	518	614	700	
20 - 23	74	116	167	226	296	376	448	548	636	732	
24	60	97	146	206	266	353	432	518	614	700	
25 & 26	59	93	137	191	257	336	408	510	590	680	

<sup>1/</sup> Girth classes are of completed unit type entitled by lower limit of each class.

STAND TABLES - TEKAM FOREST RESERVE

(No. of stems per 100 acres)

Girth Class	Heavy Hardwoods			Medium Hardwoods					Light Hardwoods					Total				
	1&4	2	Total	5	6	7	8-9	Total	10-11	12	13-18	19-20	21		22	23	24-26	
4'-6'	MS	17.0	56.5	73.5	41.9	55.7	17.9	466.8	582.3	8.7	21.1	164.6	28.1	12.1	25.7	6.8	446.0	713.1
	E%	30	18	13	18	20	28	9	7	35	24	9	31	35	42	29	6	5
	RME	11.9	46.4	63.9	34.7	44.8	13.1	428.8	542.1	5.7	16.2	149.9	19.6	8.0	15.0	4.9	419.8	681.2
7'-9'	MS	10.7	7.3	18.0	30.5	32.5	4.4	34.7	102.1	1.0	9.7	72.0	10.9	7.3	2.7	2.9	29.1	135.6
	E%	40	39	25	20	23	61	29	14	108	46	15	33	47	85	58	36	13
	RME	6.4	4.5	13.5	24.6	25.1	1.7	24.7	87.9	-0.1	5.3	61.7	7.4	3.9	0.4	1.2	18.8	118.5
10' and over	MS	3.2	nil	3.2	3.4	5.6	0.5	17.7	27.2	nil	4.1	18.4	2.4	4.6	0.5	1.2	2.2	133.4
	E%	57	nil	57	81	45	25	29	26	nil	63	19	78	43	153	113	79	16
	RME	1.4	nil	1.4	0.7	3.1	-0.6	12.6	20.2	nil	1.5	15.0	0.5	2.7	-0.3	-0.2	0.5	28.2
Total 7' and over	MS	13.9	7.3	21.2	33.9	38.1	4.9	52.4	129.3	1.0	13.8	90.4	13.3	11.9	3.2	4.1	31.3	169.0
	E%	36	39	25	15	24	70	24	12	108	40	14	31	36	83	56	34	12
	RME	8.9	4.5	15.9	29.2	29.0	1.5	40.2	113.7	-0.1	8.4	77.9	9.2	7.7	0.6	1.8	21.0	149.3
Total 4' and over	MS	30.9	63.8	94.7	75.8	93.8	22.8	519.2	711.6	9.7	34.9	255.0	41.4	24.0	28.9	10.9	477.3	882.1
	E%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	RME	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

APPENDIX 5-9

VOLUME TABLES - TEKAM FOREST RESERVE  
(Cubic Feet Per Acre)

GIRTH CLASSES	HEAVY HARDWOOD				MEDIUM HARDWOOD				LIGHT HARDWOOD								TOTAL	
	1 & 4	2	TOTAL		5	6	7	8 & 9	TOTAL	10&11	12	13-16	19&20	21	22	23		24-26
4' - 6'	M.V.	12.4	38.0	50.4	59.4	76.3	18.6	370.4	524.7	6.9	21.9	205.2	27.1	14.9	24.6	7.6	354.6	662.6
	E %	32	18	13	18	21	30	9	8	41	19	9	30	33	42	33	6	5
	R.M.E.	8.5	31.5	44.1	49.2	60.4	13.1	337.2	484.5	4.1	17.8	167.5	15.0	10.0	14.3	5.2	334.0	632.2
7 - 9'	M.V.	19.2	13.3	32.5	88.3	94.4	11.5	80.6	274.8	2.0	26.9	194.0	28.4	20.1	6.9	8.3	64.5	351.1
	E %	39	41	26	18	23	61	27	13	109	46	16	30	47	83	54	35	13
	R.M.E.	11.7	8.0	24.3	72.7	72.9	4.5	59.3	240.4	-0.2	14.5	164.1	19.9	10.7	1.2	3.9	42.4	306.8
10' & OVER	M.V.	13.6	NIL	13.6	18.9	30.3	2.3	104.2	155.7	NIL	24.4	102.3	13.5	27.1	2.2	7.3	11.7	188.5
	E %	51	NIL	51	82	47	215	29	27	NIL	66	21	79	45	153	113	80	16
	R.M.E.	6.8	NIL	6.8	3.5	16.3	-2.6	74.1	113.9	NIL	8.4	81.6	2.9	14.9	-1.2	-0.9	2.4	159.2
TOTAL	M.V.	32.8	13.3	46.1	107.2	124.7	13.8	184.8	430.5	2.0	51.3	296.3	41.9	47.2	9.1	15.6	76.2	539.6
7' & OVER	E %	32	41	26	13	26	78	22	13	109	44	15	34	37	83	63	32	12
	R.M.E.	22.3	8.0	34.2	93.6	93.2	3.1	144.3	376.0	-0.2	29.2	232.8	27.6	29.8	1.6	5.9	52.5	476.9
	TOTAL	M.V.	45.2	51.3	96.5	166.6	201.0	32.4	555.2	953.2	8.5	73.2	501.5	69.0	62.1	33.7	23.2	430.8
4' & OVER	E %	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	R.M.E.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

## APPENDIX 5-10

## TEKAM FOREST RESERVE

Percentage Composition of Groups by species  
exclusive of all defective trees

BLOCKS FROM WHICH DATA OBTAINED	GROUP	SPECIES	GROUPED GIRTH CLASSES				
			4'-6'	7'-9'	10' & over	Total	
BLOCKS 37, 40, 43, 45 and 47	1 & 4	<u>HEAVY HARDWOODS</u>					
		Merbau	90.3	90.9	100.0	91.1	
		Balau	9.7	9.1	-	8.9	
		Sengkawang	-	-	-	-	
			Giam	-	-	-	-
			%	100.0	100.0	100.0	100.0
	2	KerANJI	40.7	42.9	-	40.9	
		Kekotong	17.3	28.6	-	18.2	
		Merbatu	12.3	14.2	-	12.5	
		Membatu	12.4	14.3	-	12.5	
		Kayu Arang & Buey	7.4	-	-	6.8	
		Tembusu	3.7	-	-	3.4	
		Hesak	3.7	-	-	3.4	
		Penaga	2.5	-	-	2.3	
		Pelawan	-	-	-	-	
		%	100.0	100.0	-	100.0	
	8 & 9	<u>MEDIUM HARDWOODS</u>					
		Perah	24.2	7.5	-	21.7	
		Kelat	23.7	8.7	-	21.4	
		Tualang	3.4	33.8	81.5	9.1	
		Linyak Berok	8.8	6.2	-	8.3	
		Kasai	8.1	7.5	-	7.7	
		Simpoh	3.4	6.3	3.7	3.7	
		Keladan	3.1	8.8	-	3.6	
		Temponek	3.5	3.7	3.7	3.6	
		Meransi	3.5	-	-	3.0	
		Petaling	3.1	-	-	2.7	
		Nempening	2.8	1.2	-	2.5	
Jelawai		2.2	3.8	-	2.3		
Pauh Kijang		1.8	5.0	-	2.0		
Berangan		1.9	-	-	1.7		
Keledang		0.9	2.5	3.7	1.1		
Rengas		0.9	2.5	-	1.0		
Kulim		-	-	-	-		
Kamap		-	-	-	-		
Others		4.7	2.5	7.4	4.6		
%	100.0	100.0	100.0	100.0			

(Contd.)

## APPENDIX 5-10

## TEKAM FOREST RESERVE

Percentage Composition of Groups by species  
exclusive of all defective trees (Contd.)

BLOCKS FROM WHICH DATA OBTAINED	GROUP	SPECIES	GROUPED GIRTH CLASSES				
			4'-6'	7'-9'	10' & over	Total	
BLOCKS 37, 40, 43, 45 and 47	10 & 11	<u>LIGHT HARDWOODS</u>					
		Durian	42.9	100.0	-	52.9	
		Bintangor	57.1	-	-	47.1	
		Punggai	-	-	-	-	
			%	100.0	100.0	-	100.0
	13 - 13	Meranti Tembaga	27.6	25.4	39.1	27.6	
		Meranti Sarang Punai	19.5	15.1	8.7	17.7	
		Meranti Langgong	15.6	18.2	13.1	16.2	
		Meranti Kepong	14.9	12.7	21.7	14.7	
		Meranti Melantai	12.4	15.9	-	12.7	
		Nemesu	9.4	12.7	17.4	10.7	
		Meranti Rambai Daun	0.3	-	-	0.2	
		Meranti Batu	0.3	-	-	0.2	
		Seraya	-	-	-	-	
			%	100.0	100.0	100.0	100.0
	19 & 20	Meranti Pa'ang	55.3	33.3	20.0	48.4	
		Meranti Pipit	29.8	33.3	20.0	29.7	
		Mersawa	14.9	33.4	60.0	21.9	
			%	100.0	100.0	100.0	100.0
	24 - 26	Kendondong	27.8	42.9	-	28.3	
		Medang	11.6	-	-	10.9	
		Penarahan	11.3	-	-	10.7	
		Kembang Semangkok	6.4	8.6	-	6.5	
		Sekendok	4.8	-	-	4.5	
		Mempisang	4.3	-	-	4.1	
		Kerawan	3.7	2.9	-	3.7	
		Bata Ulat	3.0	5.7	16.7	3.2	
		Lachang	2.8	2.9	50.0	3.2	
		Pelong	2.5	14.3	-	3.1	
		Petai & Petai Kerayong	2.1	5.7	-	2.3	
		Pulai	2.1	2.8	16.6	2.2	
		Terap	1.8	5.7	16.7	2.1	
		Karas	1.6	-	-	1.5	
		Ara Berteh	1.3	-	-	1.3	
		Kungkur	0.9	5.7	-	1.1	
		Terentang	0.8	-	-	0.7	
		Geronggang	0.2	-	-	0.1	
		Melunak	-	-	-	-	
		Others	11.0	2.8	-	10.5	
		%	100.0	100.0	100.0	100.0	

## APPENDIX 6

## VEGETATION

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GRASSLAND ASSOCIATIONS OF THE JENGA TRIANGLE	84

## BOTANICAL CHECK LIST

Below are given lists of grasses, sedges, and leguminous plants collected within the Jengka Triangle in the course of the soil survey. These provide potential for the development of pasture resources. An estimate of the palatability to cattle is given for each species. Species lists for the main grassland association are also given.

Species	Habitat	Habit	Annual or Perennial	Palatability
GRASSES OF THE JENGA TRIANGLE				
<u>Acroceras sparsum</u>	Forest fringe	Stooling	P	Medium
<u>Axonopus compressus</u>	Road fringe clearing	Creeping	P	Good
<u>Brachiaria raspaloides</u>	Swamp fringe	Creeping	P	Medium
<u>Centotheca lappacea</u>	Forest fringe	Stooling	P	Low
<u>Chrysopogon aciculatus</u>	Road fringe & clearing	Creeping	P	Good
<u>Coelorachis glandulosa</u>	River bank	Stooling	P	Medium
<u>Cymbopogon citratus</u>	Cultivated in gardens	Stooling	P	Low
<u>Cymbopogon nardus</u>	Cultivated in gardens	Stooling	P	Low
<u>Cynodon dactylon</u>	Dryland	Creeping	P	Good
<u>Dactyloctenium aegyptum</u>	Road fringe	Creeping	A	Medium
<u>Digitaria longiflora</u>	Dryland	Creeping	P	Good
<u>Digitaria marginata</u>	Dryland	Creeping	P	Good

Species	Habitat	Habit	Annual or Perennial	Palatability
<u>Dimeria glabra</u>	Road fringe	Stooling	P	Medium
<u>Echinochloa colona</u>	Dryland	Stooling	A	Good
<u>Eleusine indica</u>	Dryland	Stooling	A	Medium
<u>Eragrostis amabilis</u>	Road fringe	Stooling	A	Medium
<u>Eragrostis elegantula</u>	Clearings, wetland	Stooling	P	Medium
<u>Eragrostis elongata</u>	Clearings	Stooling	P	Medium
<u>Eragrostis unioloides</u>	Wetland	Stooling	P	Medium
<u>Hymenachne myurus</u>	Ricefield, swamp	Creeping	P	Good
<u>Imperata cylindrica</u>	Dryland, fire climax	Rhizomatous Stooling	P	Medium (young)
<u>Isachne globosa</u>	Open swamp, ricefield	Creeping	P	Good
<u>Isachne rigida</u>	In road ditch	Creeping	P	Medium
<u>Leersia hexandra</u>	Swamp, ricefield	Creeping	P	Good
<u>Leptochloa chinensis</u>	Dryland	Rhizomatous Stooling	A	Medium
<u>Lophatherum gracile</u>	In forest & fringe	Stooling	P	Medium
<u>Panicum amplixicaule</u>	Ricefield, river fringe	Stooling	P	Good
<u>Panicum nodosum</u>	Forest fringe	Creeping	P	Medium
<u>Panicum repens</u>	Ricefield, swamp	Creeping	P	Good
<u>Panicum sarmentosum</u>	Forest fringe & clearings	Creeping	P	Medium
<u>Panicum pilipes</u>	Forest fringe	Creeping	P	Medium
<u>Panicum frigonum</u>	Forest fringe	Creeping	P	Medium
<u>Paspalum commersonii</u>	Dryland & wetland	Stooling	P	Good

Species	Habitat	Habit	Annual or Perennial	Palatability
<u>Paspalum conjugatum</u>	Dryland, forest clearing	Creeping	P	Medium
<u>Pennisetum purpureum</u>	Introduced, planted	Stooling	P	Good
<u>Pogonatherum saccharoideum</u>	Road cuttings	Stooling	P	Low
<u>Sacciolepis indicus</u>	Swamp, ricefield	Creeping	P	Good
<u>Sacharrum arudineceum</u>	River bank	Stooling	P	Low
<u>Setaria geniculata</u>	Road side	Stooling	A	Good
<u>Sporobolus diander</u>	Road fringe clearings	Stooling	A	Medium
<u>Sporobolus indica</u>	Road fringe	Stooling	P	Medium
<u>Themeda villosa</u>	River bank	Stooling	P	Low

SEDGES OF THE JENKKA TRIANGLE

SEDGES OF THE JENKKA TRIANGLE

<u>Cyperus aromaticus</u>	Swamp	Creeping	Creeping	Non-palatable	Medium
<u>Cyperus cyperinus</u>	Swamp	Stooling	Creeping	Non-palatable	Low
<u>Cyperus distans</u>	Swamp	Stooling	Shrub	Non-palatable	Low
<u>Cyperus elatus</u>	Swamp	Stooling	Shrub	Non-palatable	Low
<u>Cyperus iria</u>	Swamp	Stooling	Shrub	Non-palatable	Low
<u>Cyperus kyllingia</u>	Ricefield	Creeping	Shrub	Non-palatable	Low
<u>Cyperus pennatus</u>	Ricefield	Stooling	Shrub	Browsed	Low
<u>Cyperus pulcherrimus</u>	Swamp	Stooling	Shrub	Browsed	Low
<u>Cyperus zollingeri</u>	Dryland	Stooling			Low
<u>Eriocaulon sexangulare</u>	Ricefield	Stooling	Creeping	Browsed	Low
<u>Fimbristylis diphylla</u>	Swamp	Stooling	Creeping	Palatable	Low

Species	Habitat	Habit	Palatability
<u>Fimbristylis globulosa</u>	Swamp	Stooling	Medium
<u>Fimbristylis lerrugines</u>	Swamp	Stooling	Low
<u>Fimbristylis miliacea</u>	Swamp	Stooling	Medium
<u>Fimbristylis pavciflora</u>	Swamp	Stooling	Low
<u>Fimbristylis spathacea</u>	Swamp	Stooling	Low
<u>Fimbristylis trichophylla</u>	Ricefield	Stooling	Low
<u>Fuirema umbelata</u>	Ricefield	Stooling	Low
<u>Hypolythrum latifolium</u>	Swamp forest	Stooling	Low
<u>Rhynchospora aurea</u>	Paya	Stooling	Low
<u>Scleria laevis</u>	Forest fringe	Stooling	Low
<u>Scirpus grassus</u>	Swamp	Stooling	Low
<u>Scirpus mucronatus</u>	Ricefield	Stooling	Low

#### LEGUMES OF THE JENGKA TRIANGLE

<u>Calapogonium mucinoides</u>	Oil palm estate	Creeper	Browsed
<u>Canavalia microcarpa</u>	Village clearing, forest fringe	Creeper	Non-palatable
<u>Cassia alata</u>	Road fringe, jungle	Shrub	Non-palatable
<u>Cassia occidentalis</u>	Village clearing, village fringe	Shrub	Non-palatable
<u>Cassia tora</u>	Ricefield fringe padang	Shrub	Non-palatable
<u>Centrosema pubescens</u>	Oil palm estate	Shrub	Browsed
<u>Crotalaria striata</u>	Roadsides and village clearing	Shrub	Browsed
<u>Derris eliptica</u>	Rubber estate		
<u>Desmodium capitatum</u>	Roadsides and village clearing	Creeper	Browsed
<u>Desmodium heterophyllum</u>	Roadsides and village clearing	Creeper	Palatable
<u>Desmodium heterocarpum</u>	Fire subclimax	Creeper	Browsed

Species	Habitat	Habit	Palatability
<u>Desmodium ovalifolium</u>	Roadsides and village clearing	Shrub	Browsed
<u>Desmodium pulchellum</u>	Village clearing	Shrub	Browsed
<u>Desmodium triflorum</u>	Roadsides and village clearing	Creeper	Palatable
<u>Easchynomene indica</u>	Fallow ricefield	Shrub	Palatable
<u>Flemingia congesta</u> <u>var. semialata</u>	Oil palm estate	Shrub	Non-palatable
<u>Mimosa invisa</u>	Roadsides and village clearing	Creeper	Non-palatable
<u>Mimosa pudica</u>	Roadside and village clearing	Creeper	Browsed
<u>Pueraria psoraloides</u>	Oil palm estate	Creeper	Browsed
<u>Uraria orinata</u>	Young rubber plantation, village clearing		Browsed
<u>Uraria lagopoides</u>	Fire subclimax	Creeper	Non-palatable

LEGUMES CULTIVATED IN THE JENGA TRIANGLE

<u>Arachis hypogea</u>	Ground nut
<u>Dolichos lablab</u>	Bonaviste bean
<u>Glycine max</u>	Soya bean
<u>Phaseolus aureus</u>	Green gram
<u>Phaseolus vulgaris</u>	French bean
<u>Pachyrhizos tuberosus</u>	Sengkung (Malay)
<u>Psohocarpus tetragonolobus</u>	Four winged bean
<u>Stizolobium desringianum</u>	Velvet bean (white)
<u>Vigna sinensis</u>	Yardlong bean

GRASSLAND ASSOCIATIONS OF THE JENCKA TRIANGLE

Forest Clearing Association

Grasses

- Paspalum conjugatum
- Paspalum scrobiculatum
- Echinochloa colona
- Leptochloa chinensis
- Eleusine indica
- Digitaria marginata
- Digitaria longiflora
- Cynodon dactylon

Sedges

- Cyperus zollingeri
- Cyperus cyperimus
- Cyperus iria

Forest Fringe Association

Grasses

- Lophatherum gracile (deep shade)
- Cenotheca lappacea (shade)
- Panicum pilipes
- Brachiaria paspaloides (swamp)
- Panicum nodosum
- Panicum trigonum

Sedges

- Scleria laevis
- Hypolytrum latifolium

Legume

- Cassia alata

Subclimax Association

Grasses

Imperata cylindrica

Shrubs

Melastoma malabathricum

Gleicitera sp.

