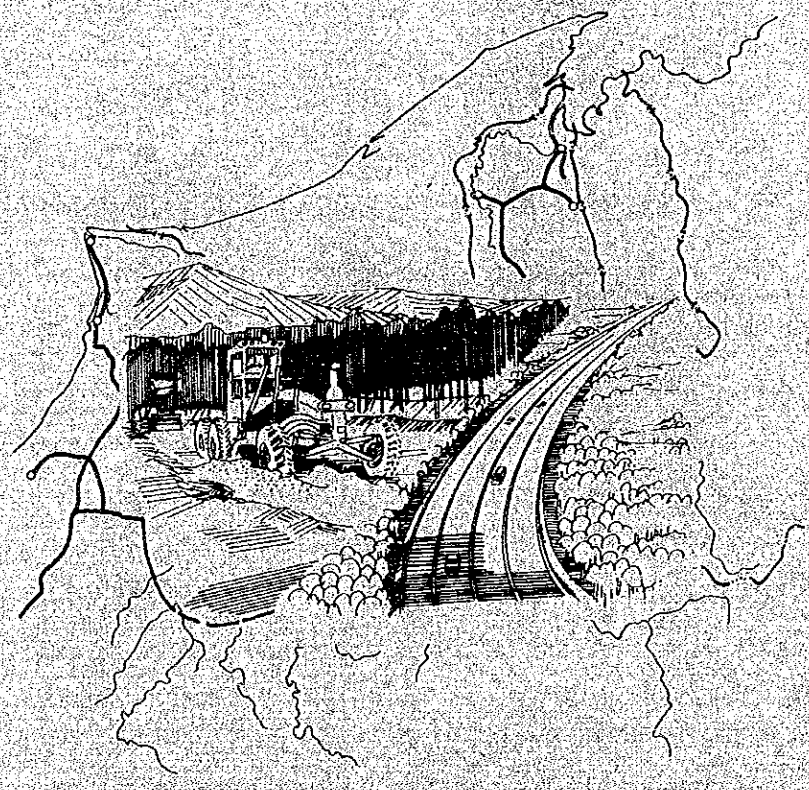
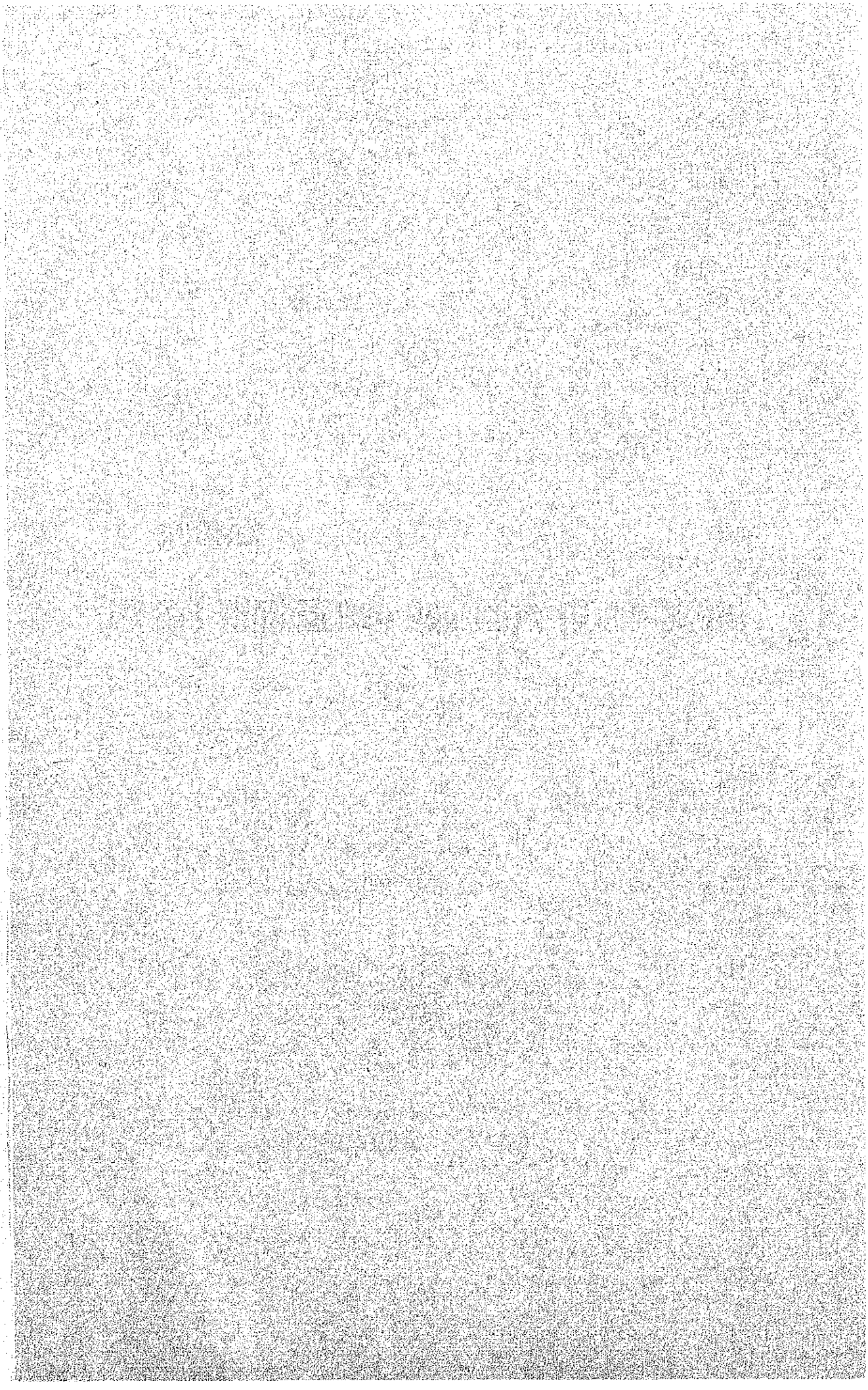
Chapter 7

IMPROVEMENT PLAN AND PRELIMINARY DESIGN





7-1 AERIAL PHOTOGRAPH SURVEY AND MAPPING

In the implementation of the feasibility study, in order to obtain the topographical conditions of the project area and level up the accuracy of the investigation, the aerial photograph surveying and its mapping were carried out along the route selected in the investigation of Phase I.

These surveying work was performed from July 13th to July 31st of 1978 in the first on-site investigation, and from August 20th to August 30th of 1978 (surveying of the ground control points) in the second on-site investigation.

The mapping work is underway in Japan.

7-1-1 Pre-Marking

Pre-marking points were installed on the selected route between Miri, Bintulu Rd., Beluru, Sg. Tinjar, Sg. Tutoh, Ng. Medamit and Limbang.

Pre-marking were performed on the existing 11 points given by the Lands and Survey Department, Sarawak and newly installed ones.

The pre-marking area was covered thickly by the toropical jungle, therefore, it required deforesting to set those new points. Fig. 7-1 shows the location of newpoints.

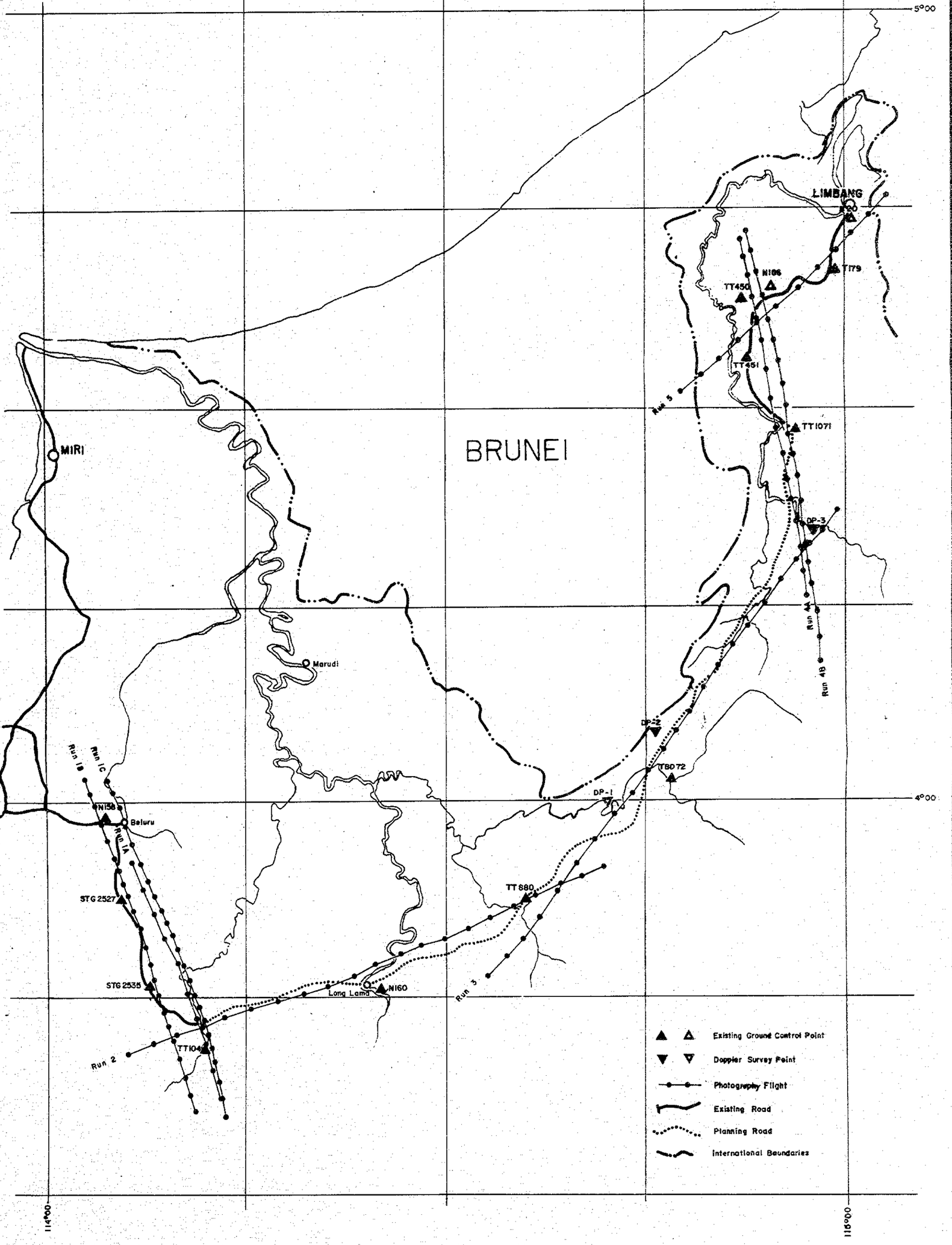
7-1-2 Aerial Photograph

Aerial photographing was performed by the plane and photographer chartered by the Lands and Survey Department, Sarawak the flying course set along the selected route during the period from September 21st to 24th of 1978.