Sedges

Scleria laevis

Legumes

Desmodium heterocarpum

Desmodium pulchellum

Uraria lagopoides

Uraria crinata

Fallow Ricefield Association

Grasses

Cryza sativa (volunteer)

Hymenachne myurus

Panicum amplexicaule

Eragrostis uniloides

Leersia hexandra

Isachne globosa

Creepers

Ipomea aquatica

Legumes

Fuirena umbellata

Cyperus elatus

Cyperus aromaticus

Cyperus pennatus

Fimbristylus diphylla

Fimbristylus globulosa

Rhynchospora aurea

Cyperus pennatus

Scirpus grassus

Neptunia oleracea

Desmodium heterocarpum

Scirpus mucronatus

Fimbristylus trichophylla

Cyperus distans

Fimbristylus pauciflora

Fimbristylus diphylla

Cyperus pulcherrimus

Fimbristylus lerrugines

Village Clearing and Roadside Association

(a) Dryland

Grasses

Chrysopogon aciculatus  
Axonopus compressus  
Paspalum scrobiculatum  
Paspalum conjugatum  
Cynodon dactylon  
Sporobolus diander  
Sporobolus indicus

Sedges

Fimbristylis lerrugines  
Cyperus aromaticus

Legumes

Desmodium triflorum  
Mimosa pudica

(b) Wetland

Grasses

Chrysopogon aciculatus  
Paspalum scrobiculatum  
Axonopus compressus  
Cynodon dactylon  
Paspalum conjugatum  
Eragrostis unioloides

Sedges

Fimbristylis lerrugines  
Fimbristylis miliacea  
Fimbristylis pauciflora  
Cyperus aromaticus  
Fimbristylis globulosa  
Cyperus pulcherrimus

Legumes

Mimosa pudica  
Desmodium triflorum

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WYATT-SMITH, J. 1964. A preliminary vegetation map of Malaya with descriptions of the vegetation types. Journal of Tropical Geography 18, 1964, 200 - 213.

APPENDIX 7

WATER RESOURCES IN PERAK,  
SELANGOR AND PAHANG

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1. The material has been reviewed and checked for accuracy.  
2. The material has been reviewed and checked for accuracy.

APPENDIX 7-1

DISCHARGE RECORDS FOR CERTAIN STREAMS IN PERAK,  
SELANGOR AND PAHANG

Stream	Location of Gauge	Area in Sq.Miles	Maximum Recorded Discharge in cusecs	Minimum Recorded Discharge per sq.mile	Period of Record
Batang Padang	Kampar	178	13.8	1.52 <sup>1/</sup>	1930-40
"	Tapah	146	104.0	1.37	1914-40
Bentong	Kuala Lumpur Road	93	82.2	0.67	1931-40
Bernam	Lima Belas	422	18.2	0.73	1933-40
"	Tanjong Malim	72	139.8	0.25	1926-40
Bidor	Bidor	35	54.3	0.43	1930-40
Dong	Kpg Dong	82	29.6	1.16	1914-40
Ijok	Titi Ijok	83	26.4	0.10 <sup>2/</sup>	1915-40
"	Batu Glugor	49	23.7	0.04 <sup>2/</sup>	1934-40
Kampar	Kpg Lanjut	169	31.1	0.31	1930-40
Kinta	Batu Gajah	407	17.3	0.63 <sup>1/</sup>	1915-40
"	Ipoh	121	57.3	0.70 <sup>1/</sup>	1915-40
"	Tanjong Rambutan	95	215.0	0.37 <sup>1/</sup>	1930-40
"	Tanjong Tualang	475	16.8	1.11 <sup>1/</sup>	1915-40
Klang	Kuala Lumpur	179	62.8	0.93 <sup>1/</sup>	1910-40
"	Petaling	218	29.8	0.60 <sup>1/</sup>	1929-40
"	Puchong	268	12.6	0.70 <sup>1/</sup>	1937-40
Kurau	Pondok Tanjong	130	32.8	0.05 <sup>1/</sup>	1930-40
Langkat	Dingkil	478	10.8	0.61 <sup>1/</sup>	1930-40
"	Kajang	148	36.2	0.34 <sup>1/</sup>	1926-40
Linggi	Rahang	73	25.3	0.03	1931-40
Pari	Ipoh	105	43.6	0.20	1915-40
Perak	Iskander Bridge	3000	133.0	0.27	1915-40
Plus	Kpg Lintang	420	18.1	1.04	1936-40
Raia	Old Kelas Estate	97	21.7	0.28	1930-40
Selangor	Batang Berjuntai	600	13.7	0.15	1930-40
"	Rantau Panjang	560	25.2	0.26	1921-40
Semenyih	Bangi-Telok Dato Road	235	33.3	0.17 <sup>2/</sup>	1926-40
"	Semenyih	82	27.5	0.11 <sup>2/</sup>	1928-40
Slim	Slim Village	124	31.7	0.69	1930-40
Sungkai	Sungkai	113	74.8	1.49	1930-40

1/ Adjusted for extraction and other losses

2/ Suspect Readings not used in calculations.

APPENDIX 7-2

SOILS INFILTRATION TESTS SUMMARY

Depth in feet	Soil moisture % or water content before test	Approximate Specific Gravity	Infiltration rate in in./hr.	Date	Test No.	Soil Type	Volume of water, gal. - Equilibrating - Total	Cover	Location	Diameter of test cylinder	Appearance of Sample
6-12	31.7 (7)	1.2	4.9	26/4	1	Segment	40.0	Soils	project	9.0"	Undisturbed
12-24	31.6	1.2	1.8	-	2	-	22.0 <sup>2</sup>	-	-	-	Probably consolidated (checked by road construction marking) - Disturbed
12-24 surface	31.6	1.2	5.2	-	1	-	-	plastic (1) surface cover crop	Dist. Jergol Phase II	-	Undisturbed
0-12	31.0	1.2	4.6	19/4	6	-	-	plastic (1) surface cover crop	-	-	Undisturbed
0-15	31.0	1.2	16.1	-	7	-	-	plastic (1) surface cover crop	-	-	Undisturbed
8-12	31.2	1.2	15.4	24/5	4	-	-	plastic (1) surface cover crop	-	-	Undisturbed
12-24	31.2	1.2	12.0	-	9	-	-	plastic (1) surface cover crop	-	-	Undisturbed
0-12	31.2	1.2	2.0	-	2	-	-	plastic (1) surface cover crop	-	-	Undisturbed
0-15	31.2	1.2	2.0	-	7	-	-	plastic (1) surface cover crop	-	-	Undisturbed
8-12	31.2	1.2	15.4	-	4	-	-	plastic (1) surface cover crop	-	-	Undisturbed
4-15	31.2	1.2	9.5	-	2	-	-	plastic (1) surface cover crop	-	-	Undisturbed
4-15	31.2	1.2	3.6	-	5	-	-	plastic (1) surface cover crop	-	-	Undisturbed
3-12	31.2	1.2	25.6	24/5	1	Moloch	42.2	plastic (1) surface cover crop	project	-	veg. - undisturbed
3-12	31.2	1.2	5.1	-	3	-	72.0 <sup>2</sup>	-	-	-	veg. - undisturbed
3-12	31.2	1.2	4.1	-	2	-	-	-	-	-	veg. - undisturbed
3-12	31.2	1.2	10.0	-	6	-	31.2	-	-	-	veg. - undisturbed
6-12	31.2	1.2	2.6	-	5	-	-	-	-	-	veg. - undisturbed
4-9	31.2	1.2	2.6	-	6	-	-	-	-	-	veg. - undisturbed
9-21	31.2	1.2	9.6	-	2	-	35.0	-	-	-	veg. - undisturbed
12-24	31.2	1.2	2.1	26/4	4	-	-	-	-	-	veg. - undisturbed
4-6	31.2	1.2	2.0	27/4	1	-	-	-	-	-	veg. - undisturbed
0-15	31.2	1.2	1.6	14/4	1	-	-	-	-	-	veg. - undisturbed
0-15	31.2	1.2	0.7	-	2	-	-	-	-	-	veg. - undisturbed
0-15	31.2	1.2	1.6	-	3	-	-	-	-	-	veg. - undisturbed
6-12	31.2	1.2	0.4	26/5	1	-	-	-	-	-	veg. - undisturbed
8-12	31.2	1.2	5.0	28/4	1	-	-	-	-	-	veg. - undisturbed
15-24	31.2	1.2	5.0	14/4	10	-	-	-	-	-	veg. - undisturbed
3-12	31.2	1.2	0.6	27/4	2	-	40.5	-	-	-	veg. - undisturbed
4-15	31.2	1.2	1.6	28/4	3	-	-	-	-	-	veg. - undisturbed
3-15	31.2	1.2	0.2	-	4	-	-	-	-	-	veg. - undisturbed
6-12	31.2	1.2	9.5	26/5	1	-	50.0	-	-	-	veg. - undisturbed
9-11	31.2	1.2	4.2	-	2	-	50.0	-	-	-	veg. - undisturbed
9-18	31.2	1.2	0.8	-	3	-	48.5	-	-	-	veg. - undisturbed

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APPENDIX 7-3

INSTALLATIONS REQUIRED FOR CONTINUING HYDROLOGICAL INVESTIGATIONS

Table 1 - List of Fixed Equipment

Rainfall Stations	Location	Full grid reference	Standard grid reference	Estimated cost of station establishment (M\$)	Remarks
		(1:63360 series L7010)			
Automatic rain fall recorder - Kent type	Sg Nerek	N 279200 E 577200	L 772792	1000 1/	
"	Sg Jengka	N 258000 E 558700	L 587580	1000 1/	
"	Kg Sentul	N 259000 E 283600	L 836590	600	To be paired with the existing rain gauge at Kuala Sentul
"	Sg Galong	N 284600 E 575600	L 756846	1000 1/	
Manual rain gauge	Sg Nerek	N 279200 E 577200	L 772792	Included in item (1) above	To be paired with item (1) above
"	Sg Jengka	N 258000 E 558700	L 587580	Included in item (2) above	To be paired with item (2) above
"	Sg Galong	N 284600 E 575600	L 756846	Included in item (4) above	To be paired with item (4) above

Contingencies 1920

Total 21,000

1/ P.I.D. Estimate  
2/ Recommended by Section 421-427 and 421-417

APPENDIX 7-3

INSTALLATIONS REQUIRED FOR CONTINUING HYDROLOGICAL INVESTIGATIONS

Table 1 - List of Fixed Equipment (Contd.)

Stream Gauging Stations	Location	Full grid reference	Standard grid reference	Estimated cost of station establishment (M\$)	Remarks
		(1:63360 series L7010)			
Staff gauge	Sg Jempol 2/	N 267200 E 578500	L 785672	60	Established during February 1966
"	Sg Jeh 2/	N 258500 E 584500	L 845585	60	"
"	Sg Tekam 2/	N 284000 E 563800	L 638840	60	"
"	Sg Siam 2/	N 284500 E 562200	L 622845	60	"
"	Sg Kundang 2/	N 246500 E 581300	L 813465	60	"
"	Sg Galong 2/	N 284200 E 569200	L 692842	60	"
"	Sg Jengka	N 242800 E 572200 N 258600 E 558800	L 722428 L 588586	120	"
Automatic float recorder - Kent type	Sg Tekam	N 284000 E 563800	L 638840	5000	complete with gauge house, stilling well etc.
"	Sg Jempol	N 267200 E 587500	L 875672	5000	"
"	Sg Jengka	N 258000 E 558	L 587580	5000	"
				Contingencies 1920	
				-----	
Total				21,000	

1/ D.I.D. Estimate

2/ Recommended in letters GKL-407 and GKL-412

APPENDIX 7-3

Table 2 - List of Ancillary Equipment

Experiment	No.	Cost (M\$)	Remarks
Surveyors level	1	1,400	Automatic
" staff	2	320	sopwith
" tapes	2	200	100' & 300' steel
" field books etc.	-	-	as required
Current meter (Ott)	1	2,300	to be maintained by D.I.D.
Winch and cable (Ott)	1	1,200	
Wading rods	1 set	400	
Weights	1 set	400	
Counter, sounder etc.	-	800	
Long wheel base Land-rover or lorry	1	10,000	
motor cycle	1	2,000	for hydrological assistants
Tools	-	300	
Contingencies	-	2,680	
	<b>Total</b>	<b>22,680</b>	

APPENDIX 7-3

Table 3 - List of Staff

Position	Part time	Full time	Annual Salary (M\$)
Hydrological assistant (who will also be a surveyor)	-	1	3,600
Rain gauge readers	4	-	480
Staff guage readers	8	-	960
Driver	-	1	1,200
Labourers for stream guaging, station maintenance, and stream surveys	-	3	3,600
Contingencies			1,160
		Annual Total	11,000

12-11	GENERAL LOGGING COSTS	112
12-12	SAW-MILL EQUIPMENT AND PLANT	113
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12-14	SAW-MILL CAPITAL INVESTMENT	115
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12-18	PREFABRICATION EQUIPMENT AND PLANT	119
12-19	PREFABRICATION PLANT MANNING TABLE	120
12-20	PREFABRICATION PLANT CAPITAL INVESTMENT	121
12-21	ADMINISTRATIVE STAFF FOR FOREST LOGGING MANUFACTURING OVER-FLONS	122

JENGA FOREST  
 FOREST UTILISATION  
 (Cubic Feet)

		Year	Total	Page
10-1	NETT VOLUME PER ACRE IN UNDISTURBED FOREST - JENGA FOREST RESERVE	75.0	75.0	93
10-2	PLYWOOD AND VENEER SPECIES	33.1	33.1	98
10-3	SAWMILL LOG INFUT BY SPECIES, WEST MALAYSIA, 1965	21.1	21.1	99
10-4	OTHER FOREST PRODUCTS	272.7	272.7	101
10-5	LOGGING EQUIPMENT LIST	42.5	42.5	104
10-6	LOGGING EQUIPMENT AND OPERATING COSTS	79.4	79.4	106
10-7	LOGGING TRUCK COSTS	9.6	9.6	108
10-8	LOGGING LABOUR FORCE	9.1	9.1	109
10-9	LOGGING ADMINISTRATION STAFF	6.2	6.2	110
10-10	LOGGING CAPITAL INVESTMENT	6.7	6.7	111
10-11	ANNUAL LOGGING COSTS	174.9	605.7	112
10-12	SAWMILL EQUIPMENT AND PLANT	24.4	27.8	113
10-13	SAWMILL MANNING TABLE	22.9	31.4	114
10-14	SAWMILL CAPITAL INVESTMENT	10.0	20.9	115
10-15	PLYWOOD FACTORY EQUIPMENT AND PLANT	40.5	71.3	116
10-16	PLYWOOD FACTORY MANNING TABLE	0.7	1.2	117
10-17	PLYWOOD FACTORY CAPITAL INVESTMENT	7.7	14.1	118
10-18	PREFABRICATION EQUIPMENT AND PLANT	8.6	15.9	119
10-19	PREFABRICATION PLANT MANNING TABLE	9.1	13.5	120
10-20	PREFABRICATION PLANT CAPITAL INVESTMENT	7.5	12.1	121
10-21	ADMINISTRATIVE STAFF FOR FOREST INDUSTRY MANUFACTURING OPERATIONS	3.7	17.3	122
	TOTAL	150.8	1306.0	

## APPENDIX 10-1

## NETT VOLUME PER ACRE IN UNDISTURBED FOREST

JENCKA FOREST RESERVE  
(cubic feet)

## NORTH EAST QUADRANT

<u>Species</u>	<u>Sawlogs</u>	<u>Veneer Logs</u>	<u>Total</u>
HEAVY HARDWOODS	78.0	-	78.0
Merbau, Balau, etc.	33.1	-	33.1
Other Heavy Hardwoods	44.9	-	44.9
MEDIUM HARDWOODS	497.9	124.4	622.3
Kempas	23.5	97.6	121.1
Keruing	272.7	-	272.7
Mengkulang	18.3	23.1	41.4
Kelat	42.5	1.1	43.6
Tualang	79.4	-	79.4
Simpoh	5.0	-	5.0
Jelawai	1.4	2.6	4.0
Kasai	9.6	-	9.6
Keladan	9.6	-	9.6
Keledang	2.7	-	2.7
Temponok	9.1	-	9.1
Kulim	0.2	-	0.2
Rengas	3.2	-	3.2
Minyak Berok	14.0	-	14.0
Petaling	6.7	-	6.7
LIGHT HARDWOODS	174.9	430.8	605.7
Bintangor & Durian	9.4	7.7	17.1
Jelutong	3.0	24.4	27.4
Red Meranti	61.0	202.0	263.0
White Meranti, Mersawa	6.5	24.9	31.4
Yellow Meranti	2.9	32.4	35.3
Nyatoh	10.5	10.0	20.5
Sepetir	2.3	9.7	12.0
Kedondong	30.8	40.5	71.3
Mata Ulat	5.2	8.0	13.2
Melunak	0.5	0.7	1.2
Medang	6.4	8.6	15.0
Penarahan	6.4	7.7	14.1
Sesendok	1.8	2.2	4.0
Merawan	7.3	8.6	15.9
Kembang Semangkok	-	9.1	9.1
Mempisang	5.7	7.8	13.5
Pelong	4.6	7.5	12.1
Machang	2.7	4.5	7.2
Petai	1.5	3.7	5.2
Other Light Hardwoods	6.4	10.8	17.2
TOTAL	750.8	555.2	1306.0

APPENDIX 10-1

SOUTH EAST QUADRANT

Species	Sawlogs	Veneer Logs	Total
<b>HEAVY HARDWOODS</b>	85.6	-	85.6
Merbau, Balau, etc.	59.2	-	59.2
Other Heavy Hardwoods	26.4	-	26.4
<b>MEDIUM HARDWOODS</b>	443.9	93.8	537.7
Kempas	14.8	80.7	95.5
Keruing	307.3	-	307.3
Mengkulang	10.9	12.5	23.4
Kelat	29.9	-	29.9
Tualang	44.2	-	44.2
Simpoh	3.0	-	3.0
Jelawai	0.9	0.6	1.5
Kassai	6.5	-	6.5
Keladan	5.6	-	5.6
Keledang	3.0	-	3.0
Temponok	4.7	-	4.7
Kulim	0.2	-	0.2
Rengas	2.0	-	2.0
Minyak Berok	9.5	-	9.5
Petaling	1.4	-	1.4
<b>LIGHT HARDWOODS</b>	148.1	401.0	549.1
Bintangor, Durian	2.7	3.8	6.5
Jelutong	1.6	36.7	38.3
Red Meranti	49.0	184.7	233.7
White Meranti, Mersawa	4.2	18.4	22.6
Yellow Meranti	2.7	30.0	32.7
Nyatoh	6.4	5.2	11.6
Sepetir	0.7	15.2	15.9
Kedondong	31.7	26.7	58.4
Mata Ulat	5.1	8.1	13.2
Melunak	0.4	0.4	0.8
Medang	6.8	9.1	15.9
Penarahan	6.8	5.6	12.4
Sesendok	1.8	1.6	3.4
Merawan	7.7	6.4	14.1
Kembang Semangkok	-	6.1	6.1
Mempisang	5.9	8.4	14.3
Pelong	4.4	7.6	12.0
Machang	2.6	5.9	8.5
Petai	1.2	8.4	9.6
Other Light Hardwoods	6.4	12.7	19.1
<b>TOTAL</b>	<b>677.6</b>	<b>494.8</b>	<b>1172.4</b>

## APPENDIX 10-1

## NORTH WEST QUADRANT

Species	Sawlogs	Veneer Logs	Total
HEAVY HARDWOODS	115.0	-	115.0
Merbau, Balau, etc.	84.0	-	84.0
Other Heavy Hardwoods	31.0	-	31.0
MEDIUM HARDWOODS	382.1	129.9	512.0
Kempas	18.7	109.8	128.5
Keruing	268.2	-	268.2
Mengkulang	13.3	17.8	31.1
Kelat	18.7	-	18.7
Tualang	33.3	-	33.3
Simpoh	2.9	-	2.9
Jelawai	0.9	0.9	1.8
Kasai	6.3	-	6.3
Keledang	1.0	1.4	2.4
Temponek	4.2	-	4.2
Kulim	0.2	-	0.2
Mengas	1.3	-	1.3
Minyak Berok	8.2	-	8.2
Petaling	1.1	-	1.1
Keladan	3.8	-	3.8
LIGHT HARDWOODS	154.6	402.5	557.1
Bintangor, Durian	1.8	5.7	7.5
Jelutong	1.8	19.9	21.7
Red Meranti	55.6	214.3	269.9
White Meranti, Mersawa	3.2	29.0	32.2
Yellow Meranti	0.3	12.5	12.8
Nyatoh	8.6	14.8	23.4
Sepetir	1.7	20.3	22.0
Kedondong	32.5	30.4	62.9
Mata Ulat	5.2	5.3	10.5
Melunak	0.5	0.4	0.9
Medang	6.7	6.4	13.1
Penarahan	6.7	6.4	13.1
Sesendok	2.0	1.8	3.8
Merawan	7.9	7.2	15.1
Kembang Semangkok	-	6.9	6.9
Mempisang	5.8	5.7	11.5
Pelong	4.4	4.6	9.0
Machang	2.6	2.7	5.3
Petai	1.0	1.6	2.6
Other Light Hardwoods	6.3	6.6	12.9
TOTAL	651.7	532.4	1184.1

APPENDIX 10-1

SOUTH WEST QUADRANT

<u>Species</u>	<u>Sawlogs</u>	<u>Veneer Logs</u>	<u>Total</u>
HEAVY HARDWOODS	79.7	-	79.7
Merbau, Balau, etc.	56.8	-	56.8
Other Heavy Hardwoods	22.9	-	22.9
MEDIUM HARDWOODS	297.3	110.0	407.3
Kempas	24.4	84.9	109.3
Keruing	138.6	-	138.6
Mengkulang	17.4	22.2	39.6
Kelat	30.3	-	30.3
Tualang	41.2	-	41.2
Simpoh	3.4	-	3.4
Jelawai	0.7	1.1	1.8
Kasai	7.0	-	7.0
Keladan	14.5	-	14.5
Keledang	1.2	1.8	3.0
Temponek	4.8	-	4.8
Kulim	0.2	-	0.2
Rengas	1.6	-	1.6
Minyak Berok	9.1	-	9.1
Petaling	2.9	-	2.9
LIGHT HARDWOODS	175.3	421.8	597.1
Bintangor, Durian	1.0	2.4	3.4
Jelutong	0.3	16.3	16.6
Red Meranti	89.6	264.7	354.3
White Meranti, Mersawa	7.0	14.9	21.9
Yellow Meranti	0.4	15.4	15.8
Nyatoh	7.7	7.8	15.5
Sepetir	0.4	16.6	17.0
Kedondong	27.9	25.3	53.2
Mata Ulat	4.4	5.7	10.1
Melunak	0.5	0.3	0.8
Medang	5.4	6.9	12.3
Penarahan	5.7	4.5	10.2
Sesendok	1.7	1.5	3.2
Merawan	6.4	6.0	12.4
Kembang Semangkok	-	5.7	5.7
Mempisang	4.8	6.3	11.1
Pelong	3.9	5.2	9.1
Machang	2.2	3.7	5.9
Petai	0.6	4.2	4.8
Other Light Hardwoods	5.4	8.4	13.8
TOTAL	552.3	531.8	1084.1

APPENDIX 10-1

TEXAS AREA

Species	PLYWOOD AND VENEER		Total
	Sawlogs	Veneer Logs	
<b>HEAVY HARDWOODS</b>	56.0	-	56.0
Merbau, Balau, etc.	28.9	-	28.9
Other Heavy Hardwoods	27.1	-	27.1
<b>MEDIUM HARDWOODS</b>	358.1	102.1	460.2
Kempas	13.6	86.2	99.8
Keruing	133.9	-	133.9
Mengkulang	9.0	9.5	18.5
Kelat	45.8	-	45.8
Tualang	73.4	-	73.4
Simpoh	12.3	-	12.3
Jelawai	3.5	2.4	5.9
Kasai	18.3	-	18.3
Keladan	10.3	-	10.3
Keledang	1.7	4.0	5.7
Temponok	11.0	-	11.0
Sengas	3.0	-	3.0
Minyak Berok	18.6	-	18.6
Jetaling	3.7	-	3.7
<b>LIGHT HARDWOODS</b>	152.5	434.5	587.0
Bintangor, Durian	2.4	2.1	4.5
Jelutong	2.2	40.5	42.7
Red Meranti	52.9	231.3	284.2
White Meranti, Mersawa	6.3	38.5	44.8
Yellow Meranti	3.8	40.1	43.9
Nyatoh	5.9	8.4	14.3
Cepetir	0.3	14.9	15.2
Kedondong	32.5	16.6	49.1
Mata Ulat	4.2	2.8	7.0
Medang	9.3	4.2	13.5
Ienarahan	9.0	4.0	13.0
Sesendok	3.8	1.7	5.5
Merawan	3.7	1.7	5.4
Kembang Semangkok	-	3.7	3.7
Mempisang	3.5	1.6	5.1
Pelong	5.4	3.1	8.5
Machang	4.3	4.0	8.3
Putri	3.0	15.3	18.3
<b>TOTAL</b>	<b>566.6</b>	<b>536.6</b>	<b>1103.2</b>

PLYWOOD AND VENEER SPECIES

Suitable for Face Veneer

Suitable for  
Corestock On

Red Woods

White Woods

Other Colours

CURRENTLY USED SPECIES:

Red Meranti  
Mengkulang  
Kembang Semangkok  
Nyatch

White Meranti  
Mersawa  
Kedondong  
Petai  
Sesendok

Yellow Meranti  
Medang (greenish  
brown)  
Machang (black and  
yellow)  
Sepetir (black and  
brown)

Bintangor  
Durian

SPECIES ASSUMED TO BE USABLE:

Penarahan  
Terentang  
Geronggang

Jelutong

Melunak (brown)  
Merawan (yellow-  
brown)

Pelong  
Kasai  
Kempas  
Keledang  
Jelawai  
Mata Ulat  
Mempisang  
Terap  
Pulai

NOTE: Only Kempas and Keledang on the above list will need steaming or boiling before they can be peeled. Such treatment will make any species easier to peel, but may increase the difficulty of chuck-holding, in softer species and in those with brittle-heart.

## SAWMILL LOG INPUT BY SPECIES, WEST MALAYSIA, 1965

(cubic tons)

Species	Nationwide		Pahang		Percentage of total input
	Volume	Percentage of total input	Volume	Percentage of total input	
HEAVY HARDWOODS					
Merbau	23,308	1.5	2,362	1.0	0.1
Balau	67,592	4.4	6,086	2.6	0.2
Giam	779	0.1	152	0.1	1.6
KerANJI	2,478	0.2	2	-	16.2
Merbatu	280	- 1/	-	-	27.9
Kekatang	141	-	-	-	0.3
Membatu	893	0.1	52	-	1.0
Penaga	12	-	-	-	2.0
Tembusu	211	-	4	-	3.2
Kesak	2,329	0.2	386	0.2	0.3
	98,023		9,044		
MEDIUM HARDWOODS					
Kempas	56,695	3.7	5,014	2.1	0.1
Keruing	257,251	16.9	63,689	26.8	-
Mengkulang	36,866	2.4	11,117	4.7	0.3
Kelat	3,196	0.2	2	-	-
Tualang	3,117	0.2	164	0.1	0.1
Simpoh	2,838	0.2	119	-	-
Jelawai	276	-	8	-	-
Kasai	1,800	0.1	3	-	-
Keladan	1,133	0.1	964	0.4	-
Keledang	1,430	0.1	205	0.1	-
Kulim	793	0.1	25	-	-
Kengas	43	-	-	-	-
Petaling	28	-	-	-	-
	365,466		81,210		

1/ denotes less than 0.1 per cent.

APPENDIX 10-3

OTHER FOREST PRODUCTS

Species	Nationwide		Pahang	
	Volume	Percentage of total input	Volume	Percentage of total input
<b>LIGHT HARDWOODS</b>				
Bintangor	8,927	0.6	238	0.1
Durian	7,027	0.5	454	0.2
Jelutong	27,368	1.8	3,813	1.6
Dark Red Meranti	222,344	14.6	38,440	16.2
Light Red Meranti	467,166	30.7	66,303	27.9
White Meranti	9,828	0.6	659	0.3
Mersawa	34,468	2.3	2,455	1.0
Yellow Meranti	51,744	3.4	4,668	2.0
Nyatch	21,065	1.4	7,502	3.2
Sepetir	18,293	1.2	682	0.3
Kedondong	6,167	0.4	72	-
Mata Ulat	2,896	0.2	-	-
Melunak	1,375	0.1	31	-
Medang	7,287	0.5	178	0.1
Penarahan	2,192	0.1	28	-
Sesendok	1,849	0.1	-	-
Merawan	5,464	0.4	676	0.3
Kembang Semangkok	12	-	-	-
Mempisang	759	0.1	119	0.1
Pelong	858	0.1	-	-
Machang	1,287	0.1	-	-
Terap	5	-	-	-
Kungkur	164	-	3	-
Petai	78	-	-	-
Karas	44	-	-	-
Pulai	184	-	-	-
Ara Berteh	141	-	-	-
Terentang	3,323	0.2	-	-
Geronggang	5,305	0.3	36	-
	907,620		126,357	
<b>Total:</b>	<b>1,371,109</b>		<b>216,611</b>	

## OTHER FOREST PRODUCTS

## A. CHARCOAL

Species in present use: Mangrove

Species being tested: Rubber and inland forest species similar to those in use at Iligan in the Philippines.

Market size, 1965-1980 (thousands of long tons):

Year	Domestic Consumption	Exports	Total
1965	224	4	228
1970	368	25	393
1975	411	40	451
1980	460	50	511

## B. POLES AND PILING

Characteristics of market: Export small and declining; domestic market could be increased by acceptance of treated round power or telephone poles.

Market size, 1965-1980 (thousands of cubic tons):

Year	Domestic Consumption
1965	70
1970	80
1975	93
1980	107

## C. FUELWOOD

Characteristics of market: Price too low to justify export, domestic needs generally filled by small entrepreneurs. Replacement fuels such as charcoal, Butane, and oil are now readily available. Jengka Triangle settlers would need about 20,000 cubic tons per year, easily supplied from logging waste and clearing operations.

Market size, 1965-1980 (thousand of cubic tons):

Year	Domestic Consumption
1965	900
1970	984
1975	1,138
1980	1,316

(Contd.)

## D. PARTICLE BOARD

Characteristics of market: Particle board has gained rapid acceptance in Europe, the U.S., and Australia, but not yet in Malaya and Singapore. A prefabricated house that incorporates particle board is in use in other parts of the world, but has not yet been introduced into Malaysia; such a house could result in a considerable market.

Market size, 1965-1980 (millions of square feet, 3/16-inch basis):

<u>Year</u>	<u>Domestic Consumption</u>
1965	1
1970	3
1975	7
1980	13

## E. FIBREBOARD

Characteristics of market: No fibreboard is manufactured in Malaya but the demand for imported fibreboard shows steady growth. Hardboard and plywood compete, but softboard or insulation board is more likely to compete with new sizes of wood wool construction boards than with plywood.

Market size, 1965-1980 (millions of square feet, 3/16-inch basis):

<u>Year</u>	<u>Domestic Consumption</u>
1965	32
1970	50
1975	67
1980	89

## F. PAPER

Characteristics of market: Supplied mostly by imports, some by local production. Only newsprint has a very large market, but newsprint <sup>1/</sup> cannot be easily manufactured from the short-fibred species that grow in Malaya. Development of a paper industry based on rubber wood and agricultural residues might provide exportable volumes eventually.

Market size, 1965-1980, domestic only (thousands of long tons):

<sup>1/</sup> Newsprint is the only homogeneous class of paper shown. "Other Paper and Board", for example, includes cardboard, filter paper, containerboard, and so on.

(Contd.)

Year	Total Paper	Printing and Writing	Newsprint	Other Paper and Board
1965	150 ✓	-	-	-
1970	156	52	33	71
1975	213	66	39	108
1980	285	84	45	156

1/ 1965 paper consumption was not recorded by the classes shown for the other years.

Caterpillar 350 or equivalent, crawler tractor with integral logging arch. 10

Caterpillar 977E track-mounted front-end loader, or equivalent. 2

200,000 lbs. GVW off-highway truck, Kenworth 849 or equivalent. 4

55,000 lbs. GVW highway truck, Comser CC-15 or equivalent. 8

Preload trailers for above trucks. 12

#### Unloading

Log stacker, P&L, Le Tourneau, or equivalent. 1

Caterpillar 960B wheel-mounted front-end loader, or equivalent. 1

#### Load construction

Caterpillar D3H bulldozer, or equivalent. 4

Caterpillar 55C or equivalent. 2

Caterpillar 14 grader or equivalent. 1

Sheepsfoot roller. 1

Grid roller. 1

10-cubic-yard dump truck, Comser CC-15 or equivalent. 20

Caterpillar 933F track-mounted front-end bucket loader, or equivalent. 1

(Contd.)

## LOGGING EQUIPMENT LIST

Item	Number Needed
<u>Felling</u>	
Chainsaws.	36
<u>Skidding</u>	
Caterpillar D6C or equivalent, crawler tractor with integral logging arch.	10
<u>Loading</u>	
Caterpillar 977H track-mounted front-end loader, or equivalent.	2
<u>Hauling</u>	
200,000 lbs. GVW off-highway truck, Kenworth 849 or equivalent.	4
53,000 lbs. GVW highway truck, Commer CC-15 or equivalent.	8
Preload trailers for above trucks.	12
<u>Unloading</u>	
Log stacker, FWD, Le Tourneau, or equivalent.	1
Caterpillar 966B, wheel-mounted front-end loader, or equivalent.	1
<u>Road construction</u>	
Caterpillar D8H bulldozer, or equivalent.	4
Caterpillar D6C or equivalent.	2
Caterpillar 14 grader or equivalent.	1
Sheepsfoot roller.	1
Grid roller.	1
10-cubic-yard dump truck, Commer CC-15 or equivalent.	20
Caterpillar 933F track-mounted front-end bucket loader, or equivalent.	1

(Contd.)

Item	Number Needed
<u>Quarrying</u>	
Rock crusher capable of 200 tons per hour output.	1
Self-propelled, track-mounted drill.	1
Compressor.	1
Northwest 80D Shovel loader or equivalent.	1
Caterpillar 769 off-highway dump truck, or equivalent.	1
Caterpillar 966B or equivalent.	1
<u>Road maintenance</u>	
Caterpillar 12 grader or equivalent.	1
<u>Administration</u>	
Maintenance shop	-
Warehouse for parts	-
Land Rover or equivalent.	4
Crew busses.	2

APPENDIX 10-6

LOGGING EQUIPMENT AND OPERATING COSTS  
(M\$)

A. ROAD-BUILDING EQUIPMENT

	Northwest Shovel, 86D	Dump truck Cat. 769	Dump Truck Commer CC-15	Caterpillar Graders Cat. 14	Quarry 1/ Equipment
Delivered cost	314,865	211,140	31,332	57,445	200,000
Tires	-	(25,200)	(3,088)	(4,305)	-
Salvage value	31,486	(21,110)	(3,133)	(11,489)	20,000
Amount for depreciation	283,379	164,830	25,111	41,651	180,000
Life in hours	15,000	12,000	15,000	12,000	20,000
Life in years	6.2	5.0	6.2	5.0	8.3
Hourly depreciation	18.89	13.74	1.67	4.18	9.00
Hourly insurance at 4%	3.04	2.11	0.24	0.69	1.81
Total hourly owning cost	21.93	15.85	1.91	4.87	10.81
Total yearly owning cost	52,632	38,040	4,584	11,688	25,944
Hourly fuel cost	4.80	4.80	0.60	2.35	2.00
Hourly lubrication cost	1.82	1.82	0.20	0.84	1.00
Hourly maintenance cost	19.87	11.00	1.67	2.51	8.10
Hourly tire cost	-	7.20	1.14	1.31	-
Hourly wages	2.76	2.76	2.55	2.76	8.87
Total hourly operating cost	29.25	27.58	6.16	9.77	19.97
Total yearly operating cost	70,200	66,192	14,784	23,448	97,928
Total hourly costs	51.18	43.43	8.07	14.64	30.78
Total yearly costs	122,832	104,232	19,368	35,136	123,872

1/ Quarry equipment includes Rock Crusher, Compressor, Drill. Wages include \$2.76 per hour for a crusher operator, \$3.19 per hour for a foreman-blaster, and \$1.46 per hour for each of two labourers. Total Yearly Operating Costs include an estimated \$50,000 for explosives, drill bits, etc.

## B. LOGGING EQUIPMENT

	Tractors <sup>1/</sup>		Loaders		Le Tourneau	
	Cat. D8H	Cat. D6C	Cat. 977H	Cat. 933F	Cat. 933F	Unloader F1304
Delivered cost	146,350	90,170	129,163	125,460	41,310	352,300
Tires	-	-	-	( 8,568 )	-	15,000 <sup>2/</sup>
Salvage value	29,270	18,034	25,833	( 25,092 )	8,260	-
Amount for depreciation	117,080	72,136	103,330	91,800	33,050	337,300
Life in hours	10,000	10,000	10,000	10,000	10,000	10,000
Life in years	4.2	4.2	4.2	3.3	4.2	2.5
Hourly depreciation	11.71	7.20	10.33	9.18	3.30	22.49
Hourly insurance at 4%	1.51	0.93	1.33	1.12	0.43	1.18
Total hourly owning cost	13.22	8.13	11.66	10.30	3.73	23.67
Total yearly owning cost	31,728	19,512	27,984	31,200	8,952	136,020
Hourly fuel cost	5.70	3.12	3.12	2.70	1.00	6.00
Hourly lubrication	1.35	0.90	0.65	0.60	0.43	2.00
Hourly maintenance	10.54	6.48	9.30	5.51	2.80	20.24
Hourly tire cost	-	-	-	2.44	-	4.28
Hourly wages	2.76	2.76	2.76	2.76	2.76	2.76
Total hourly operating cost	20.35	13.26	15.83	14.01	6.99	35.28
Total yearly operating cost	48,840	31,824	37,992	42,030	16,776	211,680
Total hourly costs	33.57	21.39	27.49	24.31	10.72	58.95
Total yearly costs	80,568	51,336	65,976	73,230	25,728	347,700

<sup>1/</sup> At least one tractor will be used in the road-building operation.

<sup>2/</sup> No salvage value can be established for Malaya at present; salvage value will depend on the market for Le Tourneau equipment in the region at the time.

APPENDIX 10-7

LOGGING TRUCK COSTS

(M\$)

	Kenworth 849	Extra Trailers for KW 849	Commer CC-15	Extra Trailers for CC-15
Delivered cost	196,107	34,941 1/	38,000	12,000 1/
Tires	(15,000)	-	(6,000)	-
Salvage value	(19,610)	-	(3,800)	-
Amount for depreciation	161,497	34,941	28,200	12,000
Life in hours	15,000	-	4.0	4.0
Life in years	3.1	5.0	7,050	3,000
Yearly depreciation	52,096	6,988	2,500	300
Insurance at 4%	5,187	838	9,550	3,300
Total yearly owning cost	57,283	7,826	-	-
Tire cost per mile:	-	2/	0.0783	0.0783
Paved road	0.5201	-	0.2734	-
Gravel road	0.6306	-	-	-
Dirt road	-	-	-	-
Cost per minute of driving time for:	0.0752	0.0109	0.1280	0.1765
Fuel	0.0218	0.0109	0.1280	0.1765
Lubrication	0.8569	-	-	-
Repairs	0.9539	-	-	-
Total	13,770 3/	-	9,600	-

Yearly labour cost

1/ Tires included in truck figure.

2/ Kenworth 849 is too large to travel on public highways, thus will not be used on paved roads.

3/ Night shift driver should be paid 1.25 times day shift rate.