The flying base were at Miri. The photographing was made by using super-wide-angle lens cone RC-10, in a photo scale of 1/43,500∿1/24,000 and at a flying

Fig.7-1 GROUND CONTROL POINT AND PHOTOGRAPHY FLIGHT INDEX

SCALE 1 : 500,000



altitude of 3,900m (11,700 feets) ∿ 2,100m (6,400 feets).

7-1-3 Photo Processing

The positive films were sent there from Japan, and development and positive printing were performed by using the facilities of the Department of Lands and Survey Department, Sarawak.

7-1-4 Satellite Positioning

Parallel with the installation of pre-marking, positioning was carried out on U.S. Navy Navigational Satellite System.

The location on the earth was determined by the observation of satellite using JMR-1 Doppler Survey Set.

By these observations, the coordinates of plan (X, Y) and altitude (Z) were computed in the average by the electronic computor.

7-1-5 Aerial Triangulation

Pass and wing points were printed on the positive film by the P.U.G-3 after selection of these points. Observation was made by the stereo comparators, which adjustment was done through the method of strip for block adjustment.

7-1-6 Mapping

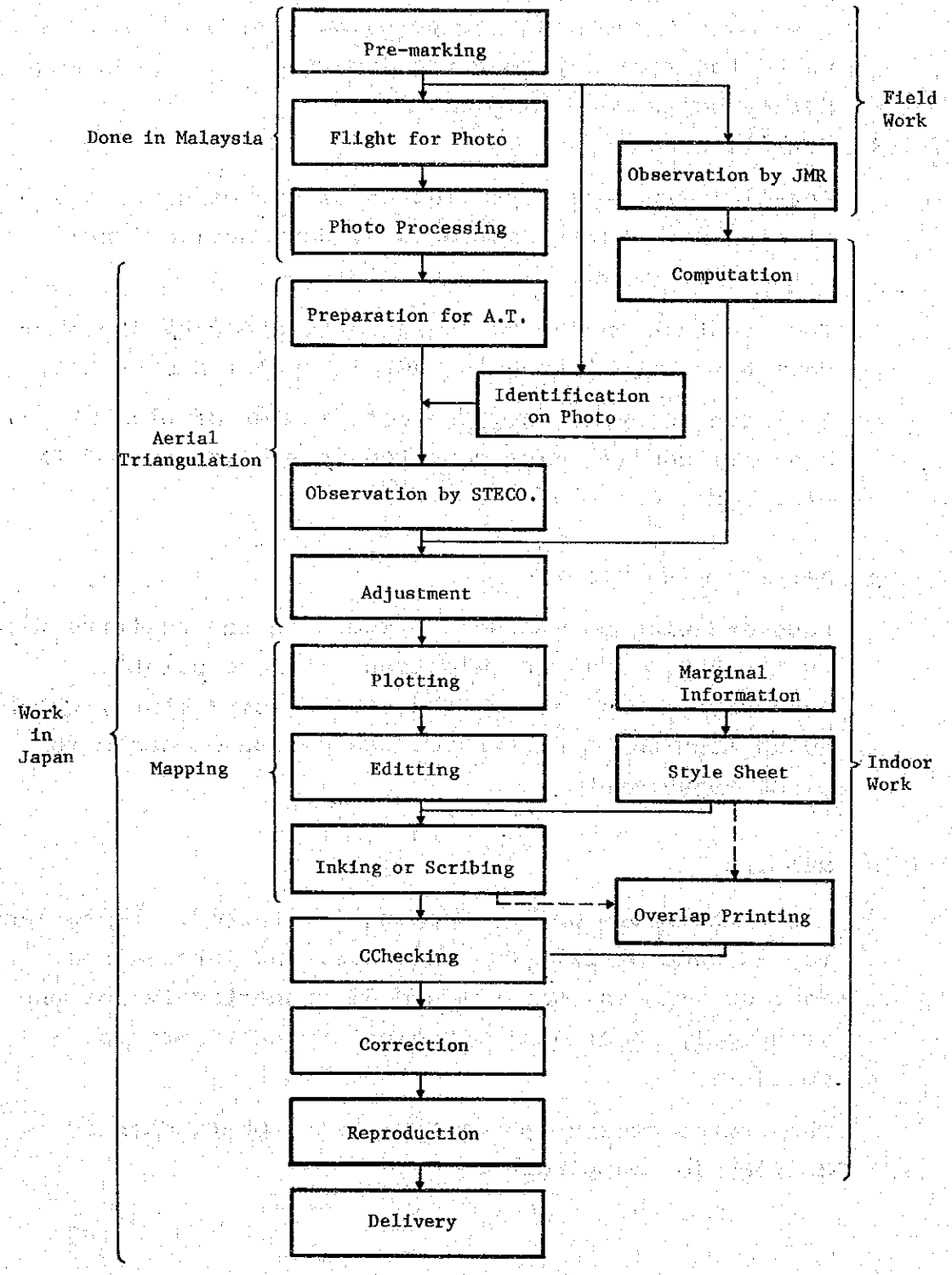
After the above works, mapping is started. Topographical map is made of 1/10,000 in scale, and intervals of contour line in 10m, 50m and 5m respectively for the principal, index and supplementary half interval contours.

The stereometorograph of Carl Zeiss Oberkochen is applied for mapping.

7-1-7 Flow Chart

The series of works are shown in the flow chart of Fig. 7-2.

Fig. 7-2 FLOW CHART



7-2 EXISTING ROAD IMPROVEMENT PLAN

7-2-1 The existing situation of the improvement sections

In the proposed trunk road construction plan, the existing road sections which will be utilized are as follows;

Section	Length km	Length mile	Standard	Pavement
Miri–Bintulu Road ∿ Beluru (Beluru Intersection)	18.0	(11.2)	Feeder	Gravel
Beluru ∿ Sg. Tinjar	35.5	(22.1)	Feeder & Trunk	Gravel
Ng. Medamit ∿ Limbang	41.0	(25.5)	Feeder	Gravel

(1) The section from the Miri-Bintulu road to Beluru was designed and construction in 1968/69 according to the feeder road standards of design criteria of P.W.D. Sarawak. It is therefore necessary to upgrade the standards for width of traffic lane, minimum curve radius, gradient, sight distance, vertical curve are to conform the standard for trunk roads.

The surface of the road is paved with a layer of crushed rocks and gravels to a depth of 10cm (3.9 in). Although there is a plan by the P.W.D. Sarawak to upgrade the criteria to meet the highest standard, there is no plan to pave the road surface with asphalt.

(2) The design of the road section from Beluru to the left bank of Sg. Tinjar was started since 1975 and at present construction works are completed with roadbed works and gravel pavement for a total length of 29km (18.0 miles) with an additional section of 4km (2.5 miles) undergoing roadbed work. The last section of 2.5km (1.6 miles) length has only been completed the grabbing works and construction works are under the NRCU. No. 10 Office. Bridges are basically designed with reinforced concrete structure and the substructures for bridges across Sg. Teman and Sg. Bakong have been contracted by the local contractors.

For the section 9.65km from the starting point, the road is designed and constructed at the criteria for feeder roads, whereas for the remaining section the criteria for trunk road are applied, due to a change of policy by the P.W.D. Sarawak during construction.

(3) The 41km (25.5 miles) road section between Ng. Medamit and Limbang was constructed before 1966 on the criteria for feeder roads so that there are sections with small curve radius, inadequate sight distance or deficient width of shoulders. The bridges, particularly are either wooden bridges or steel girder with wooden slab with a width of 3.7m (12 feet) and there is at present no plan for improvement.

Except for a section in Limbang city, the pavement is by gravel and even for the asphalt-paved section in Limbang city, the disintegration of surface and base course accompanied by damage to subgrade is noticed, due to excess fatigue of the structure.

7-2-2 Improvement Plan of the Existing Road

(1) The 18km (11.2 miles) section between Miri/Bintulu road - Beluru and 9.65km (6 miles) length from Beluru in the section between the Beluru - Sg. Tinjar was constructed of feeder road standard whereas the remaining are at trunk road standard. It is therefore necessary only to upgrade the standard of the 9.65km section, and an improvement plan is presently in the hand of the P.W.D. Sarawak. The main items for improvement are as follows:

a) Expansion of the width of roadbed and shoulder,

b) Improvement of the curve radius and reducing of vertical gradient,

c) Increase of sight distance and vertical curve radius,

d) Introduction of transition curve and super-elevation,

e) Replacement of wooden bridges by reinforced concrete bridges,

f) Improvement of surfacing, and

g) Provision of traffic signs and guardrails.

It is considered desirable that the above improvement can be implemented before the commencement of the new construction's schedule of the trunk road.

In this project, only the surfacing which are excluded in the P.W.D. Sarawak improvement program are taken up in the construction program for the trunk road, with a proposal presented for stage construction.

(2) Except for the Sg. Poyan bridge, there is at present no improvement plan by P.W.D. Sarawak for the 41km (25.6 miles) section between Ng. Medamit and Limbang. Construction of a two-lane concrete bridge is presently underway for the Sg. Poyan bridge.

Studies are therefore made to upgrade the Ng. Medamit-Limbang section to meet trunk road standard and to improve the bridges and pavement.

7-2-3 Implementation of Improvement of Existing Roads

The implementation of the improvement of the existing roads may be summarized as fóllows:

a) Upgrading of the roads from feeder road to trunk road standard

b) Replacement of gravel pavement with asphalt pavement

c) Replacement of temporary bridges to one-lane permanent bridges

d) Replacement of temporary bridges to two-lane permanent bridges

The actual improvement program will have to be finalized taking into consideration the traffic capacity and the required service level.