## LOGGING LABOUR FORCE

Table 1 - Number of Employees

	1968	1969	1970	1971	1972	1973	1974	1975
Felling	48	72	72	72	72	72	72	72
Skidding	21	30	30	30	30	30	30	30
Loading	6	6	6	6	6	6	6	6
Hauling	18	24	24	22	20	20	20	20
Roads	47	43	32	38	35	32	40	40
Unloading	12	12	12	12	12	12	12	12
Overheads	54	54	54	54	54	54	54	54
	<u>206</u>	<u>241</u>	<u>230</u>	<u>234</u>	<u>229</u>	<u>226</u>	<u>234</u>	<u>234</u>
NUMBER OF EMPLOYEES								

Table 2 - Estimated Wage Rates  
(M\$)

	Monthly	Including Fringe	Yearly, with Bonus	Hourly
Faller	450	600	7650	3.19
Faller's Assistant	300	400	5100	2.12
Tractor Operator	390	520	6630	2.76
Tractor Operator's Assistant,	300	400	5100	2.12
Tractor Operator's Assistant, or Choker-setter	360	480	6120	2.55
Truck Driver	270	360	3510	1.46
Road Labourer				

APPENDIX 10-9

LOGGING ADMINISTRATIVE STAFF

<u>Position</u>	<u>Number</u>	<u>Total Annual Salary (M\$)</u>
Logging supervisor <sup>1/</sup>	1	120,000
Road construction supervisor	1	50,000
Forest engineer	1	37,500
Surveyors	8	60,000
Side foremen	2	16,000
Falling supervisor	1	8,000
Base radio operator	1	6,000
Office manager	1	9,000
Clerks	3	18,000
Parts warehouseman	1	7,000
Master mechanic	1	50,000
Fuel station attendant	2	10,000
Draftsmen	3	25,000
Personnel manager	1	15,000
Guards	6	30,000
<b>Total</b>	<b>33</b>	<b>461,500</b>

<sup>1/</sup> Foreign staff assumed initially

LOGGING CAPITAL INVESTMENT

(M\$ millions)

Fixed Capital

Year	Road Equipment	Skidding, Loading and Unloading Equipment	Logging Trucks	Support Facilities	Total	Working Capital	Total
1967	0.9	-	-	0.4	1.3	0.1	1.4
1968	1.2	1.4	0.7	0.2	3.5	2.5	6.0
1969	0.2	0.3	0.8	-	1.3	0.8	2.1
1970	-	-	-	-	-	-	-
1971	-	0.5	-	-	0.5	-	0.5
1972	0.5	1.0	1.0	0.2	2.5	-	2.5
1973	0.3	0.3	-	-	0.8	-	0.8
1974	0.1	0.2	0.5	0.2	0.1	1.7	1.8
1975	-	-	-	-	-	-	-
1976	0.5	1.0	1.0	-	2.5	-	2.5
1977	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-
	3.7	4.5	3.5	0.8	12.5	3.4	15.9
General overheads	1.90	2.60	2.60	2.60	2.60	2.60	2.60
Royalties & premium	8.60	8.60	8.60	8.60	8.60	8.60	8.60
Contingencies	6.60	4.40	2.20	1.80	1.80	1.80	1.80
TOTAL	46.60	36.10	31.00	28.70	28.40	28.60	75.60

APPENDIX 10-11

ANNUAL LOGGING COSTS

(M\$ per cubic ton)

	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
Felling	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Skidding	2.50	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
Loading	0.90	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Hauling	13.20	6.10	6.00	5.10	4.40	4.00	3.80	3.80	4.00	4.00	4.00
Road Construction	8.30	6.20	5.50	4.50	3.50	3.40	3.60	3.70	3.70	3.70	3.70
Road Maintenance	0.20	0.10	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Unloading & sorting	1.80	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
General overheads	3.90	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Royalties & premium	8.60	8.80	8.50	8.80	8.50	8.50	8.50	8.60	8.60	8.60	8.60
Contingencies	6.60	4.60	4.40	2.20	1.80	1.80	1.80	1.80	1.80	1.80	1.80
<b>TOTAL</b>	<b>48.60</b>	<b>36.10</b>	<b>34.80</b>	<b>31.00</b>	<b>28.70</b>	<b>28.20</b>	<b>28.20</b>	<b>28.40</b>	<b>28.60</b>	<b>28.60</b>	<b>28.60</b>

APPENDIX 10-12

SAWMILL EQUIPMENT AND PLANT

Item	Initial Cost (M\$)
Sawmill equipment delivered at site	800,000
Planer	60,000
Moulding equipment	30,000
Lift trucks (2 needed)	120,000
Kilns	200,000
Drying sheds	200,000
Fire protection	50,000
Treatment plant	92,000
Wiring and piping	75,000
Site preparation	50,000
Conveyor systems	120,000
Buildings	340,000
Hog	50,000
Construction labour	400,000
Trucks (7 needed)	266,000
Equipment and facilities shared with plywood plant:	
50% of power station	500,000
boiler	150,000
office building	25,000
repair shop	60,000
log deck and cut-off saw	65,000
Contingencies (10%)	365,000
Total	4,018,000

APPENDIX 10-13  
SAWMILL MANNING TABLE

Category	Number of men		Wages per man		Total annual wages (M\$)
	1 shift	3 shifts	Per day	Per year	
<u>Sawmill Floor</u>					
Barker operator	1	3	12	3,600	10,800
Conveyor control operator	1	3	18	5,400	16,200
Head sawyer	1	3	24	7,200	21,600
Resaw operator	1	3	9	2,700	8,100
Edger man	1	3	9	2,700	8,100
Trimmer man	1	3	9	2,700	8,100
Handymen	2	6	8	2,400	14,400
<u>Indirect Labour</u>					
Filer	1	3	20	6,000	18,000
Fitter	1	3	12	3,600	10,800
Clean-up	1	3	8	2,400	7,200
<u>Maintenance</u>					
Maintenance man	1	3	20	6,000	18,000
Electrician	1	3	20	6,000	18,000
<u>Green Chain</u>					
Graders	2	6	15	4,500	27,000
Pullers	4	12	8	2,400	28,800
Lift Truck Operators	2	6	9	2,700	16,200
<u>Planing and Moulding</u>					
Set up and knife grinder	1	1	15	4,500	4,500
Feeder	1	1	8	2,400	2,400
Grader	1	1	15	4,500	4,500
Pullers	4	4	8	2,400	9,600
<u>Kilns</u>					
Kiln operator	1	1	24	7,200	7,200
Helpers	2	2	8	2,400	4,800
<u>Treatment Plant</u>					
Operator	1	3	24	7,200	21,600
Helpers	1	3	18	5,400	16,200

SAWMILL CAPITAL INVESTMENT AND PLANT  
(M\$ Millions)

Year	Fixed Capital				Working Capital	Total
	Mill	Lift Trucks	Highway Trucks	Total		
1967	1.8	-	-	1.8	-	1.8
1968	1.8	0.1	0.1	2.0	1.5	3.5
1969	-	-	0.2	0.2	1.5	1.7
1970	-	-	-	-	-	-
1971	-	-	-	-	-	-
1972	-	0.1	-	0.1	-	0.1
1973	-	-	0.2	0.2	-	0.2
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	-	-	-	-
1977	-	-	0.2	0.2	-	0.2
1978	-	-	-	-	-	-
	<u>3.6</u>	<u>0.2</u>	<u>0.7</u>	<u>4.5</u>	<u>3.0</u>	<u>7.5</u>

APPENDIX 10-15

PLYWOOD FACTORY EQUIPMENT AND PLANT

Item	(M\$)	Initial Cost (M\$)
Veneer and panel-making equipment, delivered at site	2,200	2,200,000
Lift trucks (2 needed)	60	60,000
Highway trucks (5 needed)	190	190,000
Site preparation	50	50,000
Building	340	340,000
Construction labour	400	400,000
Steaming vats	100	100,000
Equipment and facilities shared with sawmill:		
50% of power station	500	500,000
boiler	150	150,000
Office building	25	25,000
repair shop	60	60,000
log deck and cut-off saw	65	65,000
Contingencies (15%)	621	621,000
		4,761,000

## PLYWOOD FACTORY MANNING TABLE

Category	Number of men		Wages per man		Total
	1 shift	3 shifts	Per day	Per year	Annual Wages
			(M\$)	(M\$)	(M\$)
<u>Green End</u>					
Barker operators	1	3	12	3,600	10,800
Lathe spotters	4	8	9	2,700	21,600
Lathe operators	2	4	24	7,200	28,800
Green veneer clippers	6	12	12	3,600	43,200
Offbearers	4	8	6	1,800	14,400
<u>Dryer and Veneer Prep.</u>					
Dryer feeders	6	18	6	1,800	32,400
Dryer offbearers	6	18	6	1,800	32,400
Dry veneer clippers	1	3	8	2,400	7,200
Taping machine operators	2	6	8	2,400	14,400
Splicer operators	4	12	8	2,400	28,800
Patch crew	4	12	8	2,400	28,800
Graders	2	6	9	2,700	16,200
Lift truck operators	1	3	9	2,700	8,100
<u>Gluing and Panel Mfg.</u>					
Glue rustlers	1	3	8	2,400	7,200
Glue mixers	1	3	8	2,400	7,200
Glue spreader crew	4	12	8	2,400	28,800
Clean-up	2	6	8	2,400	14,400
Cold-press operators	1	3	9	2,700	8,100
Hot-press operators	1	3	9	2,700	8,100
Quality control	2	6	9	2,700	16,200
Sander operators	2	6	8	2,400	14,400
Panel patching	4	12	8	2,400	28,800
Panel Sizers	1	3	9	2,700	8,100
Graders	2	6	9	2,700	16,200
Export preparation	4	12	8	2,400	28,800
Lift truck operators	1	3	9	2,700	8,100
<u>Maintenance</u>					
Mechanics	3	7	12	3,600	25,200
Electricians	2	6	12	3,600	21,600
Parts clerk	1	1	9	2,700	2,700
Knife grinder	1	1	8	2,400	2,400
<u>Feeler Core Sawmill</u>					
Sawyers	4	4	9	2,700	10,800
Offbearers & stackers	6	6	8	2,400	14,400
Highway truck drivers	5	10	16	4,800	48,000
Total	91	226			606,600

PLYWOOD FACTORY CAPITAL INVESTMENT  
(M\$ Millions)

Fixed Capital

<u>Year</u>	<u>Factory</u>	<u>Lift Trucks</u>	<u>Highway Trucks</u>	<u>Total</u>	<u>Working Capital</u>	<u>Total</u>
1967	2.2	-	-	2.2	-	2.2
1968	2.2	0.1	0.1	2.4	1.6	4.0
1969	-	-	0.2	0.2	1.6	1.8
1970	-	-	-	-	-	-
1971	-	-	-	-	-	-
1972	-	-	0.1	0.1	-	0.1
1973	-	-	0.1	0.1	-	0.1
1974	-	-	-	-	-	-
1975	-	-	-	-	-	-
1976	-	-	0.1	0.1	-	0.1
1977	-	-	0.1	0.1	-	0.1
1978	-	-	-	-	-	-
	<u>4.4</u>	<u>0.1</u>	<u>0.7</u>	<u>5.2</u>	<u>3.2</u>	<u>8.4</u>

## APPENDIX 10-18

PREFABRICATION EQUIPMENT AND PLANT  
(M\$)

Precutting

Building	100,000
Joinery Equipment	25,000
Site preparation	25,000
Construction labour	50,000
Lift trucks	30,000
Contingencies (10%)	23,000

Assembly

Building	60,000
Site preparation	20,000
Construction labour	30,000
Lift trucks	30,000
Contingencies (10%)	14,000

Administration

Office Building	<u>10,000</u>
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Total 417,000

## APPENDIX 10-19

## PREFABRICATION PLANT MANNING TABLE

Category	Number of Men	Wages per man		Total Annual Wages (M\$)
		Per Day (M\$)	Per Year	
<u>Precutting</u>				
Machine operators	6	9	2,700	16,200
Helpers	12	8	2,400	28,800
Lift truck driver	1	9	2,700	2,700
Foremen	1	24	7,200	7,200
<u>Assembly</u>				
Carpenters	45	8	2,400	108,000
Foremen	5	24	7,200	36,000
Lift truck driver	1	9	2,700	2,700
<u>Erection</u>				
Carpenters	50	8	2,400	120,000
Foremen	5	24	7,200	36,000
Total	126			357,600

## APPENDIX 10-20

## PREFABRICATION PLANT CAPITAL INVESTMENT

(M\$ Millions)

Fixed Capital

<u>Year</u>	<u>Plant</u>	<u>Lift Truck</u>	<u>Total</u>	<u>Working Capital</u>	<u>Total</u>
1967	0.2	-	0.2	-	0.2
1968	0.1	0.1	0.2	0.5	0.7
1969	-	-	-	0.4	0.4
1970	-	-	-	-	-
1971	-	-	-	-	-
1972	-	0.1	0.1	-	0.1
1973	-	-	-	-	-
1974	-	-	-	-	-
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	0.1	0.1	-	0.1
	<u>0.3</u>	<u>0.3</u>	<u>0.6</u>	<u>0.9</u>	<u>1.5</u>

## APPENDIX 10-21

ADMINISTRATIVE STAFF FOR FOREST INDUSTRY  
MANUFACTURING OPERATIONS

<u>Position</u>	<u>Salary per annum</u> (M\$)
<u>General Overhead</u>	
Manager	200,000 (includes travel, housing, etc.)
Office Personnel (10)	50,000
<u>Plywood Plant</u>	
Manager	100,000 (includes travel, housing, etc.)
Assistant Manager	50,000 (includes travel, housing, etc.)
Quality Control Supervisor	20,000
Assistant Quality Control	16,000
Foremen (9-3 per shift)	144,000
Sales Manager	100,000 (includes travel, housing, etc.)
Salesmen (2)	100,000 (includes travel, housing, etc.)
<u>SAWMILL</u>	
Manager	80,000
Foremen (3)	45,000
Sales Manager	70,000
Salesmen (2)	70,000
<u>Prefabricated House Plant</u>	
Manager	12,000
Sales Manager	10,000
Salesman	8,000
Bookkeeper	5,000.

## APPENDIX 11

## CROP SELECTION AND AGRICULTURAL LAND USE

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## APPENDIX 11

## CROP SELECTION AND AGRICULTURAL LAND USE (Contd.)

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## RICE AND SECONDARY CROPS

Rice - Market Prospects

West Malaysia has never been self sufficient in rice and local production at present accounts for about 55 per cent of consumption. Recently, development of rice production has been accelerated to lessen dependence on overseas supplies in the face of a rapidly increasing population. Although locally produced rice is supported by price and quality controls, imported rice has always commanded a premium because of its superior quality.

Demand - Consumption of rice during the period 1959 - 64 rose at an average rate of 3.7 per cent per year (Table 1). This compares with an annual population increase of about 3.1 per cent. Assuming future annual increases in rice consumption of 3.0 per cent in West Malaysia, consumption in 1970 is estimated at about 1.0 - 1.1 million tons, rising 1.5 million tons in 1980. By 1980, consumption can be expected to be increasing by about 50 - 55,000 tons a year.

Supply - Nearly half present supplies of rice are imported, mainly from Thailand and Burma. Local production is approximately 500,000 tons per year, based on about 750,000 acres of rice land. Although double cropping has been increasing rapidly in recent years it still forms an insignificant proportion of the total area and in the 1963-4 season only 50,000 acres, or about seven per cent of the total rice land was double cropped. Recent trends show increases in double cropping of 4-10,000 acres annually.

Over 550,000 acres of rice land is at present under irrigation and it should be possible to make substantial increases in the double cropped acreage.

Even with improved yields, past performance suggests a maximum annual increase in West Malaysia rice production of 6,000 tons. Large areas of new lands would have to be developed to irrigated padi, if domestic production is to keep pace with increases in local demand.

Table 1 - Rice Consumption in West Malaysia

(000 tons)

	1959	1960	1961	1962	1963	1964
Local Production	373	478	523	494	563	462
Nett Imports	360	357	316	288	389	402
Apparent Consumption	733	835	839	782	925	864
% Increase per annum	14.0	-10.5	-6.8	18.0	-6.6	

Average 3.6

1/ No allowance has been made for changes in levels of stocks.  
Source: Statistical Digest of Ministry of Agriculture, 1965.

Jengka Production and Future Rice Supply - It would be theoretically possible to grow rice on about 21,000 acres of land in the Jengka Triangle. This would produce about 25,000 tons of rice a year, equal to less than 2% of the estimated rice consumption in West Malaysia in 1980. Consequently production from Jengka, even if all possible rice growing areas were planted to rice, should have no effect on local rice supplies and prices.

Prices - Rice prices in the last 4-5 years have remained relatively steady, or have even tended to fall (Table 2).

Table 2 - Local and Imported rice prices 1961-1965

(M\$ per ton)

(Part)

	1961	1962	1963	1964	1965
<u>Import Price</u>					
Av. c.i.f. (Milled whole)	404	450	429	409	420
<u>Wholesale Price</u>					
Thailand 100%	516	563	541	516	536
Local Kedah No. 1	443	486	469	453	444

The average import price for the period 1961-65 is just over \$420 per ton, compared with the wholesale price for local rice of nearly \$460 per ton; it is assumed that these prices will continue in the long term and remain fairly constant.

## Rice - Cultivation

There is detailed and well documented information available on rice culture in West Malaysia and further studies by the Department of Agriculture are in progress. The importance which rice has achieved in smallholder farming has led to the assembly of much field experience as well.

The gross area of land suited to the cultivation of rice although extensive, mainly occupies the many valley floors and small swamps in the Triangle. Hence opportunities for extensive development are few. There will be suitable sites where individuals or small groups will grow rice as a subsidiary activity, particularly on otherwise unused land in rubber and oil palm areas. The extent to which this will be possible can only be determined when the jungle is removed and the extent of main crop planting can be assessed.

Seed and Nurseries - At present recommended rice varieties for Jengka are Serendah Kuning 60 on riverine lands and Milek Kuning elsewhere.

Maintenance - The following quantities of fertiliser are recommended in Pahang for application to rice after planting out:

Basic dressing	Sulphate of Ammonia	30 lbs. per acre
	Rock Phosphate	115 lbs. per acre
	Muriate of Potash	25 lbs. per acre

A top dressing of 55 lbs. per acre of Urea is also recommended.

Work inputs for the maintenance of rice fluctuate sharply; transplanting and harvesting make the greatest demands on available labour. Bird control and weeding create further peak labour demands. It would be in the interests of smallholders that their efforts in the main crops, rubber or oil palm, are not diverted by the attractions of traditionally important but significantly less profitable enterprises. It may be necessary to regulate the acreages allocated to settlers for rice planting.

Yields - Evidence available from existing rice areas near Jengka indicates that under trained supervisors, small areas will yield about 2,000 lbs. per acre. Double cropping would substantially increase yields and two periods in the year lend themselves to this practice; the first between April and November, the second between October and March. At

present, however, the major floods experienced in December are an obstacle. If, during development in Jengka, river and stream control and maintenance reduces this risk it may be possible to introduce a system of double cropping in some areas. Nevertheless it is not expected that complex and expensive water control systems will be developed for rice growing.

#### Tapioca - Market Prospects

Production of tapioca is largely on a smallholder basis in West Malaysia and the area under production appears to be affected by changes in price. Production as a cash crop is estimated to be of the order of 250-350,000 tons a year.

Little information is available on future trends in demand, and it is not possible to assess accurately the acreage that could be grown in the Jengka Triangle and disposed of at ruling prices. Tapioca consumption is associated with very low income groups and therefore increases in demand as income per head rises are likely to be very low. In view of this, it is likely that acreages in Jengka which would increase total output of tapioca as a cash crop by more than 10% could only be disposed of at less than expected price levels.

1963 factory prices coincided with a period of high prices of all tapioca processed products and resulted in a price M\$36 per ton of roots 'in-factory'. The 1964 unprocessed price of M\$25 per ton was the lowest experienced over the last five years and was some 30 per cent below the 1963 peak and some 20 per cent below 1962 price levels. Given small acreages in Jengka it is assumed that M\$25 - 36 per ton of roots will be the low - high range of in-factory prices, with an expected unprocessed price of \$30 per ton.

#### Tapioca - Cultivation

Tapioca is tolerant of a wide range of soil conditions, although it cannot withstand water-logging. It is therefore suited to many parts of Jengka, provided that conservation measures are introduced where it is grown on steep slopes. Selected varieties are now under test and material from the more successful could be bulked for distribution in Jengka. This would be preferable to drawing supplies from less reliable sources which may only offer mixed varieties.

Maintenance - Tapioca makes heavy demands on soil nutrients. The replenishment of these losses therefore becomes an important factor to the smallholder if his land is to remain in production. Although definitive recommendations for fertiliser applications are not yet available it is estimated that a yield of 9 tons of tapioca per acre removes 130 pounds of nitrogen, 60 pounds of phosphorous and 110 pounds of potash. Confirmation of the levels of fertiliser needed for Jengka soils will be desirable.

From the smallholder viewpoint the low labour requirement is one of the advantages of growing tapioca. During the whole of its productive cycle it requires no more than 30 man/days per acre of which 12 days are employed in harvesting.

#### Manila Hemp - Market Prospects

World supplies of Manila hemp, which is used predominantly for manufacture of marine cordage, are dominated by production in the Philippines. Supplies from this source accounts for well over 90 per cent of world output.

Future demand for Manila hemp will be determined by the extent to which synthetic substitutes can be improved. Some technical advantages lie with both the natural and synthetic products.

World production of Manila hemp during the last 15 years has remained relatively constant at 110,000 - 130,000 tons per year, although overall demand for marine cordage has tended to rise. Future demand prospects are therefore uncertain because of competition from synthetic substitutes. Accordingly large scale increases in production are unlikely to find a ready market.

Prices - The range in Manila hemp prices due to differences in quality is greater than any year to year fluctuation. It is likely that higher quality fibres will be the most resistant to price competition from synthetics.

Malaysian hemp has commanded a relatively stable price over the period 1956 - 1963 at between M\$1,300 - 1,400 per ton of fibre (Table 3). This compares well with general world prices, but applies to a very small level of output. In the last two years prices have risen substantially and in 1964 - 1965 were around M\$1,500 for Malaysian fibre.

Table 3 - Prices of Manila Hemp 1956-63

(M\$ per ton)

	Average of 1956-8	1959	1960	1961	1962	1963
c.i.f. Europe (converted)	920	1290	1270	955	938	1111
Malaysian Export	1305	1433	1243	1430	1390	1388

Source: F.A.O. Yearbook and Malayan Trade Statistics

However, in view of possible reduction in quality of fibre produced in Jengka and to make more allowance for the effect of competition from synthetics in the long run, the expected price has been assumed as \$1,200 per ton of fibre f.o.b.