The improvement alternatives for the road sections are summarized as follows:

Section	Miri - Bintulu ∿ Beluru			Beluru ∿ Sg. Tinjar			Sg. Limbang ∿ Limbang		
Case	*1) Stand-ard	*2) Bridge	*3) Pave-ment	Stand-ard	Bridge	Pave-ment	Stand-ard	Bridge	Pave-ment
1	T	P D	G	T	P D	G	T	E	G
2	T	P D	G	T	P D	G	T	P S	G
3	T	P D	G	T	P D	G	T	P D	G
4	T	P D	A	T	P D	A	T	P D	A

*1) T : Upgrading to trunk road standard

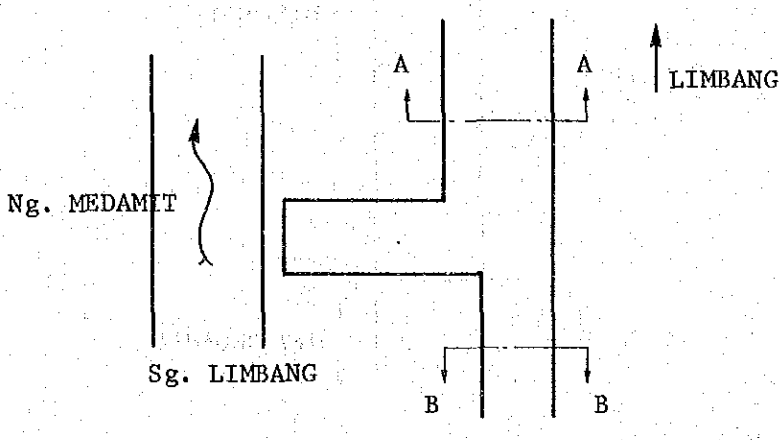
*2) P.D : Provision of two-lane permanent bridge
P.S : Provision of one-lane permanent bridge
E : Making use of existing bridge

*3) G : Gravel road
A : Asphalt-paved road

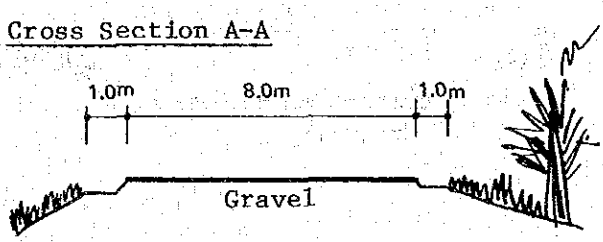
Case-1 indicates the case whereby the improvement will upgrade the whole road section to such a level as to generally meet the trunk road requirement without improvement of bridges, whereas case-4 is the case whereby the entire road section is so improved as to fully conform to the trunk road standard.

The timing of implementation of the improvement schedule is described in Chapter 9 on "Construction Plan".

Fig. 7-3 EXISTING ROAD
(Ng. MEDAMIT ∿ LIMBANG)



Cross Section A-A



Cross Section B-B

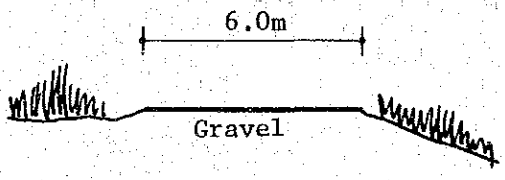
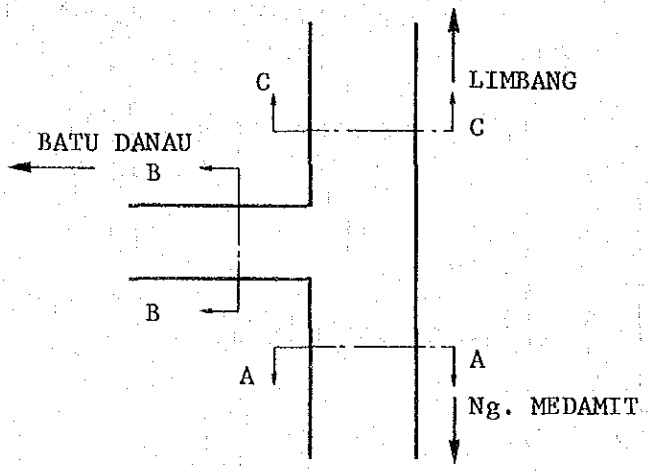
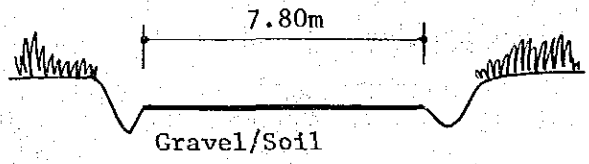


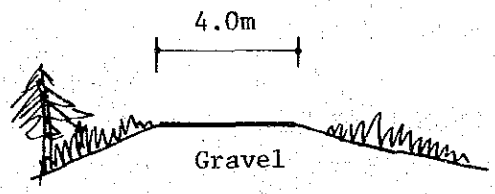
Fig. 7-4 EXISTING ROAD
(Ng. MEDAMIT ∿ LIMBANG)



Cross Section A-A



Cross Section B-B



Cross Section C-C

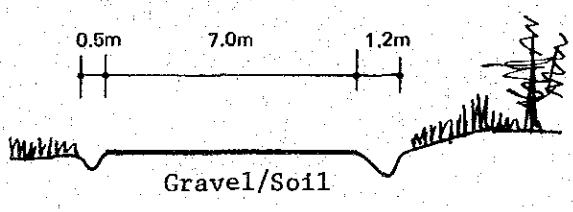
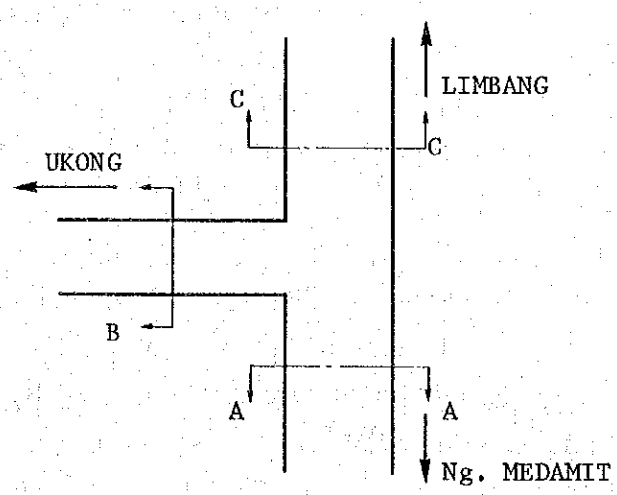
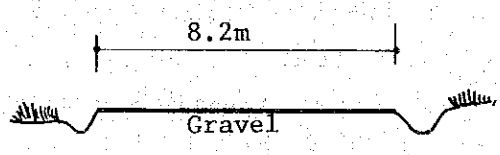


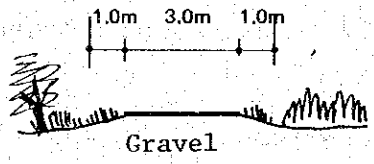
Fig. 7-5 EXISTING ROAD
(Ng. MEDAMIT ∿ LIMBANG)



Cross Section A-A



Cross Section B-B



Cross Section C-C

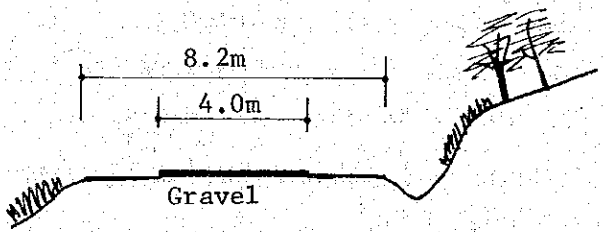


Fig. 7-6 EXISTING ROAD
(Ng. MEDAMIT ∿ LIMBANG)

END POINT OF PROJECT
J1. TARAP IN LIMBANG

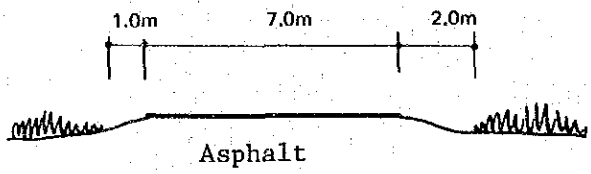
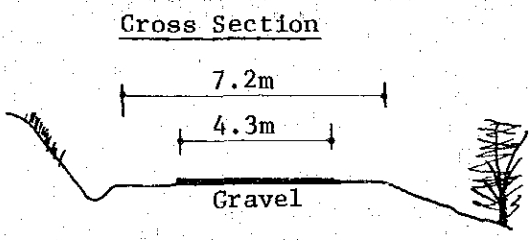


Fig. 7-7 FOREST ROAD OF LIMBANG TRADING COMPANY
(3km point from Ng. Medamit)



7-3 PRELIMINARY DESIGN

7-3-1 Route Plan

The control points selected in the determination of the route are the specific locations the route has to pass through due to techinical or social restriction.

Thus, the control points are determined taking into consideration the factors listed below, the main objective of maintaining the characteristic and importance of the road as part of the trunk road network in Sarawak, the relevant topographical, geological and other natural situation, as well as the social and economic situation. Due consideration is also given to the potential resources which are available in the study area.

Basical Guideline in Route Plan

1. To plan the road to conform to the requirements in characteristics and importance as a trunk road and to maintain the safety and comfort of the road.
2. Natural conditions: Mountain range, valleys, crossing points of lakes, and Major rivers; swampy areas, flood areas, high cut and embankment.
3. Environmental conditons: Villages, natural environmental preservation area.

The control points of the Project road are as follows:

1. The route is to connecting the crossing point of Sg. Tinjar, Long Lama and Ng. Medamit.
2. The route is to pass near the major villages.
3. Within the Mulu National Park, the route is to avoid the center of the park as much as possible from the point of environmental preservation.
4. The route will avoid traversing swampy area.

The Route is selected basing on the above control points and taking into due consideration the balance of earthworks volume, the ease in construction etc. As a result,

there is no necessity for making comparative routes except for a section that passes through the Mulu National Park. Thus, from the point of route plan, there is only route proposed.