#### Manila Hemp Cultivation

Although a very small acreage of Manila hemp is grown in Malaysia as a whole, there are several aspects of its production which suggest its suitability as a smallholder crop. It has a wide tolerance of soil conditions provided that there is free drainage, and it can be grown on steep slopes such as are found in the agricultural areas of Jengka provided that cover crops are planted; within 18 - 24 months it has established its own ground canopy.

Establishment and Maintenance - Planting is a simple operation for which material is available to satisfy reasonable demands until supplies could be built up in Jengka. Setting out and planting absorb about eight man/days per acre.

Maintenance consists of weeding and disease control. Both make small demands upon growers' time and require a total of about 15 man/days per acre in the first year. By the third year only occasional slashing of weeds is necessary. Regular fertiliser applications are required in view of the large quantities of plant material removed at harvesting. Although a rate of about 3 cwt. per acre per annum of mixed fertiliser containing nitrogen, phosphorus and potash is used elsewhere, precise requirements for Jengka soils would need to be established.

Harvesting - For each harvesting round (every 4-5 weeks) one acre

can be cut by one man, supported by three strippers who remove the crude fibre material from the cut stems. As the fibre in the standing plant does not deteriorate, harvesting intervals can be varied according to the demands of other crops or to throughput of the processing plant.

The crude material is bulky and transport is required from field to factory.

Yields of stems obtained in East Malaysia are as follows:

1st year	19 tons per acre equivalent to 0.4 tons fibre
2nd year	63 " " " " " 6.9 " "
3rd year	43 " " " " " 4.7 " "
4th year	36 " " " " " 3.9 " "
5th year	40 " " " " " 4.4 " "

Thereafter yields decline by some 3 tons per acre per year. The early achievement of a peak yield followed by a lesser peak suggested that there may be a place for Manila hemp in an intercropping system.

Processing - Small scale fibre extraction requires only 3 operators and processes about 360 pounds of fibre per day or 4 tons per month. One machine is capable of handling the production of about 50 acres. The smallness of such a unit, which can operate independently, lends itself to use in small villages.

#### Freshwater Fish - Market Prospects

Fish is an important source of protein and demand is expected to rise strongly as income per head rises. An annual increase in consumption of over 6 per cent per year could be expected over the next two decades. Further evidence of the strong demand for fish is in the rapid increases in tonnages of fish landed and the firmness of retail prices over the last five years.

Most of the fish consumed in Malaysia are sea fish. Before 1958 tonnages landed remained relatively constant at around 110 - 120,000 tons annually. Between 1959 and 1964 landings rose to 192,000 tons, an average annual increase of 10 per cent, although in 1963-64 the increase in landings was reduced.

There is evidence that further increases in landings of sea fish may become progressively more difficult to achieve and local consumption of fresh water fish is expected to rise as demand outpaces the

supply of sea fish. If in fact a shortage of sea fish develops Jengka in its inland situation appears particularly suited to becoming a market for fresh water fish. For an ultimate population of about 100,000 persons, consumption of fish could be of the order of 1,200 tons annually. In terms of fresh water fish, this would require some 2 - 4,000 acres fish ponds.

In the period 1963-1964 when only a 4.5 per cent increase in tonnage landed was achieved, increases in retail prices were experienced. In view of the strength of the market, values of fish which could be produced in Jengka have been based on current retail prices. The weighted average retail price for the three recommended varieties, Tilapia sp., Lampam Jawa (Puntius javanicus), and Grass Carp (Ctenopharyngodon idellus) is at present M\$0.90 per kati and will be the expected price over the planning period.

#### Freshwater Fish Culture

Investigations into the culture of freshwater fish are undertaken at the Tropical Fish Culture Research Station, Malacca. Sufficient information is available to warrant the introduction of fish ponds into the later phases of Jengka Development programme as a supplementary activity.

Fishpond Development - Many tributary valleys occur throughout Jengka, particularly in the northwest and southeast, these provide favourable site conditions for fish pond construction. It is estimated that in most areas there are at least 12 fishpond sites per square mile. More precise determination of the numbers of suitable sites and hence the significance of fish culture can only be established when the jungle is cleared.

Selected sites may be developed quickly by heavy equipment when it is conveniently available, or by hand excavation. Construction by hand will require approximately 200 men days per acre of pond. Total costs per acre are estimated to be approximately M\$1,800. This will provide scope for group activity by smallholders and the work could conveniently be fitted into the period of primary crop maintenance when labour demand for those crops is not high.

Fish Production - A regular supply of fingerlings of hybrid Tilapia or Lampam Jawa would have to be arranged on behalf of small-

holders. Grass Carp which are also suitable for stocking, may be used but as they do not breed under Malaysian conditions; fry will need to be imported from Hong Kong.

An initial application of about one ton per acre of lime will be necessary. Thereafter monthly or bi-monthly application of super phosphate will be needed at the rate of 3 - 4 cwts. per annum. These tasks will consume negligible proportions of smallholders' time.

Yields of 1200 lbs. of fish per acre per annum are now being obtained from smallholder ponds supervised by trained fisheries staff. It is reasonable to assume that similar yields will be obtained by settlers in Jengka.

#### Bananas - Market Prospects

The potential of bananas as a cash crop for Jengka depends almost entirely on the establishment of an efficient system of handling marketing and distribution. This is particularly critical in considering the potential of export markets. These appear to be sufficiently attractive to warrant further detailed investigation into all aspects of marketing and distribution.

Export - Demand - Japan with its rapidly rising incomes provides a large and expanding market in fruit and in particular bananas. Estimates of present banana consumption range from three quarters to one million tons annually. Based on present trends, consumption of bananas in Japan should rise by 30 - 35,000 tons a year.

In view of the large annual increase in Japan's consumption, the potential tonnage that Malaysia could export is probably substantial. Recently, for example, FLDA were offered a contract to supply up to 60,000 tons of bananas for export to Japan at an 'ex farm' price of M\$55 per ton. This could be produced on 8,000 areas, using expected yield levels of  $7\frac{1}{2}$  tons per acre. The price offered is a low one compared with current Japanese banana import prices and probably is based on the poor past performance of Malaysian exporters in terms of fruit loss during shipment.

Domestic Demand - The demand for bananas within Malaysia is limited as far as Jengka is concerned to the urban areas in and around

Kuala Lumpur and to the Triangle proper. If present producers continue to supply the existing market adequately as they now do, the domestic market potential outside the Triangle appears insignificant.

Within the Triangle, for an ultimate population of about 100,000 persons, the total consumption of fruit can be expected to be around 4,500 tons. If 50 per cent of this is consumed as bananas, about 300 acres would be sufficient to provide for the entire population. All of this acreage can be expected to be developed by the settlers on their individual houselots.

Prices - The levels of prices now offered tend to reflect levels of efficiency in distribution and marketing rather than any other market factor. It is significant that the Japanese import price is three times the present Malaysian export price. This would suggest that there should be substantial returns to organizing an efficient system of sea transport which ensures minimum loss in terms of bad fruit. The technical problems of transporting bananas from Jengka to Japan will require a high degree of managerial efficiency, but the increased income both to the farmer and the economy should well justify it. Given this level of efficiency an f.o.b. price of \$250 per ton should be feasible. Given a Japanese import price of M\$470 per ton this allows M\$220 per ton for losses en route and shipping charges. The expected f.o.b. price is taken as M\$150 per ton which is similar to recent prices of bananas into and out of Singapore. M\$100 per ton f.o.b. has been taken to demonstrate the effect of a fall in price on profitability.

#### Bananas - Cultivation

Although critical performance data for conditions similar to Jengka are not available, field observations and recordings were made during this study to supplement current information on which to assess the crops in the smallholder context. Bananas are grown both separately and as an intercrop, particularly with young rubber, although on a small scale.

The widespread popularity of bananas depends greatly upon their acceptance as a food and their small demands upon labour and skill. On these grounds they have a claim for inclusion in planning for Jengka

Planting material - Suckers and corms are usually supplied from areas where bananas are cultivated extensively. As these sources include a mixture of varieties, selected material would have to be multiplied to meet Jengka demands. Three varieties of the thirty recorded in Malaysia are popular - Pisang Rastali, Pisang Mas and Pisang Embun. The two former varieties are less acceptable in overseas markets than Pisang Embun. Thus if market opportunities and marketing organisation are adequate to support expansion of banana production, a carefully controlled nursery programme would be necessary, through which growers in Jengka would be supplied with suitable export varieties.

Maintenance - Recommendations have been published in West Malaysia covering the main features of field maintenance including spacing, planting, manuring and desuckering.

These operations are estimated to occupy 86 man/days of labour per acre in the first year of production. In the second and third years however, this falls by seventy five per cent to 21 man/days per acre. In these years therefore, there is little or no competition for the smallholders' time between bananas and the main crop.

Bananas are relatively free from disease in Malaysia. Occasional instances of Panama disease have been recorded but without serious effect. More widespread and intensive cultivation might lead to more serious outbreaks.

Marketing - When large scale banana production for export markets is embarked upon considerable skill in timing and organisation of harvesting and dispatch of bunches is necessary. This type of organisation has not been required in Malaysia in the past because exports have been on a very small scale. If export markets can be tested successfully and continuous demand assured, FLDA settlement schemes afford good opportunities for developing the skilled organisation which export of bananas demands.

Yields - Evidence of yield is variable. Field observations indicate that Pisang Rastali may produce from 3 to  $4\frac{1}{2}$  tons per acre per year; Pisang Mas from 3 to  $4\frac{1}{2}$  tons and Pisang Embun, already noted the most suitable export variety, from  $4\frac{1}{2}$  to 9 tons.

#### Profitability of Rice and Secondary Crops

The profitabilities of the secondary crops discussed above have

been calculated on a comparable basis to oil palm, and rubber. Most of them are annual crops or perennial crops with short periods of immaturity. However, their gross margins have been discounted at similar interest rates over a 25 year period and are shown in Table 4. The bases for these comparisons are given in Appendix 11-2.

Rice - Rice cultivation with its very high seasonal demand for labour requires about one worker per acre at harvesting time. Unless complementary seasonal employment can be found elsewhere the returns from labour from rice farming are very low indeed being 1/5 of rubber and 1/10 of oil palm, and compared with oil palms and two types of rubber. Rice cultivation, even if irrigated and double cropped, is clearly inferior to oil palm and rubber. While the area of competition of these crops is limited to lowlying or swamp land, the small additional costs of drainage for oil palm, or even rubber (\$100 per acre) still leaves rice as clearly the least profitable crop.

Tapioca - With the exception of single cropped rice tapioca appears the least profitable crop at low rates of interest. However its small capital requirements make it preferable to double cropped rice at interest rates in excess of 7 per cent. However, this crop should be given low priority unless prices and yields improve substantially.

Manila Hemp - Although less profitable at the level of prices expected than bananas or fish, Manila hemp has some advantages. It is a non-perishable crop consequently it does not require a highly sophisticated system of distribution and marketing. It has a relatively simple technique of processing which would be suitable for production in small units and is a relatively simple crop to grow. Further investigation will be necessary to discover markets.

Fish - Given that the volume of output does not exceed the demand from within the Triangle and its surrounding area, fish cultivation appears highly profitable from the limited data available. If the settler constructs his own pond the activity has a high priority in terms of its contribution to development. It has a further advantage that, being relatively labour intensive during the initial years of construction, it provides employment for unused settler labour during the

years immediately prior to tapping, or harvesting the primary crops.

Bananas - Bananas appear highly profitable. In fact at expected price levels this crop is more profitable than oil palm. However, it is very doubtful at present whether marketing facilities are available to transport bananas in bulk to the port of shipment in condition to achieve the expected price though small quantities could be sold at the expected price level of M\$150 per ton f.o.b. Being a highly perishable product, the price offered is critical. This can be seen by the substantial fall in profitability which takes place were the price to fall to the low level projected in Table 4. The key to achieving the higher price level lies in an efficient system of marketing and transportation. While it is possible that this can be achieved in the future, at present large scale development under bananas for urban markets or a port outside the Triangle is unlikely to achieve the price levels which could be obtained with small scale production.

The crop is more profitable than rubber, and even oil palm at rates of interest above 10%.

APPENDIX 11-1

Table 4 - Comparison of Crop Profitability

	Expected yield per acre per annum at maturity	Price during first year of production	Present worth of annual Gross Margin <sup>3/</sup>		
			5%	10%	15%
<u>Oil Palms</u>					
FIDA Smallholder <sup>1/</sup> Independent Smallholder <sup>2/</sup>	9 tons FFB 4.5 tons FFB	M\$500 per ton oil M\$325 per ton kernels } f.o.b.	5942 2319	3095 1089	1658 472
<u>Rubber (budgrafted)<sup>1/</sup></u>					
FIDA Smallholder <sup>1/</sup> Independent Smallholder <sup>2/</sup>	1400 lbs latex d.r.c. 700 lbs latex d.r.c.	M\$ 53 per lb } f.o.b. M\$ 53 per lb }	4830 2097	2415 977	1259 448
<u>Rubber (clonal seedling)</u>					
FIDA Smallholder	1270 lbs latex d.r.c.	M\$ 53 per lb f.o.b.	4822	2496	1355
<u>Rice</u>					
Double cropped Single cropped	1.225 tons rice 0.575 tons rice	M\$ 420 per ton } c.i.f. M\$ 420 per ton }	3638 1884	1779 1033	843 589
<u>Tapioca</u>	.12 tons roots	M\$ 30 per ton (unprocessed)	3598	2217	1504
<u>Manila hemp</u>					
Freshwater Fish <sup>4/</sup>	0.54 tons fibre 1200 lbs	M\$1200 per ton f.o.b. M\$ 67 per lb	5510 <sup>~</sup> 9189	3629 5630	2600 3800
<u>Bananas</u>	7.5 tons	M\$150 (expected) M\$100 (ton)	8192	5073	3478
			3310	2006	1342

1/ High density supervision

2/ Low density supervision

3/ Years 0-25 and discounted to date of planting for oil palms, rubber and rice; years 1-15 discounted to years of land development (year 0) for tapioca, manila hemp, freshwater fish, bananas. Factors used in discounting assume even annual flow of expenditure and income except for rice and tapioca.

4/ Ponds constructed using smallholder labour.

APPENDIX 13

DETERMINATION OF SMALLHOLDINGS

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Table 1	Settler's Gross Margin and Return to Labour and Capital - Rubber (budgrafted)
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Table 3	Farm Gross Margin on Rubber Holdings
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Table 5	Rubber - Refund of Replanting Cess to FLDA
Table 6	Cost of Farm Labour on Rubber Holdings
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Table 10	Investment by and Repayment to FLDA (10 Acre Rubber Holding)
Table 11	Investment by and Repayment to FLDA (10 Acre Oil Palm Holding)
Figure 1	Rates of Interest Payable on Loan with Different Levels of Settler's Cash Income and different sizes of Oil Palm Holding
Figure 2	Rates of Interest Payable on Loan with Different Levels of Settler's Cash Income and different sizes of Rubber Holding

former are calculated in tables showing a) the farmers gross margin and b) the return per acre to settler labour and capital. The farm gross margin is calculated in a similar way to the social gross margin. Additional costs are incurred in duties and cesses. The 'ex' farm unit costs include capital elements which earn a return of 7%. An exception is the initial cost of oil palm harvesting roads which is shown as a separate item and discounted. This is because the cost does not vary with the increase in production and therefore is more realistically considered as a single payment than an annual cost.

APPENDIX 13-1

DETERMINATION OF SMALLHOLDING SIZE

The tables and figures set out in this appendix provide the supporting data from which the tables and figures shown in Chapter 13 of Volume II have been derived.

In particular certain figures in Chapter 13 have been plotted directly from the following:

Figure 13.1	plotted from	table	3
13.2	"	"	4
13.3	"	"	8
13.4	"	"	9
13.5	"	appendix Figures 1 and 2	
13.8	"	table	10
13.9	"	"	11

Farm incomes (Rubber and oil palms)

To facilitate the calculations required to determine the interaction of holding size, farm income and repayment capacity over uneven streams of farm income and expenditure, the concept of present worth has been used throughout the analysis. Those items of revenue less cost which change per unit of land have been calculated separately from those costs which are incurred per unit of labour i.e. per settler. The former are calculated in tables showing a) the farmers gross margin and b) the return per acre to settler labour and capital. The farm gross margin is calculated in a similar way to the social gross margin. Additional costs are incurred in duties and cesses. The 'ex' farm unit costs include capital elements which earn a return of 7%. An exception is the initial cost of oil palm harvesting roads which is shown as a separate item and discounted. This is because the cost does not vary with the increase in production and therefore is more realistically considered as a single payment than an annual cost.

In Tables 1 and 2 the settler's gross margins for rubber and oil palm are shown for the 25 year period and the total capitalized (discounted) to year 1 at 7% for both rubber and oil palm. The costs of management are deducted to leave a return to agricultural labour and capital.

In Tables 6 and 7 cash expenditure on the main crop attributable to each settler is calculated similarly. This includes the cost of the settler's house, the cost of clearing the houselot and village area, the settler's income during the immature period and four levels of income during the production period. With the exception of one cash income which starts and remains constant at M\$2400 throughout the repayment period, these all start at \$1,200 per settler in the second year of production and rise respectively to \$3,600, \$2,400 and \$1,800 in the 25th year after planting.

The returns to FLDA for each holding size and income level are given in Figure 1 and 2 by the interest rates at the points of intersection between settler's cash income and the return to capital and labour of different sizes of holding.

The features of investment and repayment periods of the 10 acre holdings selected are shown in Tables 10 and 11.

Year	Revenue A Kob. P. P/ha	Costs A.T. %	Gross P/ha	Net P/ha
1	101	15	86	71
2	102	15	87	72
3	103	15	88	73
4	104	15	89	74
5	105	15	90	75
6	106	15	91	76
7	107	15	92	77
8	108	15	93	78
9	109	15	94	79
10	110	15	95	80
11	111	15	96	81
12	112	15	97	82
13	113	15	98	83
14	114	15	99	84
15	115	15	100	85
16	116	15	101	86
17	117	15	102	87
18	118	15	103	88
19	119	15	104	89
20	120	15	105	90
21	121	15	106	91
22	122	15	107	92
23	123	15	108	93
24	124	15	109	94
25	125	15	110	95

Table 1 - Settler's Gross Margin and Return to Labour and Capital - Rubber (budgrafted)

(M\$ per acre)

Year	Revenue @ f.o.b. Prices A	Duty 4% A.V. B	Cesses @ \$ 5.375 per lb. C	Ex Farm Costs @ \$ 5.83/lb. D	On Farm Cost E	Gross Margin A - (BCDE) F	Cost of Management G	Return to Labour and Capital H - (F - G)	Present Worth Discounted to date of planting @ 5% I	7% J	10% K
1971-0						(303)	322	(625)	(644)	(650)	(656)
1	161	6	17	19	303	112	104	216	221	219	215
2	386	15	43	46	112	47	100	147	132	132	128
3	505	20	57	62	47	47	107	154	137	129	122
4	605	24	70	75	47	47	100	147	123	116	106
5	683	27	79	86	47	47	82	129	103	95	84
6	718	29	84	91	42	77	73	4	3	3	2
7	748	30	87	94	39	243	73	170	124	109	92
8	750	30	88	96	39	327	70	257	177	154	126
9	743	30	88	96	39	397	70	327	216	183	147
10	739	29	88	96	39	452	70	382	241	202	153
11	735	29	88	96	39	475	70	405	243	198	150
12	728	29	88	96	39	498	70	428	244	197	141
13	724	29	88	96	39	497	67	430	232	185	129
14	719	29	88	96	39	490	67	423	220	169	118
15	707	28	86	94	39	486	67	419	205	159	105
16	691	27	83	90	39	483	67	416	196	146	96
17	673	26	80	88	39	476	67	409	184	135	86
18	639	25	77	85	39	472	67	405	174	126	77
19	626	25	75	83	39	467	67	400	164	116	68
20					39	457	67	390	152	105	62
21					39	444	67	377	137	93	52
22					39	430	67	363	127	83	47
23					39	418	67	351	116	77	42
24					39	405	67	338	108	68	37
25					39	395	67	323	98	62	33

Alternate day tapping.  
Third day tapping (assume 7 1/2 per cent fall in yield of rubber).

2133 1229 452  
1525 860 184

1/ Years before bearing.