7-3-2 Alignment Design

The alignment design is made on the 1 : 50,000 scale topographical map, taking case to maintain the road at a level required of a trunk route and to enable drawing at constant speed as far as possible. Since both the alignment and the profile are planned on 1 : 50,000 scale topographical map, the road is design at an excessive high speed in the economic and environmental aspects. In other words, the minimum curve radius was set at 1,000m (3,000 feet) and the maximum gradient in mountainous terrain was set at 6%. In the phase II study, whereby design will be proformed with the 1 : 10,000 scale topographical maps to be completed, detailed studies will be made and necessary modification will be carried out in order to achieve maximum economy of the road. The fixed points for Route alignment shown in Fig.7-8.

7-3-3 Description of Alignment

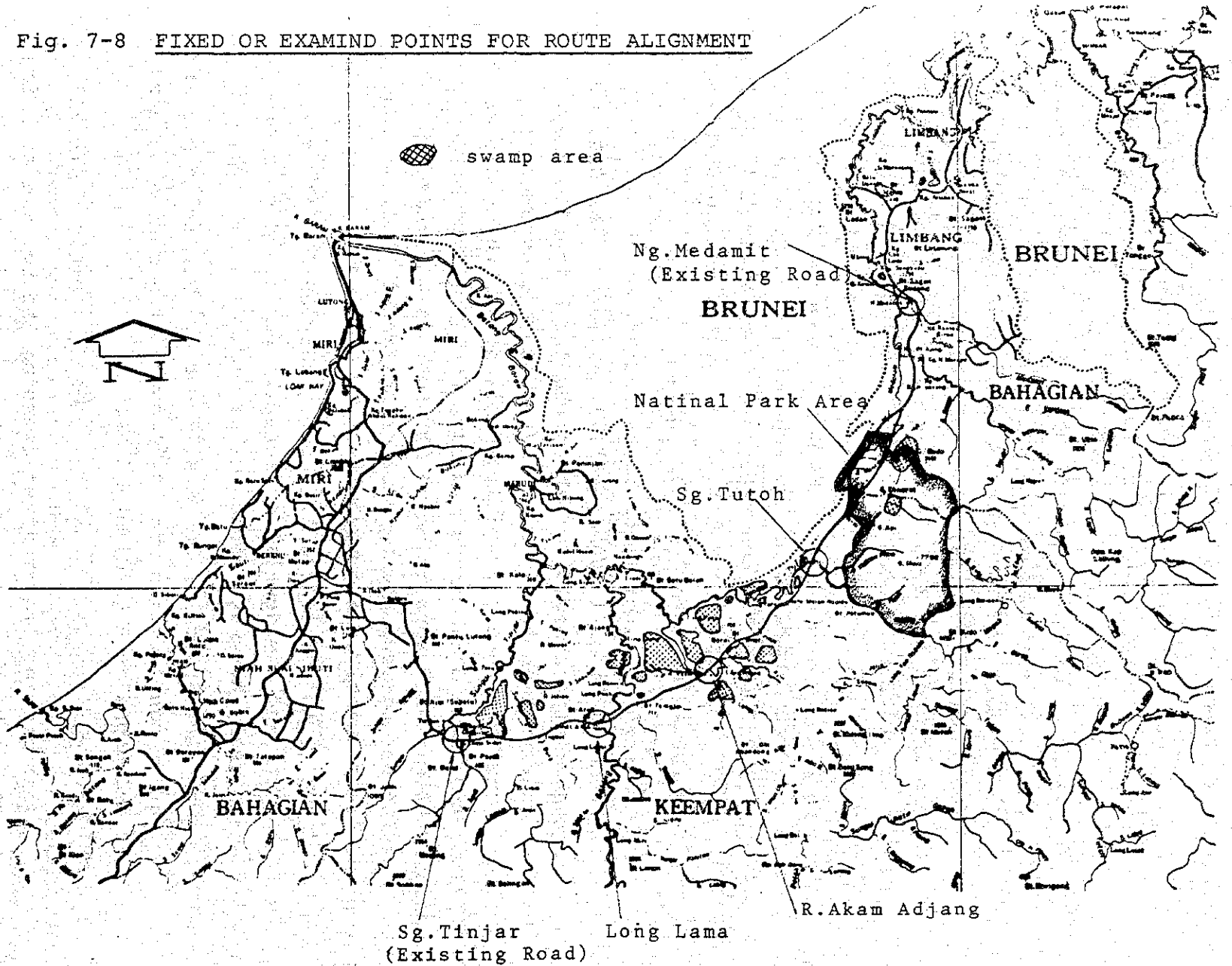
(1) Miri/Bintulu road ∿ Beluru (Beluru road) section - STA.0 ∿ STA.18

The project stands at the junction of the Miri/Bintulu road which is designated as Station 0.

The section STA.0 ∿ STA.18 is an existing gravel road constructed at feeder road standard. At the section STA.10 ∿ 15, the road is used for transport of felled timber logs form the forest along the road and the road conditions are relatively well maintained.

On the whole there are no major problems with regards to the horizontal alignment but improvement is necessary for some sections in the profile particularly for the sections with inadequate sight distance.

Fig. 7-8 FIXED OR EXAMIND POINTS FOR ROUTE ALIGNMENT



(2) Beluru ∿ Sg. Tinjar Section (Beluru - Loagan Bunut road) - STA.18 ∿ STA.54.5

At about 1km (0.6 miles) before reaching the town of Beluru, there is an intersection between the Beluru road and the Beluru - Loagan road. The project the road extends from this junction up to Sg. Tinjar. At present the road is a completed gravel road except for a 6.5km (4.0 miles) section under construction by MRCU.10. From the junction (STA.18) to a point 4.7km (2.9 miles) away are located the MRCU.10 office and its motor pool. The road crosses Sg. Teman at STA.24.5, where a steel girder bridge is presently under construction, through contract awarded to contructor. Test piling of RC pile with 40 ton drop hammer found the support stracture at a depth of 120 feet. The concrete used is by volumetric design at a proportion of 1 : 1.5 : 3, with a design strength of $\sigma 28 = 264$ kg/cm^2 (3,750 psi).

Crossing of minor river is by culvert pipes of either 800mm (36") or 1,000mm (48") in diameter. At STA.36.5 the route crosses Sg. Bakong where a bridge is under construction by adopting cast-in-site concrete piles and concrete sheet-piles. From this point, the route ascend in elevation to cross a saddle at 50m (150 feet) in elevation before reaching Sg. Bok. At Sg. Bok, a temporary assembly-type steel bridge of 36.6m in length is presently being assembled.

"Shifting cultivation" is being carried out along the route and residential communities are found scattered sparsely here and there.

The section of between STA.48 and Sg. Tinjar is presently under construction and is composed of a series of ups and downs at a gradient of 6%.

(3) Sg. Tinjar ∿ Long Lama Section - STA.0 ∿ STA.25

This section starts after crossing the Sg. Tinjar bridge. Since this is a new construction section, the station number is designated as STA.0. From Sg. Tinjar to Long

Lama, the route runs in a westerly direction. In the north, the route is located the Lake Loagan Bunut which is enclosed by swampy area, and to the south it skirts the mountain terrain. The alignment is so selected as to avoide the mountain terrain. The alignment is so selected as to avoid the hills of 50-70m (150 ∿ 210 feet) scattered in the region. At STA. 12.5 the route crosses Sg. Tru. From this point to Batang Baram, foresty roads are relatively well developed along the route, and the section from STA.17 to STA.24, the alignment runs almost parallel to the forestry road. Wet paddy fields are found near STA.21, the neighbourhood of which is left untouched to allowed further development of wet paddy in the future. The point of crossing Batang Baram is 200m (600 feet) upstream from a point where a camp of timber company is located on the left bank. The favourable physical features of the section enable the determination of the alignment without difficulties.

(4) Long Lama ∿ Sg. Apoh Section - STA.25 ∿ STA.49.3

The route passes the north of the school campas on the right bank, passing through rubber plantations to enter the hilly terrain. The alignment runs generally along Batang Baram up to Sg. Temala (STA.33.5). The original proposal calls for two alternative routes after crossing Sg. Temala but the alternative that passes Long Atip was adopted for the reason that with the distance being shortened by 10km (6.3 miles), there is ample merit in choosing the route.

The section from Sg. Temala to Sg. Apoh is a jungle belt with forestry roads crossing the alignment. The crossing of Sg. Apoh is at a point 500m (0.3 miles) towards the downstream of R. Akam Ajang.

There are no alignment problems in this section where the rolling terrain is stable in geological structure and there are no difficulties anticipated in earthworks.

(5) Sg. Apoh ∿ Sg. Tutoh Section - STA.49.3 ∿ STA.79

This section is through flat terrain with isolated hills of 200m (600 feet) in height. Since part of the flat area is swampy, care is taken to keep the alignment close to the skirt of the hills. Evidence of past floods can be observed in the section STA.65 to STA.79 near Sg. Tutoh and this portion was avoided by routing the alignment near the hill.

(6) Sg. Tutoh ∿ Sg. Medalam Section - STA.79 ∿ STA.108.5

The section STA.79 to STA.94 is an uphill section where a forestry road is presently under construction. Two alternative routes are proposed from STA.87. The alternative C runs in a curve whereas alternative B runs in a straight line to the north. The section STA.93 to STA.106 is in the Mulu National Park boundary and cares are taken to avoide excessive cuts and fills while maintain the road at the required standard, in the planning of the profile.

The details of the comparative study of routes B and C are presented in Chapter 10. A third alternative, route A, was originaly proposed to pass through the center of the National Park but this alternative was abandon due to its possible destruction of the academic value of the park.

(7) Sg. Medalam ∿ Ng. Medamit Section - STA.108.5 ∿ STA.134.2

Up to STA.121, the route passes through rolling terrain covered with thick tropical jungle. The location of the bridge was carefully investigated in view of the fact that Sg. Limbang meander very vigorously. Ng. Medamit is a town developed towards the left of Sg. Limbang. The origianl intention was to connect the main route to Ng. Medamit, but because of the physical conditions and the number of views crossing necessary, this plan was abandon but instead the selected route was made to cross Sg. Medamit, run on the forestry road and terminate at the opposite bank of Ng. Medamit.

(8) Ng. Medamit ∿ Limbang S ction - STA.0 ∿ STA.41

The termial of the existing road at the opposite bank of Ng. Medamit is designated as STA.0. The existing road is at present used for the transportation fo timber logs, the conveying supporting commodities from the camp of timber company in Ng. Medamit and the traffic of passager to Limbang. It is well maintained gravel road, but since the bridge is a singel lane wooden bridge, it is necessary to reduce the running speed at crossing the bridge. The gravel used in the road surface is mainly the sedimented river gravel fo Sg. Limbang. A portion of the road is subject to inundation during the flood period and improvement is necessary in this aspect.

7-3-4 Designing Pavement

For the design criteria of pavement, we adopt the "AASHO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURE 1972". The fundamental elements of the standard are design traffic volume, bearing strength of subbase and Life of pavement.

It is needed for the thickness and structure of the pavement to accord with those under execution or plan, and to be reflected on by the existing condition of the project area.

The results of design of pavement thickness according to the AASHO and the British Road Note 29 is shown in Table 7-3 and Table 7-4.

(1) Analysis of Traffic Volume and Design Axle load

The traffic volume of each construction section is shown in Table 7-2, so it is observed it differs much. In perticuny, the traffic volume of section between Bt. Baram and Sg. Limbang are observed very low volume.

The design axle load is assumed as below.

Design Axle Load

Item	Value
Max. Loading Capacity of a truck	6 ton (Total Weight of a Truck is 11 ton)
Total Equivalent axle load to 8.2 ton single axle load of a 6.0 ton Truck	0.4

(2) Pavement Structure

1) Layer Coefficient of Pavement Composing Materials

The Layer Coefficient is determined following to the formula of the Interim Guide of AASHO.

$$SN = a_1D_1 + a_2D_2 + a_3D_3$$

where, SN; Layer Coefficient of Pavement Composing Material

a_1, a_2, a_3; Coefficient of Retative Strength of Surface Course, Base Course and Subbase Course respectively.

D_1, D_2, D_3; Thickness of Surface Course, Base Course and Subbase Course respectively

In addition, the rate of regional modification is assumed as 1.0.

Table 7-1 LAYER COEFFICIENT OF PAVEMENT COMPOSING MATERIALS

Pavement Coposing Materials	Layer Coefficient
Surface Course	
Hot-mixed Asphalt (Plant Mix)	0.44
Penetration	0.24
Base Course	
Unscreened Crushed Stone	0.07
Crushed Stone (CBR $\geq$ 80)	0.14
Subbase Course	
Gravel with Sand	0.11
Sand or Silty Clay	0.05 - 0.10

2) Determination of Pavement Structure

An asphalt concrete pavement is constituted of subbase, base course and surface course on the subgrade in order. Each course has its specified function, for which an appropriate material shall be selected in consideration of an economical point. For the surface course a hot asphalt concrete is suitable and for the

Table 7-2 DESIGN CONDITION FOR PAVEMENT STRUCTURE

	Construction Section	Subgrade C B R	Soil Support Value	Initial Traffic	Total Accumulative 8.2t Single Axles	Equivalent 8.2t Single Axles	Structure Number
				vehicles	x 10^6	a day	
1	Miri Bintulu Rd - Beluru	3%	3.7	674	0.65	90	10.3
2	Beluru - Sg. Tinjar	3	3.7	184	0.17	23	8.3
3	Sg. Tinjar - B. Baram	3	3.7	139	0.12	17	8.0
4,5	B. Baram - Sg. Tutoh	3	3.7	97	0.07	10	7.0
6,7	Sg. Tutoh - Sg. Limbang	5	4.6	68	0.06	8	6.3
8	Sg. Limbang - Ukong	4	4.3	163	0.11	15	6.0
8	Ukong - Batu Danau	4	4.3	183	0.12	16	6.0
8	Batu Danau - Kubong	4	4.3	288	0.20	27	6.5
8	Kubong - Limbang	4	4.3	1,248	0.85	116	8.5

Table 7-3 PAVEMENT COMPOSITION DETERMINED BY AASHO STANDARD

	Construction Section	Existing Subbase Course	Subbase Course	Base Course	Surface Course	Structure Number	Required Structure Number
1	Miri Bintulu Rd - Beluru	15	10	15	10	9.3	8.8
2	Beluru - Sg. Tinjar	15	10	15	5	7.1	6.9
3	Sg. Tinjar - B. Baram	-	20	15	5	6.5	6.5
4,5	B. Baram - Sg. Tutoh	-	15	15	5	6.0	5.8
6,7	Sg. Tutoh - Sg. Limbang	-	15	15	5	6.0	5.0
8	Sg. Limbang - Ukong	15	-	15	5	6.0	6.0
8	Ukong - Batu Danau	15	-	15	5	6.0	6.0
8	Batu Danau - Kubong	15	5	15	5	6.5	6.5
8	Kubong - Limbang	15	5	15	10	8.7	8.5

Table 7-4 PAVEMENT COMPOSITION DETERMINED BY ROAD NOTE 29

Construction Section		Existing Subbase Course	Subbase Course	Base Course	Surface Course	Subgrade Design C B R	Cumulative Number of Standard Axles
1	Miri Bintulu Rd - Beluru	15	20	15	7	3	0.65^{x10^6}
2	Beluru - Sg. Tinjar	15	15	15	6	3	0.17
3	Sg. Tin - B. Baram	-	30	15	5	3	0.12
4,5	B. Baram - Sg. Tutoh	-	30	15	5	3	0.07
6,7	Sg. Tutoh - Sg. Limbang	-	20	15	5	5	0.06
8	Sg. Limbang - Ukong	15	10	15	5	4	0.11
8	Ukong - Batu Danau	15	10	15	5	4	0.12
8	Batu Danau - Kubong	15	10	15	6	4	0.20
8	Kubong - Limbang	15	10	15	7	4	0.85

subbase, from the viewpoints of site conditions, constructability and economics, it is recommendable to apply the combined aggregate in the base course and the crucker-run or unscreened gravel in the subbase course respectively.

The outline of those is summarized in followings.

a) Surface Course

The hot asphalt concrete is applied which functions to resist to wearing and shearing by traffic vehicles and serve the comfortable driving in smooth and non-slip condition, and also prevent the rain penetrating into the lower layers.

b) Base Course

The method is to spread and compact the combined aggregate of several sizes of material in a well grained distribution, which is suitable for the mechanized earth moving work.

c) Subbase Course

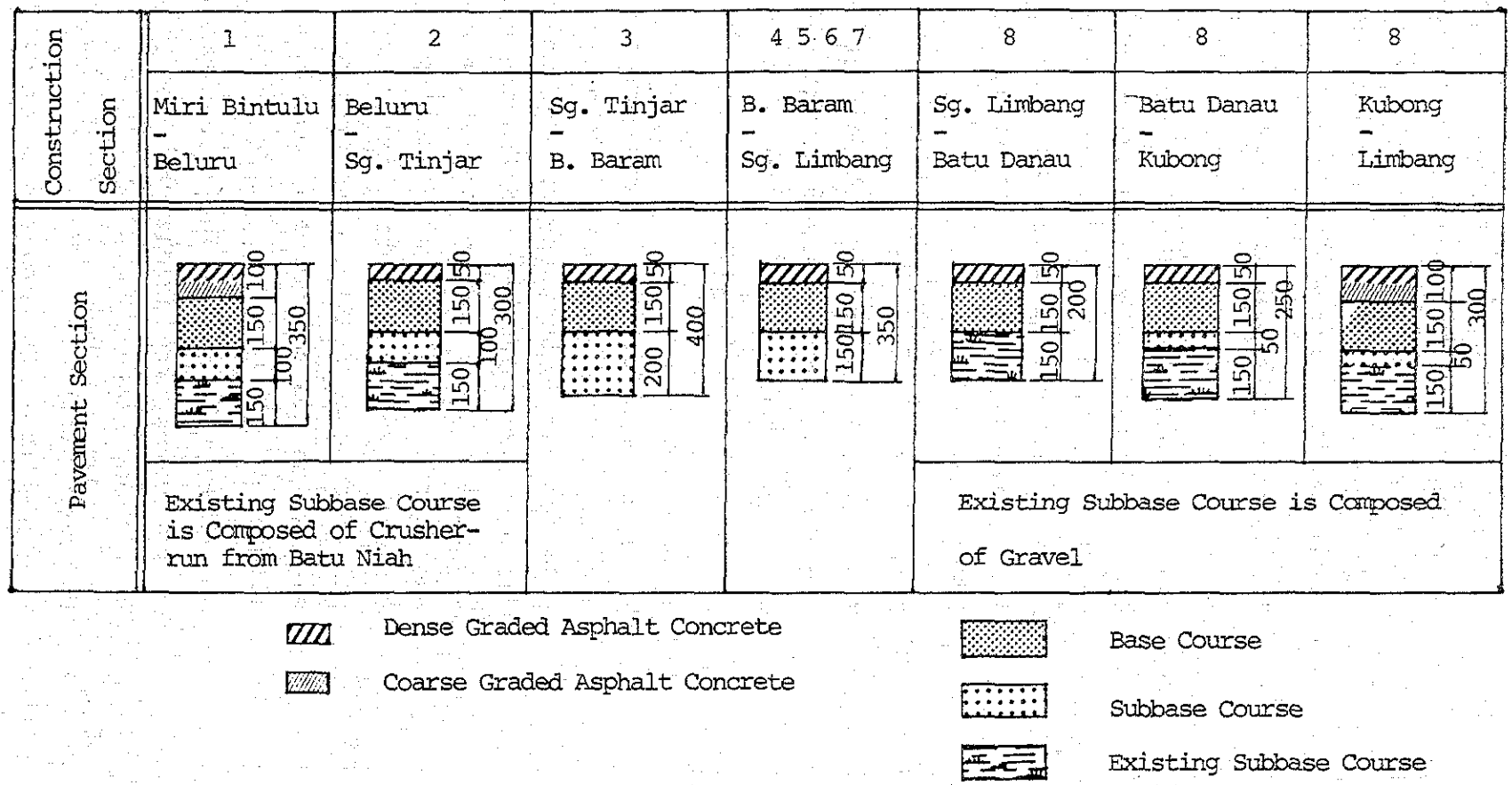
The subbase course is a layer which is executed directly on the subgrade and plays an important role to prevent both the underground water and the subgrade soil from penetrating upward into the base course, and to distribute and transmit the traffic load downward onto the subgrade surface. For the material it is common to use the unscreened gravel, crucher-run, slag or sand which are economically obtained around the site.