APPENDIX 13-1

Table 2 - Settler's Gross Margin and Return to Labour and Capital - Oil Palms

(M\$ per acre)

Year	Revenue @ f.o.b. prices A	Duty 7½% A.V. B	Ex farm cost \$22 per ton FFB C	On farm cost D	Gross Margin A-(BCD) E	Cost of Management F	Return to Labour and Capital (E-F) G	Present Worth discounted to date of planting @		
								5%	7%	10%
1970-0				$\frac{1}{345}$	(345)	322	(767)	(790)	(798)	(805)
1	554	41	137	$\frac{1}{200}$	(200)	104	(304)	(298)	(295)	(289)
2	823	62	167	$\frac{1}{30}$	(30)	100	(130)	(121)	(117)	(113)
3	864	65	178	$\frac{1}{50}$	(50)	107	(157)	(140)	(132)	(124)
4	901	67	188	$\frac{1}{89}$	(89)	100	(189)	(164)	(152)	(133)
5	915	68	194	$\frac{1}{89}$	(89)	82	(205)	(164)	(152)	(133)
6	927	70	196	$\frac{1}{89}$	(89)	73	(432)	(328)	(298)	(294)
7	918	69	198	$\frac{1}{89}$	(89)	73	(432)	(328)	(298)	(294)
8	900	68	196	$\frac{1}{89}$	(89)	70	(487)	(336)	(292)	(239)
9	890	67	198	$\frac{1}{89}$	(89)	70	(494)	(326)	(277)	(222)
10	882	66	198	$\frac{1}{89}$	(89)	70	(500)	(315)	(265)	(200)
11	873	65	198	$\frac{1}{89}$	(89)	70	(562)	(295)	(241)	(182)
12	864	65	198	$\frac{1}{89}$	(89)	70	(492)	(276)	(223)	(160)
13	855	64	198	$\frac{1}{89}$	(89)	67	(483)	(259)	(206)	(144)
14	846	63	198	$\frac{1}{89}$	(89)	67	(479)	(244)	(188)	(131)
15	837	63	198	$\frac{1}{89}$	(89)	67	(469)	(226)	(176)	(116)
16	837	63	198	$\frac{1}{89}$	(89)	67	(521)	(213)	(159)	(104)
17	837	63	198	$\frac{1}{89}$	(89)	67	(512)	(200)	(147)	(93)
18	837	63	198	$\frac{1}{89}$	(89)	67	(504)	(188)	(135)	(83)
19	837	63	198	$\frac{1}{89}$	(89)	67	(496)	(176)	(124)	(73)
20	837	63	198	$\frac{1}{89}$	(89)	67	(487)	(167)	(116)	(69)
21	837	63	198	$\frac{1}{89}$	(89)	67	(487)	(155)	(105)	(59)
22	837	63	198	$\frac{1}{89}$	(89)	67	(487)	(147)	(97)	(55)
23	837	63	198	$\frac{1}{89}$	(89)	67	(487)	(139)	(92)	(50)
24	828	62	198	$\frac{1}{89}$	(89)	67	(479)	(132)	(82)	(45)
25	828	62	198	$\frac{1}{89}$	(89)	67	(479)	(124)	(78)	(41)

Table 3 - Farm Gross Margin on Rubber Holdings  
(M\$ per year)

Year	Gross Margin from Houselot			Acres of Main Crop			
	Consumed	Sold	Total	6	8	10	12
(1971)	0	-	-	(1820)	(2420)	(3030)	(3636)
	1	-	-	660	880	1100	1320
	2	80	80	200	300	390	480
	3	100	100	180	280	370	460
	4	120	120	140	260	350	440
	5	120	20	120	240	330	420
	6	120	40	620	740	930	950
	7	120	60	1580	2050	2610	2780
	8	120	80	2160	2820	3470	3690
	9	120	100	2600	3400	4190	4470
	10	120	110	2940	3850	4750	5080
	11	120	120	3090	4040	4990	5340
	12	120	130	3240	4230	5230	5600
	13	120	140	3240	4240	5230	5600
	14	120	150	3210	4190	5170	5530
	15	120	160	3200	4170	5140	5500
	16	120	170	3200	4170	5140	5470
	17	120	180	3160	4110	5060	5410
	18	120	190	3140	4090	5030	5400
	19	120	200	3120	4060	4990	5340
	20	120	210	3070	3990	4900	5240
	21	120	220	3000	3890	4780	5100
	22	120	230	2930	3790	4650	4970
	23	120	230	2860	3690	4530	4840
	24	120	230	2780	3590	4400	4690
	25	120	230	2720	3510	4300	4570

Note: a) Budgrafted rubber assumed in all tables in Appendix 13.1

b) 7½ per cent fall in yield assumed with 12 acres of rubber due to three day tapping.

APPENDIX 13-1

Table 4 - Farm Gross Margin on Oil Palm Holdings  
(M\$ per year)

Year	Gross Margin from Houselot			Acres of Main Crop				Farm Gross Margin Main Crop and Houselot
	Consumed	Sold	Total	6	8	10	12	
(1971)	-	-	-	(2070)	(2760)	(3450)	(4140)	
0	-	-	-	(1140)	(1600)	(2000)	(2400)	
1	80	-	80	(100)	(160)	(220)	(280)	
2	100	-	100	(200)	(300)	(400)	(500)	
3	120	-	120	710	830	1110	1310	
4	120	20	140	1860	2430	3010	3580	
5	120	40	160	3190	4200	5210	6220	
6	120	60	180	3370	4440	5500	6560	
7	120	80	200	3540	4660	5770	6880	
8	120	100	220	3600	4730	5860	6990	
9	120	110	230	3650	4790	5930	7070	
10	120	120	240	3620	4740	5860	6980	
11	120	130	250	3570	4680	5790	6900	
12	120	140	260	3540	4630	5720	6810	
13	120	150	270	3490	4570	5640	6710	
14	120	160	280	3450	4510	5570	6630	
15	120	170	290	3420	4460	5500	6540	
16	120	180	300	3370	4400	5420	6440	
17	120	190	310	3330	4340	5350	6360	
18	120	200	320	3300	4290	5280	6270	
19	120	210	330	3310	4300	5290	6280	
20	120	220	340	3260	4240	5210	6180	
21	120	230	350	3270	4250	5220	6190	
22	120	230	350	3270	4250	5220	6190	
23	120	230	350	3220	4180	5140	6100	
24	120	230	350	3170	4180	5140	6100	
25	120	230	350	3170	4180	5140	6100	

excluded from analysis of smallholding as amount uncertain

APPENDIX 13-1

Table 5 - Rubber - Refund of replanting Cess to FLDA  
(M\$ per acre)

Year	Amount @ M \$ 4.5 per lb.	Present worth discounted to date of Planting		
		5%	7%	10%
6	15	11	10	9
7	36	26	23	19
8	48	33	29	24
9	58	38	32	26
10	66	41	35	26
11	70	42	34	26
12	73	42	34	24
13	74	40	32	22
14	74	38	30	21
15	74	36	28	19
16	74	35	26	17
17	74	33	24	16
18	74	32	23	14
19	74	30	21	13
20	73	28	20	12
21	72	27	18	10
22	71	25	16	9
23	70	23	15	8
24	68	22	14	7
25	67	20	13	7
		<u>622</u>	<u>477</u>	<u>329</u>
<u>State Land Rent <sup>1/</sup> (Assumed Rent - M\$ per acre)</u>				
<u>Rubber</u>				
6	66	50	45	39
7-25	6	<u>56</u>	<u>43</u>	<u>26</u>
		<u>106</u>	<u>88</u>	<u>65</u>
<u>Oil Palm</u>				
4	66	55	52	48
5-25	6	<u>64</u>	<u>51</u>	<u>37</u>
		<u>119</u>	<u>103</u>	<u>85</u>

<sup>1/</sup> excluded from analysis of smallholding as amount uncertain

Cash income per settler including cost of maintenance payment and house

APPENDIX 13-1

Table 6 - Cost of Farm Labour on Rubber Holdings

Cash income per settler including cost of subsistence payment, house and cash income from main crop

Year	Income per settler plus house and tools			
	I M\$2400 throughout	II Rising to M\$3600 P.S.R.	III Rising to M\$2400 P.S.R.	IV Rising to M\$1800 P.S.R.
0	1880 1/	1880 1/	1880 1/	1880 1/
1	600 2/	600 2/	600 2/	600 2/
2	1300 2/	1300 2/	1300 2/	1300 2/
3	1100 2/	1100 2/	1100 2/	1100 2/
4	700 2/	700 2/	700 2/	700 2/
5	500 2/	500 2/	500 2/	500 2/
6	700	700	700	700
7	2400	1200	1200	1200
8	2400	1500	1300	1300
9	2400	1600	1400	1400
10	2400	1700	1450	1430
11	2400	1900	1500	1460
12	2400	2000	1550	1500
13	2400	2100	1600	1520
14	2400	2200	1650	1550
15	2400	2400	1700	1570
16	2400	2500	1750	1600
17	2400	2600	1800	1620
18	2400	2800	1850	1650
19	2400	2900	1900	1670
20	2400	3000	1950	1700
21	2400	3100	2000	1720
22	2400	3200	2100	1750
23	2400	3400	2200	1770
24	2400	3600	2400	1800
25	2400	3600	2400	1800
Present worth	28098	27978	22295	20,35
discounted to	23624	22415	13924	17362
date of planting, 10%	18151	11869	14255	13073

1/ Capital cost of house and clearing and destumping household area.  
 2/ Income being payment for maintenance work done or subsistence allowance.

Table 7 - Cost of Farm Labour on Oil Palm Holdings

Cash income per settler including cost of subsistence payment and house

Year	Income per settler plus house and tools			
	I M\$2400 throughout	II Rising to M\$3600 p.a.	III Rising to M\$2400 p.a.	IV Rising to M\$1800 p.a.
0	1880	1880	1880	1880
1	600	600	600	600
2	900	900	900	900
3	600	600	600	600
4	2400	1000	1000	1000
5	2400	1200	1200	1200
6	2400	1400	1300	1300
7	2400	1500	1400	1400
8	2400	1600	1450	1430
9	2400	1800	1500	1460
10	2400	1900	1550	1500
11	2400	2000	1600	1520
12	2400	2100	1650	1550
13	2400	2200	1700	1570
14	2400	2300	1750	1600
15	2400	2400	1800	1620
16	2400	2500	1850	1650
17	2400	2600	1900	1670
18	2400	2800	1950	1700
19	2400	2900	2000	1720
20	2400	3000	2050	1760
21	2400	3100	2100	1770
22	2400	3200	2150	1800
23	2400	3400	2200	1800
24	2400	3500	2400	1800
25	2400	3600	2400	1800
Present worth	31167	29274	23657	22005
discounted to	25653	23521	19418	18253
date of planting	19571	17719	15074	14360

1/ Capital cost of labour and clearing and destumping household area.  
 2/ Income being payment for maintenance work done or subsistence allowance.

APPENDIX 13-1

Table 8 - Possible Settler's Incomes on Rubber Holdings including Income from Houselot

(M\$ per year)

Year	Possible Settler's Incomes			
	I	II	III	IV
(1978)				
7	2580	1380	1380	1380
8	2600	1700	1500	1500
9	2620	1820	1620	1620
10	2630	1930	1680	1660
11	2640	2140	1740	1700
12	2650	2250	1800	1750
13	2660	2360	1860	1780
14	2670	2470	1920	1820
15	2680	2680	1980	1850
16	2690	2790	2040	1890
17	2700	2900	2100	1920
18	2710	3110	2160	1960
19	2720	3220	2220	1990
20	2730	3330	2280	2030
21	2740	3440	2340	2060
22	2750	3550	2450	2100
23	2750	3750	2550	2120
24	2750	3950	2750	2150
25	2750	3950	2750	2150

Table 9 - Possible Settler's Incomes on Oil Palm Holdings including Income from Houselot  
(M\$ per year)

Year	Possible Settler's Incomes			
	I	II	III	IV
(1976)				
5	2540	1340	1340	1340
6	2560	1560	1460	1460
7	2580	1680	1580	1580
8	2600	1800	1650	1630
9	2620	1820	1720	1680
0	2630	1930	1780	1730
11	2640	2140	1840	1760
12	2650	2250	1900	1800
13	2660	2360	1960	1830
14	2670	2470	2020	1870
15	2680	2680	2080	1900
16	2690	2790	2140	1940
17	2700	2900	2200	1970
18	2710	3100	2260	2010
19	2720	3220	2320	2040
20	2730	3330	2380	2090
21	2740	3440	2440	2110
22	2750	3550	2500	2150
23	2750	3750	2550	2150
24	2750	3950	2750	2150
25	2750	3950	2750	2150

Table 10 - Investment by and repayment to FLDA  
(10 acre Rubber Holding)

(M\$)

FLDA INVESTMENT PERIOD					
Year	Settler's Income	Manage- ment	Development Costs <sup>1</sup>	Interest @ 7 per cent.	Total Annual investment
(1971) 0	1880 <sup>1/</sup>	3220	3030	240	8370
1	600 <sup>2/</sup>	1040	1120	730	3490
2	1300 <sup>3/</sup>	1000	470	670	3640
3	1100 <sup>3/</sup>	1070	470	1230	3870
4	700 <sup>3/</sup>	1000	470	1450	3620
5	500 <sup>3/</sup>	820	470	1640	3430
6	660 <sup>4/</sup>	730	-	780	2370
FLDA REPAYMENT PERIOD					
Year	Settler's Income	Manage- ment	Annual repay- ment of loan <sup>5/</sup>	Farm Gross Margin	Replanting Cost
(1978) 7	1380	730	500	2610	360
8	1500	700	1270	3470	480
9	1620	700	1370	4190	580
10	1660	700	2390	4750	660
11	1700	700	2590	4990	700
12	1750	700	2780	5230	730
13	1780	670	2780	5230	740
14	1820	670	2680	5170	740
15	1850	670	2620	5140	740
16	1890	670	2580	5140	740
17	1920	670	2470	5060	740
18	1960	670	2400	5030	740
19	1990	670	2330	4990	740
20	2030	670	2200	4900	730
21	2060	670	2050	4780	720
22	2100	670	1880	4650	710
23	2120	670	1740	4530	700
24	2150	670	1580	4400	680
25	2150	670	1480	4300	670

- Notes: <sup>1/</sup> Values of settler's house and clearing house and village area.  
<sup>2/</sup> Settlers on project for second half of year only.  
<sup>3/</sup> Includes maintenance income and subsistence loan in immature period and income from houselot.  
<sup>4/</sup> Includes cash income from main crop and income from houselot.  
<sup>5/</sup> Repayment of principal and interest at 7 per cent.

## APPENDIX 13-1

Table 11 - Investment by and repayment to FLDA  
(10 acre Oil Palm Holding)

(M\$)

FLDA INVESTMENT PERIOD					
Year	Settler's Income	Management	Development Costs	Interest @ 7 per cent.	Total Annual Investment
(1971) 0	1880 <sup>1/</sup>	3220	3450	260	8810
1	600 <sup>2/</sup>	1040	2000	790	4430
2	900 <sup>3/</sup>	1000	300	960	3160
3	600 <sup>3/</sup>	1070	500	1270	3440
4	1120 <sup>4/</sup>	1000	-	340	2460

FLDA REPAYMENT PERIOD					
Year	Settler's Income <sup>4/</sup>	Management	Annual Rent	Annual Repayment of Loan <sup>5/</sup>	Farm Gross Margin
(1976) 5	1340	820	790	60	3010
6	1460	730	790	2230	5210
7	1580	730	790	2400	5500
8	1630	700	790	2650	5770
9	1680	700	790	2690	5860
10	1730	700	790	2710	5930
11	1760	700	790	2610	5860
12	1800	700	790	2500	5790
13	1830	670	790	2430	5720
14	1870	670	790	2310	5640
15	1900	670	790	2210	5570
16	1940	670	790	2100	5500
17	1970	670	790	1990	5420
18	2010	670	790	1880	5350
19	2040	670	790	1780	5280
20	2090	670	790	1740	5290
21	2110	670	790	1640	5210
22	2150	670	790	1610	5220
23	2150	670	790	1610	5220
24	2150	670	790	1530	5140
25	2150	670	790	1530	5140

- Notes: <sup>1/</sup> Value of settler's house and clearing village area.  
<sup>2/</sup> Settlers on project for second half of year only.  
<sup>3/</sup> Includes maintenance income and subsistence loan in immature period and income from houselot.  
<sup>4/</sup> Includes cash income from main crop and income from houselot.  
<sup>5/</sup> Repayment of principal and interest at 7 per cent.

FIGURE 1

RATES OF INTEREST PAYABLE ON LOAN WITH DIFFERENT LEVELS OF SETTLER'S CASH INCOME AND DIFFERENT SIZES OF OIL PALM HOLDING

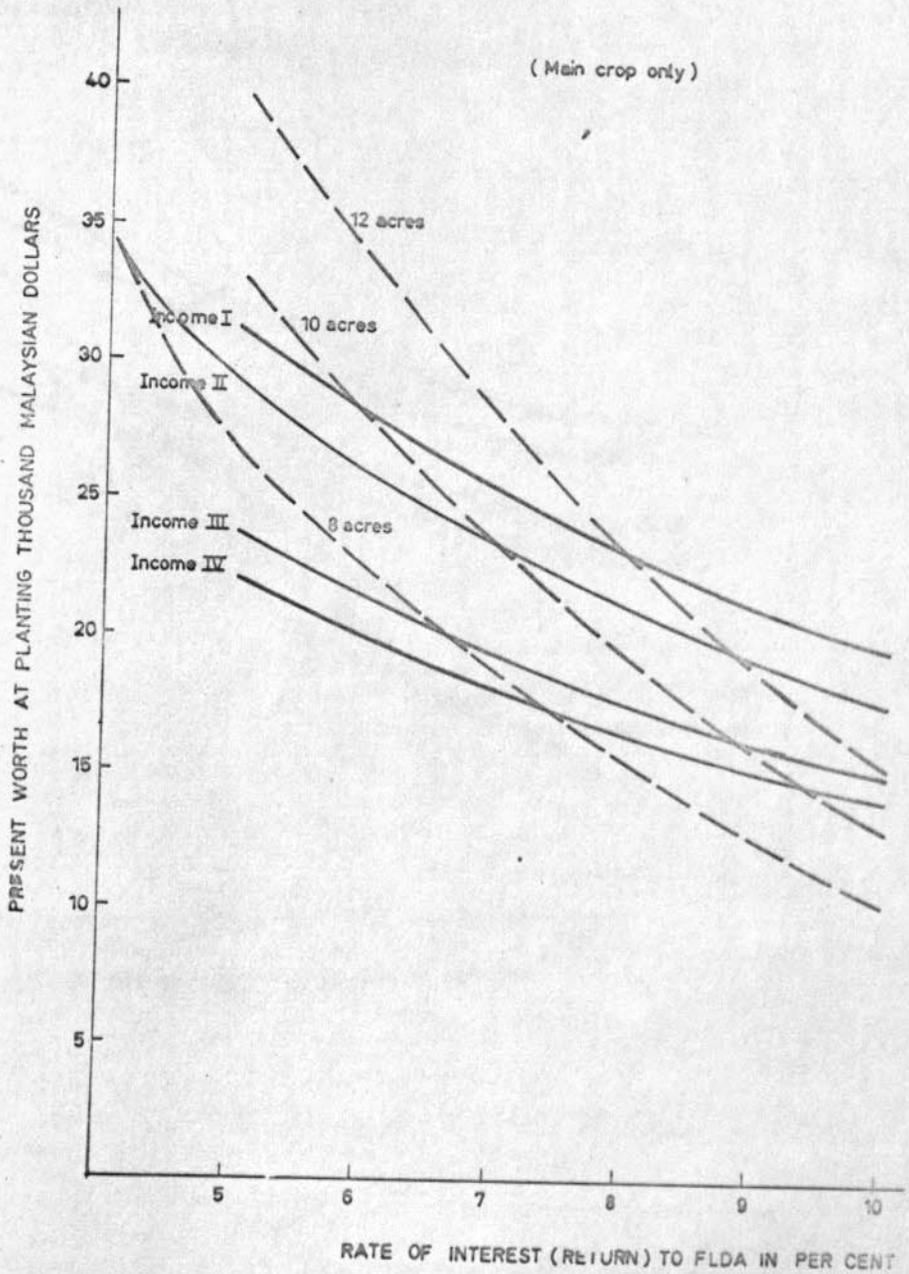
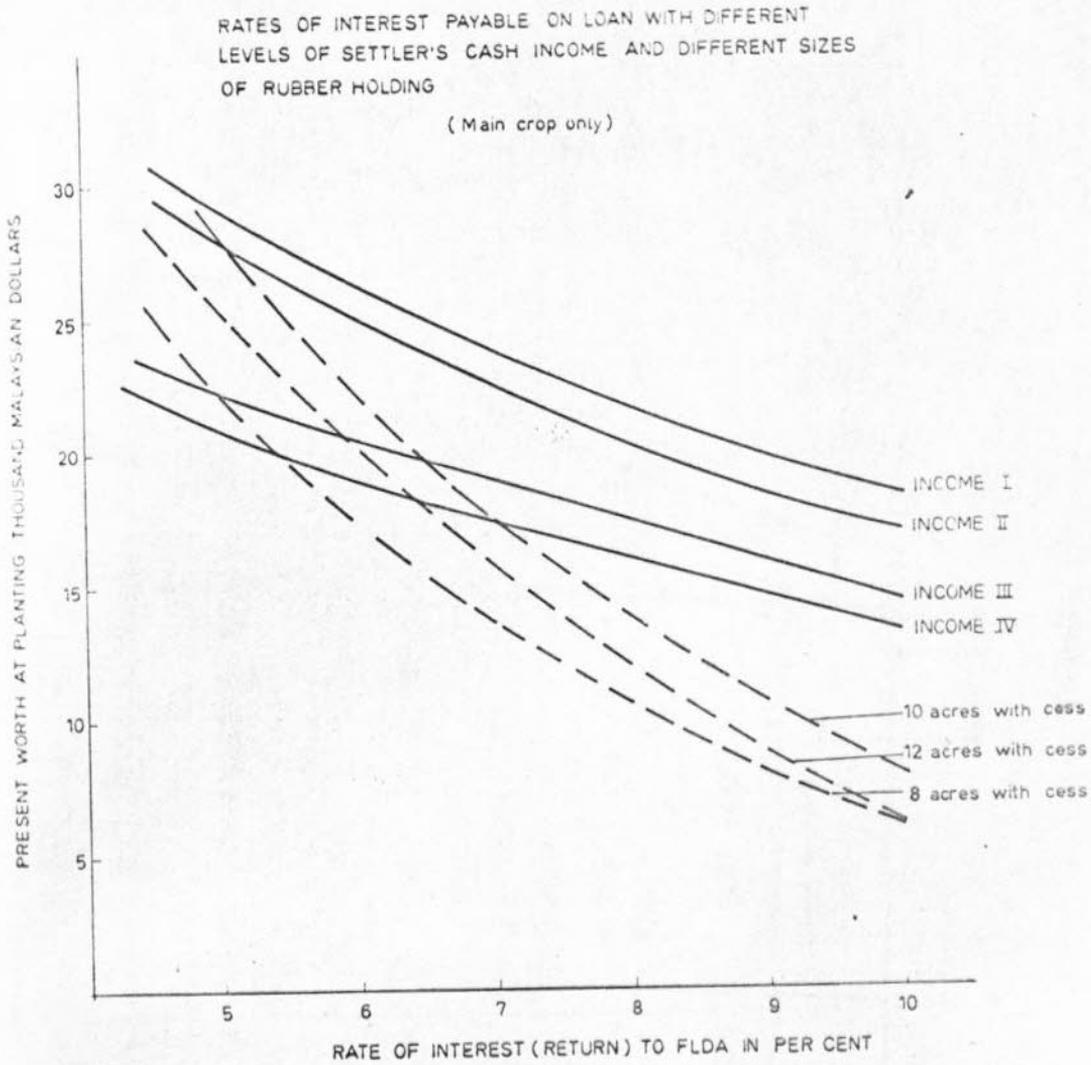