According to the site investigation, we propose to use mainly the crucher-run and partially the unscreened gravel.

d) Pavement Structure

Fig. 7-9 shows the cross section of structure provided that its life is 20 years.

Fig. 7-9 PAVEMENT SECTION DESIGNED BY AASHO STANDARD



The review will be carried out on the economic comparison of stage construction in Phase II that its life is to be 10 years on the initial stage and to be overlaid after the 10 years.

7-3-5 Desing of Main Structure

At the present stage, design of main structure (including drainage structure) is limitted in a level to estimate the construction cost for economic review. The detailed design will be followed in Phase II stage.

The estimate of construction cost is made on the appropriate type, and size of structures which are based on the designs and informations of the past constructed structures of similar nature.

According to the site conditions, the following 3 types are selected for the design of bridge.

1) Short span of bridge (span length is less than 20m)

   The superstructure: RC beam

   The substructure : Inverse T typed abutment and footing with RC piles

2) Middle spancy of bridge (span length is less than 60m)

   The superstructure: RC beam or composite steel girder

   The substructure : high, inverse T typed abutment with RC piles

3) Long spancy of bridge (span length is more than 60m)

   The superstructure: Ranger type

   The substructure : high, inverse T typed abutment with RC piles

As for the superstructure, in particular, in determining the span division, should be taken

into account the states of flow, topographical situation at river crossing point and the existence of raft navigation.

With respect to the substructure, the final determination will be brought on the type and other dimensions according to the investigation results of Phase II.

It is not allowed to locate the substructures in the river Batang Baram, Sg. Apoh, Sg. Tutoh and Sg. Limbang with rafts navigation as above mentioned therefore, the longerspan of bridge shall be designed.

The tipe and dimension of the drainage structure is proposed as follows according to the site investigation.

Box culvert (RC)

2^m x 2^m (6.6 feets x 6.6 feets)
2^m x 3^m (6.6 feets x 9.8 feets)
3^m x 3^m (6.6 feets x 9.8 feets)

Pipe culvert (RC)

$\phi 1.0^m$ (3.3 feets)
$\phi 1.5^m$ (4.9 feets)

The design load and other conditions are to meet with the criteria of the P.W.D. Sarawak but the conditions which are not stipulated therein are to conform to those of British standards or AASHO standard.

Table 7-5 LIST OF MAJOR BRIDGE (New Construction Section)

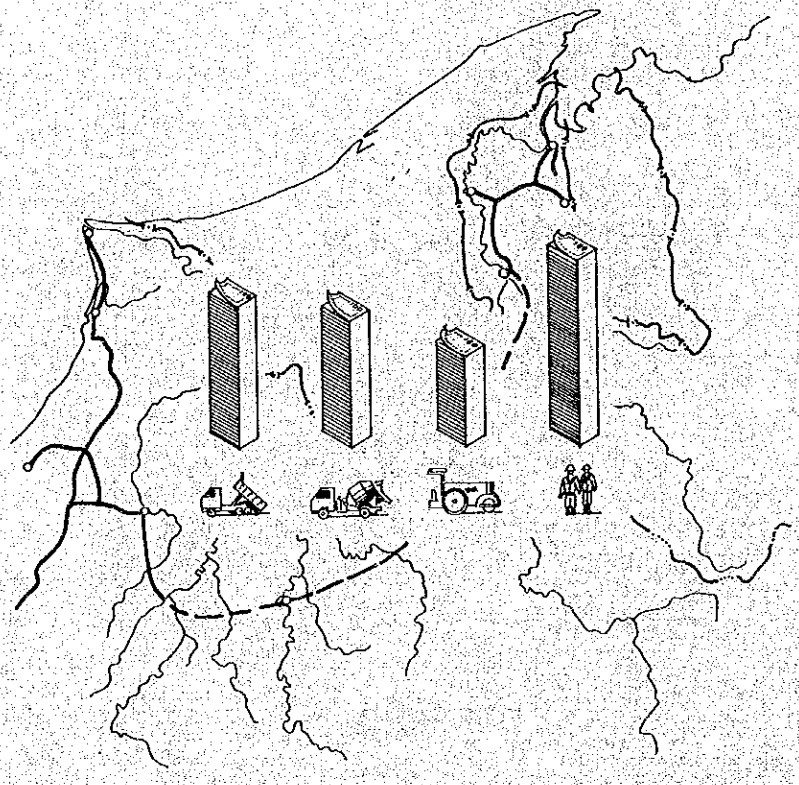
Name	Station	Type	Bridge Length
Sg. Tru	12 + 500	R.C.	60m (3 @ 20m)
Batang Baram	24 + 800	Steel C. Langer Truss.	300 (30 + 150 + 4 @ 30)
Sg. Temala	33 + 600	R.C., Steel C.	90 (20 + 50 + 20)
Sg. Apoh	49 + 200	P.C.	90 (3 @ 30)
Sg. Terawan	60 + 100	R.C.	40 (10 + 20 + 10)
Sg. Tutoh	79 + 000	Steel C.	110 (30 + 50 + 30)
Sg. Mentawai	99 + 200	R.C.	40 (10 + 20 + 10)
Sg. Medalam	108 + 200	R.C.	40 (10 + 20 + 10)
Sg. Limbang	121 + 800	Steel C.	120 (30 + 60 + 30)
Sg. Medamit	129 + 500	R.C., Steel C.	60 (15 + 30 + 15)
Sg. Saliban	132 + 800	R.C.	50 (15 + 20 + 15)

(IMPROVEMENT SECTION)

Name	Station (from Ng. Medamit)		
Sg. Lubang	1 + 900	R.C.	15 m
Sg. Polub Merah	7 + 000	R.C.	15
Sg. Mengari	12 + 400	R.C.	15
Sg. Palas	18 + 800	R.C.	10
Sg. Berleras	22 + 000	R.C.	10
Sg. Lubai	23 + 300	R.C.	40 (10 + 20 + 10)
Sg. Melaban	25 + 300	R.C.	20
Sg. Bakol	27 + 800	R.C.	20
Sg. Brangas	28 + 500	R.C.	15
Sg. Berawan	30 + 400	R.C.	20
Sg. China	34 + 800	R.C.	15

Chapter 8

CONSTRUCTION COST ESTIMATES



8-1 STANDARD FOR ESTIMATE OF CONSTRUCTION COST

8-1-1 Description

a) Currency is to be shown by Malaysian Dollar (M$).

b) US$1.0 is to be equivalent to M$2.25.

c) Equipments, materials and labour costs are the present value of July of 1978.

d) Construction cost is to be classified into the foreign and domestic currencies.

e) Treatment of tariff and tax component is to be at disretion of Malaysia.

f) Inflation factor is to be not taken into account in the economic evaluation.

8-1-2 Portion of Foreign Currency

a) Costs of improted machinery (CIF price), and materials such as steel product, asphalt, etc.

b) A part of final engineering and supervision cost.

c) A part of overhead, prefit and contingency.

8-1-3 Portion of Domestic Currency

a) Domestic products such as cement, round steel bar, etc.

b) A part of final engineering and supervision cost.

c) Labour cost and transportation cost.

d) Cost of land acquisition and compensation.

8-2 ESTIMATE OF CONSTRUCTION COST

3-2-1 Unit Price of Labourer

Table 8-1 shows the unit prices of labourer by work items obtained through the site investigation of Phase I. They are given by the office of M.R.C.U. 10 of 4th Division. The rate of income tax is around 5%.

8-2-2 Unit Price of Material

The costs of main material required for the construction is obtained in Miri and Limbang, in July of 1978, through the site investigation of Phase I. Table 8-2 shows those unit prices.

The research for the domestic and foreign portions of the prices and the tax rate of marcket prices will be carried out in Phase II.

8-2-3 Equipment Cost

Since the proposed project consists of large scale of earth moving works, the cost of equipment and plant accounts for the large percentage of the whole construction costs. Therefore, the sufficient examination shall be carried out on the selection of equipment and plants.

The estimate of equipment cost of this time is made on a condition that the equipment and plants are imported ones. In this case, the cost will be higher, but shall be deemed appropriate in consideration of the holding numbers of equipemnt of P.W.D. Sarawak.

There are another arrangements, that is, the use of equipment of P.W.D. Sarawak and the lease of them from the Singapore lease companies. Those arrangements of eqipment will be studied in Phase II. Table 8-3 shows the example of computation of hourly costs and operation cost of equipment. The purchase price for the estimate of equipment cost is on the basis of CIF miri.

Table 8-4, 5 shows also the CIF Miri prices, domestic currency portions and taxes. The constant figures and rates for the computation of equipment cost are derived from the following materials.

The life: M.S.A Contribution, January 1st, 1976.
The rate of maintenances and repairs cost: The Table of Japan construction equipment use cost, 1978.

8-2-4 Number of Workable Days

The estimate of workable days number is based on the rainfall data during the past 4 years in Long Lama, the central part of the project area.

Table 8-6 shows the number of rainy days with a rainfall more than 50mm/hr. We deem the one and a half days following to such a rainy day as unworkable and estimate the number of annal workable day is 260 in consideration of numbers of high days and holidays.

The number of annual workable days for earth works is assumed as 180 ∿ 200, taking into account the kind of equipment, schedule, constructional condition, etc.

8-2-5 Selection of equipment by work item and daily production rate Table 8-7 shows the attempt of combination of equipment and daily production rates by work items. In Phase I, the soil, geographical and site conditions are not fully obtained, so further investigation for them will be needed for the estimate in Phase II.

8-2-6 Unit Cost of Item

Table 8-8 shows the unit cost of work item on the basis of the combination of equipment assumed in the previous section.

8-2-7 Total Construction Cost

Table 8-9 shows the Total construction cost of project.