Figure 2



APPENDIX 14

SETTLEMENT UNITS

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APPENDIX 14  
LIST OF SETTLEMENT UNITS  
(contd.)

Project	Settlement Unit No.	Green Area	Rail Flaming Area (Acres)	Oil Palm	Rubber	Oil Palm
1	1	1169		200		1169
2	2	1517		200		1517
3	3	1079		200		1079
4	4	1075		200		1075
5	5	785		200		785
6	6	1804		200		1804
7	7	1424		200		1424
8	8	1119		200		1119
9	9	1376		200		1376
10	10	1235		200		1235
11	11	1236		200		1236
12	12	1312		200		1312
	TOTAL	11536		612		11536

APPENDIX 14-1

LIST OF SETTLEMENT UNITS

(acres)

Project	Settlement Unit No.	Gross Area Rubber	Gross Area Oil Palm	Nett Planting Area (acres) Rubber	Nett Planting Area (acres) Oil Palm	Village Area (acres)	Settler Families	Settler Population
I	1		1169		965	87	97	615
	2		1517		1252	113	125	793
	3		1079		891	80	89	564
	4		1075		887	80	89	564
	5	785				55	61	387
II	6		1404		1160	104	116	735
	7		1424		1176	106	118	748
	8		1119		924	83	92	583
	9		1376		1135	103	114	723
	10		1233		1018	92	102	647
	11	1346	1230		1015	92	102	647
	12	1214	1312		1084	97	108	685
	TOTAL	785	13938	612	11507	1092	1213	7691

APPENDIX 14-1

LIST OF SETTLEMENT UNITS (CONTD.)

(acres)

Project	Settlement Unit No.	Gross Area Rubber	Gross Area Oil Palm	Nett Planting Area Rubber	Nett Planting Area Oil Palm	Oil Palm Area (acres)	Village Area (acres)	Settler Families	Settler Population
II	13		1065		879	79	88	558	
	14		1182		976	88	98	621	
	15		910		751	68	75	476	
	16		1320		1090	98	109	691	
	17		772		637	58	64	406	
	18		857		707	64	71	450	
	19		1160		958	86	96	609	
	20		997		823	74	82	520	
	21		1354		1118	101	112	710	
	22		1041		860	77	86	545	
	23		1250		1032	93	103	653	
	24		1235		1019	92	102	647	
	25		1346		1049	95	105	666	
	26		1214		946	86	95	602	
	27		991		773	69	77	488	
	28		1397		1089	98	109	691	
	29		1187		925	84	93	590	
	TOTAL		6135	13143	4782	10850	1410	1565	9923

APPENDIX 14-1

LIST OF SETTLEMENT UNITS (CONTD)

Project	Settlement Unit No.	Gross Area		Nett Planting Rubber	Area (acres) Oil Palm	Village Area (acres)	Settler Families	Settler Population
		Rubber	Oil Palm					
III	30		920		782	71	78	499
	31		1171		984	90	98	632
	32		1592		1331	122	133	854
	33		1104		929	85	93	594
	34		778		665	60	66	423
	35		867		737	68	73	429
	36		952		803	74	80	519
	37		1535		1285	117	128	822
	38		992		841	77	84	537
	39		942		800	73	80	512
	40		887		755	68	75	480
IV	41	1016		827		75	82	524
	42		1019		859	78	86	550
	43		889		757	69	75	486
	44		1017		857	78	85	550
	45		1516		1269	115	127	810
	46		1029		870	80	87	562
	47		1312		1103	101	111	708
	48		847		721	66	72	461
	49	803		662		59	66	416
	50	1070		870		78	87	550
TOTAL	2889	19369	2359	16348	1704	1866	11918	

APPENDIX 14-1

LIST OF SETTLEMENT UNITS (CONTD.)

(acres)

Project	Settlement Unit No.	Gross Area Rubber Oil Palm	Nett Planting Rubber	Area (acres) Oil Palm	Village Area (acres)	Settler Families	Settler Population
IV	51	1260		1040	94	104	659
	52	983		812	73	81	514
	53	1379		1138	103	114	723
	54	1082		894	80	89	564
	55	1110		916	83	92	583
	56	1157		955	86	96	609
	57	1386		1144	103	114	723
	58	1036		855	77	86	545
	59	1446		1194	107	119	754
	60	921		761	68	76	482
TOTAL	61	1239		1023	92	102	647
	62	981		810	73	81	514
	63	1137		938	85	94	596
	64	1238		1022	92	102	647
		16355		13502	1216	1350	8560

APPENDIX 14-1

LIST OF SETTLEMENT UNITS (CONTD.)

Project	Settlement Unit No.	Gross Area Rubber Oil Palm	Nett Planting Rubber (acres)	Area (acres) Oil Palm	Village Area (acres)	Settler Families	Settler Population	
V	65	1957		1615	146	162	1027	
	66	1032		852	77	85	539	
	67	987		815	73	81	514	
	68	1087		897	81	90	571	
	69	998		824	74	82	520	
	70	1160		958	86	96	609	
	71	1158		956	86	96	609	
	72		1034	806	73	81	514	
	73		1221	952	86	95	602	
	74		1145	893	80	89	564	
	75		1211	944	85	94	596	
	76		1225	955	86	96	609	
	77		1335	1041	94	104	659	
	78		1129	881	79	88	558	
	79		1477	1151	104	115	729	
	80		1041	812	73	81	514	
	81		1148	895	81	90	571	
	82		1287	1004	90	100	634	
	TOTAL		8379	10334	6917	1554	1725	10939

APPENDIX 14-1

LIST OF SETTLEMENT UNITS (CONTD.)

Project	Settlement Unit No.	Gross Area Rubber	Gross Area Oil Palm	Nett Planting Rubber	Area (acres) Oil Palm	Village Area (acres)	Settler Families	Settler Population
VI	83	1517			1252	113	125	793
	84	1441			1190	107	119	754
	85	1165			962	86	96	609
	86	1172			968	87	97	615
	87	1246			1028	93	103	653
	88	1210			999	90	100	634
	89	1024		798		72	80	507
	90	1419		1106		100	111	704
	91	1530		1193		107	119	754
	92	1050		818		74	82	520
TOTAL				1619		146	162	1027
				775		70	78	495
				886		80	89	564
				1188		107	119	754
				1048		95	105	666
GRAND TOTAL		7751	6399	27518	1427	1585	10049	
6 PROJECTS		35162	78935	27518	8403	9304	59080	
		114097		93041				

APPENDIX 14-2  
POPULATION COMPOSITION ON FOUR FELDA SCHEMES

FELDA SCHEME	NO. OF FAMILIES	AGE GROUPS (YEARS)					AVERAGE FAMILY SIZE
		6 AND BELOW	7 - 13	14 - 20	21 AND ABOVE	ALL AGES	
Kemendore	208	281	369	187	454	1291	6.21
S. Tekam	117	207	135	32	238	612	5.23
Kg. Awah	117	212	221	82	245	760	6.50
Bilut	575	1007	936	533	1315	3791	6.59
All Schemes	1017	1707	1661	834	2252	6454	6.35
Percentage	-	26.5	25.7	12.9	34.9	100	-

APPENDIX 14-3

TYPICAL SETTLEMENT UNIT DEVELOPMENT COSTS

Table 1 - Oil Palm

	<u>Unit</u>	<u>Quantity</u>	<u>Unit Cost (M\$)</u>	<u>Estimated Cost (M\$)</u>	<u>Percentage of total</u>
<u>Site Preparation</u>					
Forest Clearing	acre	1,161	167	194,000	
Land Draining (15% of Plantable Land)	"	144	40	5,800	
Plantforming (67% of Plantable Land)	"	650	60	39,000	
Destumping Village	"	87	242	21,100	
			Sub-Total	259,900	28
<u>Agricultural Planting</u>					
Roads (within Settlement Unit)	mile	12.00	7,675	92,100	
Tertiary (Harvesting)	"	0.56	22,000	12,300	
Tertiary - improved	"	0.40	22,000	8,800	
Secondary	"	0.62	68,000	42,500	
	"	0.63	68,000	42,800	
			Sub-Total	198,500	21
<u>Water Supply</u>	lump sum	-	-	136,500	15

TYPICAL SETTLEMENT UNIT DEVELOPMENT COSTS

Table 1 - Oil Palm (Contd.)

	Unit	Quantity	Unit Cost (M\$)	Estimated Cost (M\$)	Percentage of total
<b>Buildings</b>					
Settler Houses	each	96	1,430	137,300	
FLDA Field Office	"	1	6,000	6,000	
Assistant Manager's House	"	1	9,000	9,000	
Senior Supervisor's House	"	2	6,000	12,000	
Field Assistant House	"	1	2,000	2,000	
Religious Building	"	1	2,000	2,000	
Community Building	"	1	2,000	2,000	
Co-operative Shop	"	1	7,000	7,000	
Market Shed	"	1	2,000	2,000	
		Sub-Total		179,300	19
<b>Amenities</b>					
Sports Field (Padang)	acres	2	1,000	2,000	
Walks: Village Centre	sq. yard	400	6	2,400	
		Sub-Total		4,400	
		TOTAL COST		932,200	100



TYPICAL SETTLEMENT UNIT DEVELOPMENT COSTS

Table 2 - Rubber (Contd.)

	Unit	Quantity	Unit Cost (M\$)	Estimated Cost (M\$)	Percentage of total
<u>Buildings</u>					
Settler Houses	each	95	1,430	135,800	
FLDA Field Office	"	1	6,000	6,000	
Assistant Manager's House	"	1	9,000	9,000	
Senior Supervisor's House	"	2	6,000	12,000	
Field Assistant House	"	1	2,000	2,000	
Religious Building	"	1	2,000	2,000	
Community Building	"	1	2,000	2,000	
Co-operative Shop	"	1	7,000	7,000	
Market Shed	"	1	2,000	2,000	
		Sub-Total		177,800	22
<u>Amenities</u>					
Sports Field (Padang)	acre	2	1,000	2,000	
Walks: Village Centre	sq. yard	400	6	2,400	
		Sub-Total		4,400	1
		TOTAL COST		814,200	100

APPENDIX 14-4

COMPARISONS OF AREAS

	EXISTING FLDA- TYPE SETTLEMENT  (Kg. Awab)	AVERAGE SETTLEMENT UNIT (RUBBER)	
		1 - unit	4 - units for comparisons
BASIC SETTLEMENT UNIT CHARACTERISTICS			
Settler families	450	95	380
Settler population	2,860	603	2,409
Household Size	$\frac{1}{4}$ acre	$\frac{3}{4}$ acre	--
Dusun	800 acres	nil	nil
Main crop area	3,600	950 acres	3,800 acres
SETTLEMENT VILLAGE AREAS			
Household	112 acres (44%)	71.2 ac. (83%)	285 acres (83%)
Other	145 acres (56%)	14.8 ac. (17%)	59 acres (17%)
Total	257 acres (100%)	86.0 ac. (100%)	344 acres (100%)

Appendix 18-2

GRASSES FOR TERTIARY ROAD SURFACING

In areas of Group II soils where there may be opportunities to eliminate the application of laterite or other foundation materials on the tertiary road system, the following grasses which occur naturally in the vicinity of the Triangle should be considered.

1. Axonopus compressus
2. Cynodon dactylon
3. Desmodium triflorum
4. Cynodon seticulatus
5. Paspalum conjugatum

All of these grasses could be propagated by turfing, but in view of potentially large areas involved, seed would be preferable.

Seed should be applied after grading and before rolling. Laboratory tests by the Faculty of Agriculture of the University of Malaya on Axonopus compressus indicated a germination of 80 per cent. If Axonopus compressus is used, it can be sown when about six inches high to encourage a flat growing habit, thus minimising later sowing requirements. The total cost of the grass surface, including seed (150 lb. per mile at M\$300 per cwt.), equipment and labour, is estimated at roughly M\$400 per mile.

The amount of seed required and the estimated cost is given in Table 1.

Notes

1. The amount of seed required and the estimated cost is given in Table 1.

## DRAINAGE AND BRIDGES

Drainage

Based on plots of run-off for catchments of one square mile and above and assumed circular catchment areas, volumes of road cross-flow were computed for 25 per cent and 50 per cent run-off. The 25 per cent run-off coincided with a theoretical curve constructed separately for a 5 hr storm and was used to determine cross drainage requirements.

Cross drainage was estimated for typical road layouts on the FLDA Ulu Jempol Scheme where adequate topographic data was available. The drainage requirement thus computed was used for all classes of roads.

Pipe drains were taken as pre-cast reinforced concrete pipe. For primary roads a concrete surround was added; for secondary and tertiary roads, pipe drains were assumed to be bedded on river sand and backfilled.

Reinforced concrete box culverts were assumed for all points where flows were estimated to exceed the capacities of 72-inch pipes.

The amount of cross drainage and the estimated cost is given in Table 1.

Bridges

Allowances for minor bridges were made on the basis of map inspection and correlated approximately with the actual linear feet of bridge per mile on existing roads in the area. Assumed bridge quantities and costs (based on unit prices obtained for estimating purposes from the Public Works Department are given in Table 2.

The proposed Sungai Pahang bridge was assumed to have a crossing length of 400 feet, based on map inspection. An allowance of M\$1,500,000 was included in the estimates for its construction; this assumes that some type of practicable low-level design could be developed, otherwise costs would be higher.

Table 1 - Road Cost Estimate

Class of Account	No. of Accounts	Unit Price	Quantity	Estimated Cost (M\$)	Actual Cost (M\$)
2.40	1	1,500,000	1	1,500,000	1,500,000
6.50	104	100	10,400	1,040,000	1,040,000
6.55	505	215	108,575	23,422,500	23,422,500
6.30	930	170	158,100	26,877,000	26,877,000
6.35	575	185	106,275	19,660,625	19,660,625
6.45	195	210	40,950	8,600,000	8,600,000
6.50	1,000	375	375,000	140,625,000	140,625,000
6.55	1,460	160	233,600	37,376,000	37,376,000
6.60	1,100	300	330,000	99,000,000	99,000,000
6.65	1,260	360	453,600	163,300,000	163,300,000
6.70	812	511	414,852	212,000,000	212,000,000
				M\$1,500,000	M\$1,500,000
				M\$5,131	M\$5,131
					M\$1,234

APPENDIX 18-3

Table 1 - Road Cross Drainage

Pipe Size (in)	Culvert Size (sq. ft.)	No. of Crossings per mile	Cost Per Mile (M\$)			Tertiary L = 20 ft
			Primary L = 75 ft	Secondary L = 50 ft	Tertiary (improved) L = 40 ft	
24	-	2.20	M\$ 2,640	M\$ 1,120	M\$ 902	M\$ 451
30	-	0.20	304	130	104	52
36	-	0.30	505	218	174	87
42	-	0.30	930	330	264	132
48	-	0.15	535	185	146	73
54	-	0.15	595	200	160	80
60	-	0.22	1,010	345	276	138
72	-	0.22	1,380	552	442	221
-	100	0.32 <sup>1/</sup>	1,350	900	360	-
-	150	0.26 <sup>1/</sup>	1,440	960	384	-
-	200	0.31 <sup>1/</sup>	831	554	222	-
			M\$11,520	M\$5,494	M\$3,434	M\$1,234

<sup>1/</sup> Reduced by 1/2 for tertiary (improved) roads

Table 2 -- Minor Bridge Construction

Road Class	No. Bridges	Type	Width (ft)	Length per mile (ft)	Cost (M\$/sq ft)	Total Cost per mile (M\$)
Primary	16	concrete	24.5	17.6	40	17,250
Secondary	9	concrete	22.5	10.6	40	9,540
Tertiary (improved)	-	wood	12.0	5.0	20	1,200
Tertiary	-	-	-	-	-	-

APPENDIX 18-4

ESTIMATED ROAD CONSTRUCTION COSTS

Table 1 - Primary Roads, Stage 1

Item	Unit	Unit Price (M\$)	Quantity per mile	Est. Cost per mile (M\$)
Earthwork	cu yd	0.98	70,000	68,000
Drainage	L. S.	-	-	11,520
Base	cu yd	8.70	4,700	40,836
Seal coat	sq yd	0.175	14,080	2,464
Bridges	lin ft	980.00	17.6	17,250
Grassing	sq yd	0.0825	10,560	870
Engineering, supervision of construction				141,540
Engineering, supervision of construction, and contingencies (25%)				<u>35,385</u>
		Total		176,925
		Say		<u>177,000</u>

Table 2 - Tertiary (Approved) Roads

Table 2 - Primary Roads, Stage II

Item	Unit	Unit Price (M\$)	Quantity	Est. Cost per mile (M\$)
Levelling Grade	L. S.	-	-	1,210
Double Surface treatment	sq yd	1.11	14,080	15,630
				<u>16,840</u>
Engineering, supervision of construction, and contingencies (25%)				<u>4,210</u>
		Total		21,050
		Say		<u>21,000</u>

APPENDIX 18-4

Table 3 - Secondary Roads

Item	Unit	Unit Price (M\$)	Quantity	Estimated Cost per mile (M\$)
Earthwork	cu yd	0.98	18,600	18,200
Base Course	cu yd	6.82	3,130	21,300
Drainage	L.S.	-	-	5,494
Bridges	lin ft	900	10.6	9,540
				54,534
Engineering, supervision of construction, and contingencies (25%)				<u>13,633</u>
Total				68,167
Say				<u><u>68,000</u></u>

Table 4 - Tertiary (improved) Roads

Item	Unit	Unit Price (M\$)	Quantity per mile	Est. cost per mile (M\$)
Earthwork	cu yd	-	-	3,624
Laterite	cu yd	6.79	1,370	9,300
Drainage	L.S.	-	-	3,434
Bridges	lin ft	240	5	1,200
				17,558
Engineering, supervision of construction, and contingencies (25%)				<u>4,389</u>
Total				21,947
Say				<u><u>22,000</u></u>

Table 5 - Tertiary Roads, Oil Palm Areas

<u>Item</u>	<u>Unit</u>	<u>Unit Price (M\$)</u>	<u>Quantity per mile</u>	<u>Est. Cost per mile (M\$)</u>
Earthworks	cu yd	0.515	1,760	906
Laterite	cu yd	6.79	587	4,000
Drainage	L.S.	-	-	<u>1,234</u>
				6,140
Engineering, supervision of construction, and contingencies (25%)				<u>1,535</u>
Total				7,675

Table 6 - Tertiary Roads, Rubber Areas

<u>Item</u>	<u>Unit</u>	<u>Unit Price (M\$)</u>	<u>Quantity per mile</u>	<u>Est. Cost per mile (M\$)</u>
Earthworks	cu yd	0.515	1,760	906
Drainage	L.S.	-	-	1,234
Grassing	sq yd	0.0825	7,040	<u>580</u>
				2,720
Engineering, supervision of construction, and contingencies (25%).				<u>68</u>
Total				3,400

ROAD CONSTRUCTION SCHEDULE  $\frac{1}{2}$   
(Miles)

Class	Initial Construction	Initial Standard	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	Total
Primary	Government	Primary	6.0	12.5	-	4.8	2.5	3.2	-	4.4	1.6	4.5	0.1	39.6
	Logger	Main Logging	-	1.4	8.8	5.3	-	-	-	-	-	-	-	15.5
	Logger	Secondary Logging	-	-	3.8	5.4	-	-	-	-	-	-	-	<u>9.2</u> 64.3
Secondary	Government	Secondary	7.5	15.5	13.0	16.4	3.6	6.1	16.8	1.6	-	-	-	80.5
	Logger	Secondary Logging	-	-	6.6	4.0	12.5	-	1.5	-	-	-	-	24.6
	Logger	Main Logging	-	10.4	-	-	-	-	-	-	-	-	-	10.4
	Logger	Spur Logging	-	-	-	3.1	12.2	14.0	16.3	12.9	11.4	11.2	5.7	<u>86.8</u> 202.3
Tertiary-improved	Government	Tertiary-improved	3.7	7.2	13.1	5.9	8.1	8.0	10.0	8.7	8.0	2.1	-	74.8
	Logger	Spur Logging	-	-	-	1.5	3.1	4.2	3.1	2.5	2.8	1.8	-	<u>19.0</u> 93.8
Tertiary	Government	Tertiary	38.8	99.0	110.0	130.0	138.5	148.0	133.8	107.0	64.4	56.2	-	1025.7

$\frac{1}{2}$  Years shown are those of expected initial construction by Government or logger.