Table 8-1 LABOUR COST

unit: M$

	Wage per Day (A)	Tax (A)x0.05	(A) - (B)
Foreman	23.19	1.16	22.03
Driver	14.76	0.74	14.02
Operator	15.91	0.80	15.11
Carpenter	18.21	0.91	17.30
Assistant Operator	10.93	0.55	10.38
Earth Worker	10.93	0.55	10.38
Skilled Labour	23.19	1.16	22.03
Reinforce Worker	21.73	1.09	20.64
Scaffolding Man	18.07	0.9	17.17
Mechanic	16.49	0.82	15.67

Source: MRCU-10

Table 8-2 COST OF MATERIALS

at Miri Limbang

Materials	Describe	Unit	Market Price (M$)	
Portland Cement		ton	180	
Asphalt 80-100		ton	412.63	
Asphalt Emulsion	Cut back	ton	527.88	
Round Bar 1/4"-1.1/4"		ton	850	
Concrete Pipe ø900	L = 3' include of collar	1 set	78	Nam Aik Cement Factory
Corrugated Pipe ø900		ft	66	
Gravel	PWD Limbang	yd^3	11.9	
Crusher-run	MRCU-10	yd^3	6.0 - 7.0	
Sand for Concrete	MRCU-10	yd^3	25	Kiong Hing Construction
Crushed Stone		yd^3	25	
Gasoline	Regular	gal	2.90	MRCU-10
Diesel	PWD Miri	gal	1.42	
Heavy Oil	PWD Limbang Rotolla-30	gal	6.66	
Board	4' x 8' x 0.5"	piece	23	
Rectangular Timber	1" x 6" x 12' 1" x 8" x 12' 1" x 2" x 12'	ton	450	
Wood Log	ø6" x 30'	ton	8 - 10	
Brick		piece	0.15 - 0.18	
Explosive	Gelemite	lbs	207	

Table 8-3 HOURLY EQUIPMENT OWNERSHIP AND OPERATION COST

(ECONOMIC)

Equipment: Bulldozer D7G

Item		Calculation	Number	Unit
I.	General Data			
	A. Type of Fuel	Diesel		
	B. Fuel Consumption		6.2	GAL/Hr
	C. Fuel Cost		1.57	M$
	D. Economic Life		8,000	Hours
	E. Economic Life		8	Years
II.	Acquisition Costs			
	F. Total Cost CIF		271,383	M$
	G. Cost of Tires		-	
	H. Total Cost Less Tires	F - G	271,383	M$
III.	Hourly Ownership Costs			
	I. Depreciation	H/D	33.92	M$
	J. Major Repairs and Overhaul	$\frac{1.1 \times 271,383}{D}$	37.32	M$
	K. Interest	$\frac{0.1 \times 271,383 \times 0.5625}{D/E}$	15.27	M$
	L. Hourly Ownership Cost (Economic)	I + J + K	86.51	M$
			E = 0.22314%	
IV.	Hourly Operation Costs			
	M. Cost of Fuels	6.2 x 1.57	9.73	M$
	N. Cost of Lubricants and Filters	M x 0.2	1.95	M$
	O. Cost of Tires:			
	a - Depreciation	-		
	b - Repairs	-		
	P. Operation Cost	M + N + O	11.68	M$
V.	TOTAL ECONOMIC COST	L + P	98.19	M$

Table 8-4 ACQUISITION COST OF EQUIPMENT - (1)

Equipment	C.I.F. Price	Local Component	Import Duty and Taxes	Total	Daily Rate As % of Cost
1. Bulldozer D 155 A	350,000	59,204	35,875	445,079	E = 0.22312
2. Bulldozer D 155 A with Ripper	422,408	73,010	43,297	533,715	E = 0.22312
3. Bulldozer D 8K	407,075	68,500	41,725	517,300	E = 0.22311
4. Bulldozer D 7G	271,383	46,400	27,817	345,600	E = 0.22314
5. Scraper 627B Struck 10.7m^3	574,694	95,800	58,906	729,400	E = 0.18739
6. Motor Grader 140G	223,492	38,600	22,908	285,000	E = 0.20126
7. Excavator (Back-hoe) 0.6m^3	153,972	27,277	15,782	197,631	E = 0.227451
8. Truck Loader 955L 1.6m^3	167,619	29,500	17,181	214,300	E = 0.20997
9. Truck Loader 977L 2.1m^3	263,401	45,100	26,999	335,500	E = 0.20994
10. Tired Roller 8 - 20 ton	77,424	14,810	7,936	100,170	E = 0.1866
11. Macadam Roller 10 - 12 ton	70,240	13,640	7,200	91,080	E = 0.18656
12. Dump Truck 8 ton	57,992	19,411	63,936	141,339	E = 0.21002
13. Dump Truck 11 ton	80,123	25,979	88,336	194,438	E = 0.20129
14. Flat-Bed-Truck 4 ton	33,083	15,676	62,858	137,547	E = 0.2101
15. Water Tanker 6000 L	65,816	12,920	6,746	85,482	E = 0.20994
16. Asphalt Plant 75 ton/hr	1,530,000	257,190	156,825	1,944,015	E = 0.2333
17. Asphalt Finisher 4.5m	155,392	27,508	15,928	198,828	E = 0.16099
18. Asphalt Sprayer 30 L/min	4,337	1,263	499	6,099	E = 0.28339
19. Generator 60KVA	25,855	6,411	2,650	34,916	E = 0.15161

Table 8-5 ACQUISITION COST OF EQUIPMENT - (2)

Equipment	C.I.F. Price	Local Component	Import Duty and Taxes	Total	Daily Rate As % of Cost
20. Generator 100KVA	37,938	8,378	3,887	50,203	E = 0.15185
21. Generator 180KVA	66,249	12,990	6,791	86,030	E = 0.151624
22. Generator 250KVA	112,129	20,463	11,493	144,085	E = 0.15263
23. Air Compressor 10m^3/min	75,350	14,772	7,723	97,845	E = 0.19685
24. Concrete Mixer 0.5m^3	29,566	7,015	3,031	39,612	E = 0.31488
25. Concrete Vibrator	2,004	301	205	2,510	E = 0.3238
26. Crushing Plant 100 ton/hr	1,600,000	268,590	164,000	2,032,590	E = 0.10966
27. Crushing Plant 150 ton/hr	2,400,000	398,886	246,000	3,044,886	E = 0.10966
28. Truck Crane 10 ton	140,896	25,147	14,442	193,213	E = 0.1551
29. Wheel Loader 950 1.6m^3	183,583	32,100	18,817	234,500	E = 0.21001
30. Power Shovel 1.2m^3	191,808	33,440	19,660	244,908	E = 0.22743
31. Under Water Pump 1.0m^3/min	2,725	719	279	3,723	E = 0.33137
32. Bar Bender max 25mm	2,820	734	289	3,843	E = 0.32393
33. Bar Cutter max 29mm	2,171	628	223	3,022	E = 0.32404
34. Hand Drill 3.1m^3/min	1,211	124	182	1,517	E = 0.12469
35 Crawler Drill	57,508	11,406	5,895	74,809	E = 0.19687

Table 8-6 RAINFALL DAYS MORE THAN 50MM PER DAY FROM 1971 TO 1974 AT LONG LAMA

Rainfall more 50mm / Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jly.	Aug.	Sept.	Oct.	Nov.	Dec.	
													Days
1971	1	3	1	2	8	1	1	6	1	3	4	6	37
1972	-	0	0	2	0	1	0	0	1	3	-	-	7
1973	-	1	2	1	5	0	-	-	-	-	-	-	9
1974	2	5	0	3	1	3	3	-	-	-	-	-	17
Total													70
Average of 4 years													18

Source; Hydrogical Year Book, 1971-1974

Table 8-7 ECONOMIC LIFE AND REPAIR COEFFICIENT OF MECHANICAL EQUIPMENT

Mechanical Equipment	Economic		Repair Coefficient
	Years	Hours	
Bulldozer	8	8,000	1.1
Dump Truck	5	7,000	0.8
Tractor Loader	8	8,000	0.95
Motor Scraper	8	8,000	0.9
Power Shovel	8	8,000	1.15
Excavator (Back hoe)	8	8,000	1.15
Drag Line	8	8,000	1.0
Clam Shell	8	8,000	1.0
Flat-Bed-Truck	5	7,000	0.7
Truck Crane	8	8,800	0.5
Crawler Crane	8	8,800	0.85
Tired Roller	10	9,000	0.85
Macadam Roller	10	9,000	0.85
Asphalt Finisher	8	10,000	0.85
Motor Grader	8	8,000	0.85
Asphalt Plant	10	7,200	0.85
Concrete Mixer	10	5,000	0.7
Asphalt Sprayer	8	4,800	0.5
Asphalt Distributor	8	7,200	0.6
Concrete Vibrator	10	4,000	0.3
Crushing Plant	10	15,000	0.8
Bar Cutter	10	4,000	0.3
Bar Bender	10	4,000	0.3
Generator	10	9,000	0.4
Water Tanker	5	7,000	0.8
Pump	10	6,000	1.3
Batcher Plant	10	8,000	0.8
Arc Welder	10	6,000	0.8
Air Compressor	10	8,000	0.7
Concrete Pump Car	6	6,000	1.1
Diesel Pile Hammer	10	9,000	1.0
Vibro Pile Driver	10	9,000	1.0
Wheel Loader	8	8,000	0.95
Crawler Drill	10	8,000	0.70

* M.S.A. Contribution (Effective on 1st January, 1976)

* The table used for estimating hire of construction equipment 1978 Mar. 3rd, published by Japan Construction Equipment Association.