See Appendices 18-6 and 18-7 for years of assumed investment.

APPENDIX 18-6

PHASING OF CAPITAL COST - PRIMARY AND SECONDARY ROADS <sup>1/</sup>  
(Thousands of MS)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	TOTAL
<u>Primary Roads</u> <sup>2/</sup>												
Miles <sup>3/</sup>	6.00	12.51	-	4.82	13.11	3.20	5.30	4.35	1.67	13.22	0.10	64.26
Est. Cost	1,062	2,214	339	853	2421	842	1,005	881	837	2875	778	14,207
<u>Secondary Roads</u>												
1. Outside SU's <sup>4/</sup>												
Miles	2.41	7.32	2.54	8.52	17.40	6.12	16.81	1.65	14.03	4.00	-	80.80
Est. Cost	164	498	1.73	632	1193	734	1143	112	1080	272	-	5,991
2. Within SU's, but outside Villages <sup>5/</sup>												
Miles	2.56	3.81	4.23	2.86	9.44	4.66	9.41	7.25	5.10	6.80	5.75	60.87
Est. Cost	174	259	288	194	574	317	640	493	347	462	391	4,139
3. Within Villages <sup>6/</sup>												
Miles	2.50	4.37	6.25	3.12	6.83	9.38	6.88	5.62	2.25	4.37	-	60.62
Est. Cost	170	297	425	552	468	638	468	382	425	297	-	4,122
4. Total												
Miles	7.47	15.50	13.02	19.50	32.72	20.16	33.10	14.52	25.38	15.17	5.75	202.29
Est. Cost	508	1054	836	1378	2225	1689	2251	987	1852	1031	391	14,252

<sup>1/</sup> Years shown are assumed years of capital expenditure.

<sup>2/</sup> Capital cost assumed to be incurred in year of initial construction if by Government, or in year of improvement to public standard (after logging) if by logger.

<sup>3/</sup> Mileage is for Stage I only; Stage II (bituminous surfacing) mileage not shown.

<sup>4/</sup> See note <sup>3/</sup>.

<sup>5/</sup> Capital cost assumed to be incurred one year after land clearing, whether initial construction by Government or logger.

## APPENDIX 18-7

## PHASING OF CAPITAL COST - TERTIARY ROADS 1/

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	TOTAL
<u>Tertiary-Improved</u>												
<u>1. Within Villages</u>												
Miles	2.25	3.94	5.62	7.31	6.19	8.44	6.19	5.06	5.62	3.94	-	54.56
Est. Cost (M\$000)	50	87	123	161	136	186	136	111	123	87	-	1,200
<u>2. Outside Villages</u>												
Miles	1.50	3.21	7.51	-	4.99	3.80	6.90	6.21	5.20	-	-	39.32
Est. Cost (M\$000)	33	70	165	-	110	84	152	137	114	-	-	865
<u>3. Total</u>												
Miles	3.75	7.15	13.13	7.31	11.18	12.24	13.09	11.27	10.82	3.94	-	93.88
Est. Cost (M\$000)	83	157	288	161	246	270	288	248	237	87	-	2,065
<u>Tertiary</u>												
<u>1. Oil Palm</u>												
Miles	38.75	90.00	110.00	115.00	117.50	130.00	133.75	80.00	-	-	-	815.00
Est. Cost (M\$000)	297	690	844	883	903	998	1026	614	-	-	-	6,255
<u>2. Rubber</u>												
Miles	-	9.00	-	15.00	21.00	18.00	-	27.00	64.50	56.25	-	210.75
Est. Cost (M\$000)	-	31	-	52	71	61	-	92	219	191	-	717
<u>3. Total</u>												
Miles	38.75	99.00	110.00	130.00	138.50	148.00	133.75	107.00	64.50	56.25	-	1025.75
Est. Cost (M\$000)	297	721	844	935	974	1059	1026	706	219	191	-	6,972

1/ Years shown are assumed years of capital expenditure. Capital costs are assumed to be incurred one year after clearing, whether initial construction by Government or logger.

APPENDIX 19

WATER SUPPLY, DRAINAGE AND IRRIGATION (Contd.)

Page

RUBBER FACTORY

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Table 2 Water Supply Capital Costs Using Ground Water Supplies

ESTIMATED CAPITAL AND OPERATING COSTS FOR A SPRAY IRRIGATION SCHEME FOR 150 ACRES OF OIL PALM NURSERY 260

Table 1 Capital Cost

Table 2 Operating Cost

Table 3

ESTIMATED CAPITAL AND OPERATING COSTS FOR RICE WATER DRAINAGE

Table 1

Table 2

Table 3

Table 4

19-5

ESTIMATED CAPITAL COSTS OF IRRIGATION WATER SUPPLY FOR RICE

Table 1

Table 2

## WATER SUPPLY, DRAINAGE AND IRRIGATION

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APPENDIX 19-1

DOMESTIC WATER SUPPLY STANDARDS

Description	World Health Standards (ppm)	Normal Range expected at Jengka Triangle (ppm)	Remarks
Residual Chlorine	1.0 - 2.0	1.0 - 2.0	After treatment
*Chlorides as Cl	200	Nil - 18	
*Total solids	500	30 - 100	
Oxygen absorption	See remarks	0.5 - 4.7	Increases above these values indicate a rise in pollution and thus indicate a need for further investigation
Ammoniacal nitrogen	See remarks	0.01 - 0.05	
Albuminoid nitrogen	See remarks	0.06 - 0.22	
Oxidized nitrogen	See remarks	0.03 - 0.42	
*Total hardness as CaCO <sub>3</sub>	300	5 - 50	
*Total alkalinity as CaCO <sub>3</sub>	335	5 - 50	
Nitrates as NO <sub>3</sub>	100	Unknown	
*Turbidity	5	14 - 85	
*pH range	7.0 - 8.5	6.5 - 9.0	
*Silica as SiO <sub>2</sub>	20	7 - 14	20 ppm is the upper limit for small rural supplies
*Iron	0.3 (1.0)	0.4 - 1.5	(1.0) is upper limit for small rural supplies
Manganese	0.1	0 - 0.06	
*B. COLI-Aerogenes colonies	10 colonies per 100 ml	3500 - 9000 per 100 ml	Raw water
*B. COLI-Faecal types	10 colonies per 100 ml	250 - 5500 per 100 ml	Raw water
Colour	5 Hazen units	5 - 40 Hazen units	

\* Only these items are of interest for Malayan conditions.

## APPENDIX 19-2

## BOILER FEEDWATER STANDARDS

Description	Tolerance limit for 250 psi pressure (ppm)	Range of Jengka Triangle rivers (ppm)	Remarks
Turbidity	10	14 - 85	High values cause foaming and priming
Dissolved oxygen	0.2	0.5 - 4.7'	High values cause corrosion
Hydrogen sulphide	3	Unknown	Unimportant except on account of odour
Total hardness as CaCO <sub>3</sub>	40	5 - 50	High values cause scale formation
Sulphate/carbonate ratio (Na <sub>2</sub> SO <sub>4</sub> : N Na <sub>2</sub> CO <sub>3</sub> )	2:1	Unknown	Causes caustic embrittlement if ratio is high
Aluminium oxide (Al <sub>2</sub> O <sub>3</sub> )	0.5	Unknown	Causes scale formation if high
Silica (SiO <sub>2</sub> )	20	7 - 14	Causes scale formation if high
Bicarbonate (HCO <sub>3</sub> <sup>-</sup> )	30	Unknown	Causes corrosion if high
Carbonate (CO <sub>3</sub> <sup>=</sup> )	100	3 - 34	Causes corrosion if high
Hydroxide (OH <sup>-</sup> )	40	Unknown	
*Total solids	500 - 2500	30 - 100	High values cause foaming and priming
Maximum pH value	8.5	6.5 - 9.0	Low pH causes corrosion
Colour	40 Hazen units	5 - 40 Hazen units	

\* Depends upon boiler design

ESTIMATED CAPITAL AND OPERATING COSTS FOR RURAL  
WATER SUPPLIESTable 1 - Village Water Supply Capital Costs  
Using Stream Supplies

(1200 design population)

Description	Cost 1/ M\$
Intake and pump-well	2,000
Pumps, pump-house, instruments etc.	17,000
Treatment plant 2/	25,000
Transmission mains	21,000
Distribution system	32,000
Service reservoir (one day supply)	18,000
Stand pipes	1,000
Engineering, supervision and contingencies	24,000
Total	140,000 3/

1/ Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

2/ Filtration but not sedimentation.

3/ Cost per head for design population (1200 people) M\$117  
Cost per head for initial population (690 people) M\$203

Table 2 - Village Water Supply Capital Costs  
Using Groundwater Supplies

(1200 design population)

Description	Cost	Cost <sup>1/</sup> M\$
Exploration, test drilling, casing, screening, development, pumps, pump-house, instruments etc.	31,000	31,000
Treatment plant <sup>2/</sup>	17,000	2,000
Transmission mains	25,000	17,000
Service reservoir (one day supply)	18,000	18,000
Distribution system	30,000	30,000
Stand pipes (one day supply)	1,000	1,000
Engineering supervision and contingencies	26,000	26,000
Total	125,000	125,000 <sup>3/</sup>

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Chlorination only.

<sup>3/</sup> Cost per head for design population (1200 people) M\$105  
Cost per head for initial population (690 people) M\$182

## APPENDIX 19-3

Table 3 - Village Water Supply Capital Costs  
Using Local Catchment Supplies

(1200 design population)

Description	Cost <sup>1/</sup> M\$
Reservoir construction <sup>2/</sup>	12,000
Pumps, pump-house, instruments etc.	17,000
Treatment plant <sup>3/</sup>	25,000
Transmission mains	22,000
Distribution system	32,000
Service reservoir (one day supply)	18,000
Standpipes	1,000
Engineering, supervision and contingencies	29,000
Total	156,000 <sup>4/</sup>

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Dam site assumed to supply 4 villages (M\$10.2 per capita)

<sup>3/</sup> Filtration but not sedimentation.

<sup>4/</sup> Cost per head for design population (1200 people) M\$130  
Cost per head for initial population (690 people) M\$226

APPENDIX 19-3

Table 4 - Village Water Supply: Operating Costs  
For One Village Per Annum

12,000 M\$ (1200 design population)

Description	Unit rate	Operating Costs M\$
Power costs for fuel, oil etc.	M\$1.00 for 5000 gallons output	5,000
Staff wages plus supervisory over-head housing, leave etc.	wages of 2 engine driver/operators plus 50%	4,500
Maintenance of plant	at 3% per annum	1,000
Maintenance of pipe-lines	at 2 cents per foot run of all mains	500
Chemicals	M\$1.00 per 20,000 gallons output	1,000
	Cost per annum	12,000

Includes sedimentation and filtration for iron removal.

## ESTIMATED CAPITAL AND OPERATING COSTS FOR TOWN WATER SUPPLIES

Table 1 - Regional Centre Water Supply Capital Costs  
Using Ground Water Supplies

(12,000 Design Population)

Description	Cost <sup>1/</sup> M\$
Exploration, bore-holes screens, <sup>2/</sup> casing, development, pumps, power lines, transformers, switches, etc.	230,000
Treatment plant <sup>3/</sup>	200,000
Transmission mains	125,000
Service reservoir (one day supply)	255,000
Distribution system	320,000
Engineering, supervision and contingencies	270,000
Total	1,400,000

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Electric power from town is assumed.

<sup>3/</sup> Includes sedimentation and filtration for iron removal.

Table 2 - Southeast and Southwest Town Water Supply  
Capital Costs Using Stream Supplies

(4000. Design Population Each)

Description	Cost per town <sup>1/</sup> M\$
Intake structure	3,000
Pumps, including motors, power lines, <sup>2/</sup> wiring, switches, transformers	33,000
Treatment plant <sup>3/</sup>	80,000
Transmission mains	55,000
Service reservoir (one day supply)	75,000
Distribution system	128,000
Engineering, supervision and contingencies	86,000
Total Each Town	460,000

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Electric power from town is assumed.

<sup>3/</sup> Includes sedimentation and filtration.

Table 3 - Regional Centre Water Supply Operating Costs Per Annum Using Ground Water Supplies

Description	Unit Rate	Operating Cost M\$
Power costs for electricity, oil etc.	80 cents per 5000 gallons	49,000
Staff wages plus supervisory overheads, housing, leave etc.	Wages of 6 engine driver/operators plus 50%	13,000
Maintenance of plant	at 3% per annum	8,200
Maintenance of pipelines	at 2 cents per foot run	4,500
Chemicals	33 cents for 20,000 gallons output	5,300
	Cost per annum	80,000

Table 4 - Southeast and Southwest Town Water Supply Operating Costs Per Annum Using Stream Supplies

Description	Unit Rate	Operating Costs per town M\$
Power costs for electricity, oil etc.	80 cents per 5000 gallons	16,000
Staff wages plus supervisory overheads, housing, leave etc.	Wages of 4 engine driver/operators, plus 50%	9,000
Maintenance of plant	at 3% per annum	3,000
Maintenance of pipelines	at 2 cents per foot run	1,500
Chemicals	M\$1 per 20,000 gallons output	4,500
	Cost per annum	34,000

ESTIMATED CAPITAL COSTS OF INDUSTRIAL WATER SUPPLIES <sup>1/</sup>  
PALM OIL MILL

Table 1 - Water Supply Capital Costs  
Using Ground Water Supplies

Description	Cost <sup>2/</sup> M\$
Exploration, bore-holes, screens, casing, development	14,000
Pumps, pump-house, instruments etc.	7,000
Treatment plant <sup>3/</sup>	25,000
Transmission mains	6,000
Reservoir (service tanks) <sup>4/</sup>	-
Distribution system <sup>4/</sup>	-
Electric power line	25,000
Engineering supervision and contingencies	19,000
Total	96,000

<sup>1/</sup> Operating costs are included in the over-all mill and factory operating costs.

<sup>2/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>3/</sup> Includes sedimentation and filtration for iron removal.

<sup>4/</sup> Included in mill costs.

## PALM OIL MILL

Table 2 - Water Supply Capital Costs  
Using Stream Supplies

Discription	Cost <sup>1/</sup> M\$
Intake and pump-well	1,500
Pumps, pump-house, instruments etc.	5,500
Treatment plant <sup>2/</sup>	30,000
Transmission mains	6,000
Reservoir (service tanks) <sup>3/</sup>	-
Distribution system <sup>3/</sup>	-
Electric power line	25,000
Engineering supervision and contingencies	17,000
Total	85,000

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Includes sedimentation and filtration.

<sup>3/</sup> Included in mill costs.

## APPENDIX 19-5

## RUBBER FACTORY

Table 1 - Water Supply Capital Costs  
Using Stream Supplies

Description	Cost <sup>1/</sup> M\$
Intake and pump-well	1,500
Pumps, pump-house, instruments etc.	3,300
Treatment plant <sup>2/</sup>	25,000
Transmission mains	6,000
Reservoir (service tanks) <sup>3/</sup>	-
Distribution system <sup>3/</sup>	-
Electric power line	25,000
Engineering supervision and contingencies	15,200
Total	76,000

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Includes filtration but not chlorination.

<sup>3/</sup> Included in mill costs.

## APPENDIX 19-5

## RUBBER FACTORY

Table 2 - Water Supply Capital Costs  
Using Ground Water Supplies

Description	Cost <sup>1/</sup> M\$
Exploration, test drilling, casing, screening, development, pumps, pump-house, instruments etc.	19,000
Treatment plant <sup>2/</sup>	-
Transmission mains	6,000
Reservoir (service tanks) <sup>3/</sup>	-
Distribution system <sup>3/</sup>	-
Electric power lines	25,000
Engineering supervision and contingencies	12,000
Total	62,000

<sup>1/</sup> Lump sum cost based on estimated costs of 16 FLDA water schemes, 2 large PWD schemes, mining company data, and quotations from equipment suppliers.

<sup>2/</sup> Not required.

<sup>3/</sup> Included in mill costs.

## APPENDIX 19-6

ESTIMATED CAPITAL AND OPERATING COSTS  
FOR A SPRAY IRRIGATION SCHEME FOR  
150 ACRES OF OIL PALM NURSERY

Table 1 - Capital Cost

Description	Cost M\$
Engines, pumps, mountings, pipe manifold, gauges, bends, foot valves	85,000
Main pipeline-pumps to irrigation areas	12,000
Main pipelines in irrigation areas	40,000
Spray lines and fittings	83,000
Engineering and contingencies (10%) <sup>1/</sup>	25,000
Total	245,000 <sup>2/</sup>

<sup>1/</sup> A low figure is used because very little engineering work is required in establishing the scheme. The above costs cover supply of equipment and are based upon suppliers' quotations.

<sup>2/</sup> M\$1,640 per acre.

## APPENDIX 19-6

Table 2 - Operating Costs

Description	Cost M\$
Pumping costs for fuel, <sup>1/</sup> lubricating oil.	17,300
Staff wages, plus overheads, housing <sup>2/</sup> leave etc.	34,800
Maintenance of equipment including pipelines at 2% P.A. of capital cost.	4,900
Establishment costs for setting up in <sup>3/</sup> new areas each year.	5,000
Total	62,000

<sup>1/</sup> Operating time 1300 hours/year at 385 H.P. from a total of 8 pumping units.  
Lubricating oil at 0.004 pints/BHP-Hr. at 80% load at M\$0.60/pint.  
Fuel oil at 0.42 pints/BHP-Hr. at 80% load at M\$0.60/gallon.

<sup>2/</sup> Area divided into 3 separate schemes using a total of 8 labourers, 6 pump attendants, 2 supervisors.

<sup>3/</sup> Assumes new irrigation areas established each year to accord with development phasing, with labour provided by item 2, but requiring transport, some earthmoving and replacement of breakages.

# JOHOR TENGGARA MASTER PLAN