Table 8-8 CONSTRUCTION ITEMS AND ECONOMIC UNIT COST

Construction Items		Unit	Output per day	Unit Cost M$
1. Clearing & Grubbing				
i. Forest area		m^2	350	4.84
ii. Cultivated area		m^2	1,000	0.75
iii. Rubber Plantation		m^2	500	3.30
2. Excavation & Filling				
i. Cut Soil		m^3		5.00
Soft Rock		"	600	7.50
Hard Rock		"	110	59.50
ii. Borrow for Fill (1.0km)		"	500	7.59
iii. Removal of Top Soil		"	400	2.86
3. Drainage Structure				
i. Box Culvert	2.0 x 2.0	m		185.00
"	3.0 x 2.0	"		235.00
"	3.0 x 3.0	"		317.00
ii. Pipe Culvert	ϕ 900	"		109.90
	ϕ1,500	"		200.15
4. Bridge				
i. Short Span		m^2		1,940.00
ii. Middle Span		m^2		2,195.00
iii. Long Span		m^2		2,262.00
5. Pavement				
i. Sub-grade Preparation		m^2	3,200	0.41
ii. Sub-base Course		m^2	200	44.31
iii. Base Course		m^3	200	46.43
iv. Bituminus Prim-coat		m^2	7,800	0.66
v. Bituminus Surface Course		m^2	2,800	13.85
6. Guard Rail		m		66.00
7. Marking		m		1.20
8. Traffic Sign				
i. Traffic Sign		Piece		560.00
ii. Mailage Post		"		91.00
9. Concrete				
i. Class A.		m^3	30	143.59
ii. Class B.		"	30	137.04
iii. Class C.		"	30	122.06
10. Reinforced Bar		tan		999.24
11. Form Work				
i. Steel Form		m^2	100	28.24
ii. Wooden Form		m^2	90	14.95
12. Staging with Wood Log		m^3	100	3.60

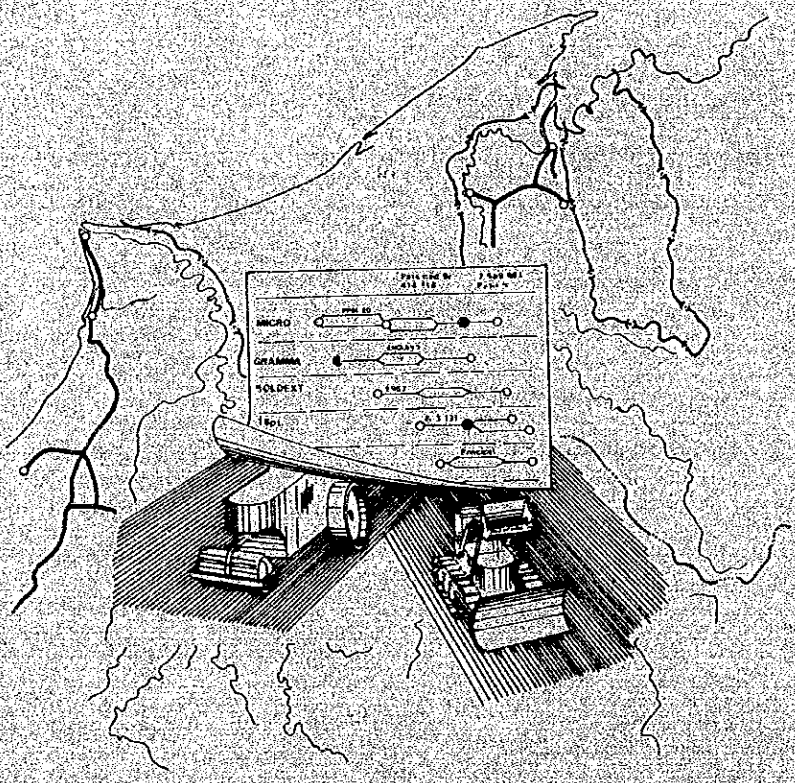
Table 8-9 SUMMARY OF CONSTRUCTION COST

UNIT: 1,000 M$

Items	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Total
I. CONSTRUCTION COST (a)	2,830	5,581	26,050	24,938	25,060	17,487	19,319	10,198	131,463
i. Clearing & Grubbing	-	-	2,032	2,291	3,088	2,599	1,399	-	11,409
ii. Excavation & Filling	-	-	4,830	9,202	7,464	1,650	3,836	-	26,982
iii. Drainage Structure	-	-	250	250	307	307	263	-	1,377
iv. Bridge	-	-	11,540	5,839	5,259	5,259	7,308	3,753	38,958
v. Pavement	2,830	5,581	6,438	6,259	7,647	6,640	5,785	6,445	47,625
vi. Guard Rail	-	-	898	1,306	1,221	967	664	-	4,786
vii. Marking	-	-	60	59	72	63	62	-	316
viii. Traffic Sign	-	-	2	2	2	2	2	-	10
II. CONTINGENCIES (b) (a x 10%)	283	558	2,605	2,494	2,506	1,749	1,932	1,020	13,147
III. SURVEY & ADMINISTRATION FEE (c) [(a+b) x 10%]	312	614	2,866	2,743	2,757	1,924	2,125	1,122	14,463
IV. TOTAL COST (a + b + c)	3,425	6,753	31,521	30,175	30,323	21,160	23,376	12,340	159,073
(Cost of Per km)	(190.3)	(190.3)	(1,260.8)	(1,241.8)	(1,021.0)	(717.3)	(909.6)	(301.0)	

Chapter 9

CONSTRUCTION SCHEDULE



9-1 ORGANIZATION OF ROAD CONSTRUCTION IN SARAWAK

9-1-1 Sarawak Public Work Department (P.W.D.)

The administration and management of public works including road construcitons are carried out by the P.W.D.

In the P.W.D., the road constructions are handled by the Division of Roads and Airports, which are controlled by either construction system of by the contract system of that M.R.C.U. constructed the whole works and managed the construction with contractors by the tender contracts.

The P.W.D. has 5 Divisional offices as its subordinate and in which the sections of roads and airports are organized.

The road construction is executed by M.R.C.U. under the control of the Divisional Office. Fig. 9-1 shows the organization chart of the Division of roads and airports of the P.W.D. Sarawak.

9-1-2 Divisional Office

5 Divisional Offices administrated by the Divisional Enginner of which under the control of P.W.D. Sarawak.

The Divisional Engineer manages all public works of the division, and also the works by M.R.C.U. which will be established at the time of the road construction.

The Divisional Offices are established in Kuching (The First Div.), simanggang (The Second Div.), Sibu (The Third, Sixth and Seventh Div.), Miri (The Fourth Div.) and Limbang (The Fifth Div.). The said trunk road is proposed within the Fourth and Fifth Divisions.

The organization of Divisional Office is shown as in Fig. 9-2.

9-1-3 M.R.C.U. (Mechanical Road Construction Unit)

M.R.C.U. is a execution unit controlled by the relevant Divisional Office, and manages construction or improvement of roads, which organization is shown in Fig. 9-3.

Fig. 9-1 ORGANIZATION CHART OF ROADS & AIRFIELDS BRANCH OF PUBLIC WORKS DEPARTMENT (P.W.D.) SARAWAK

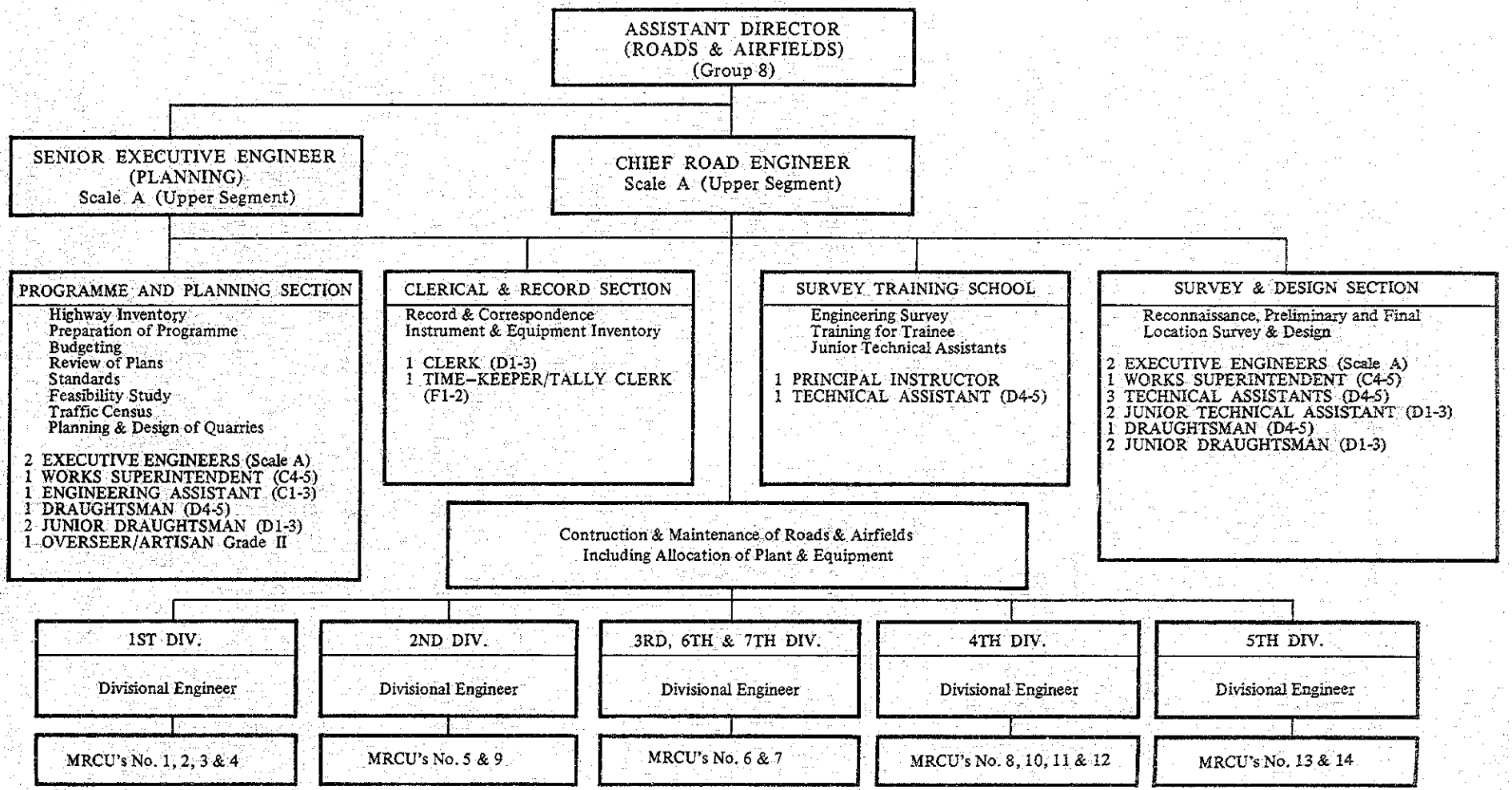
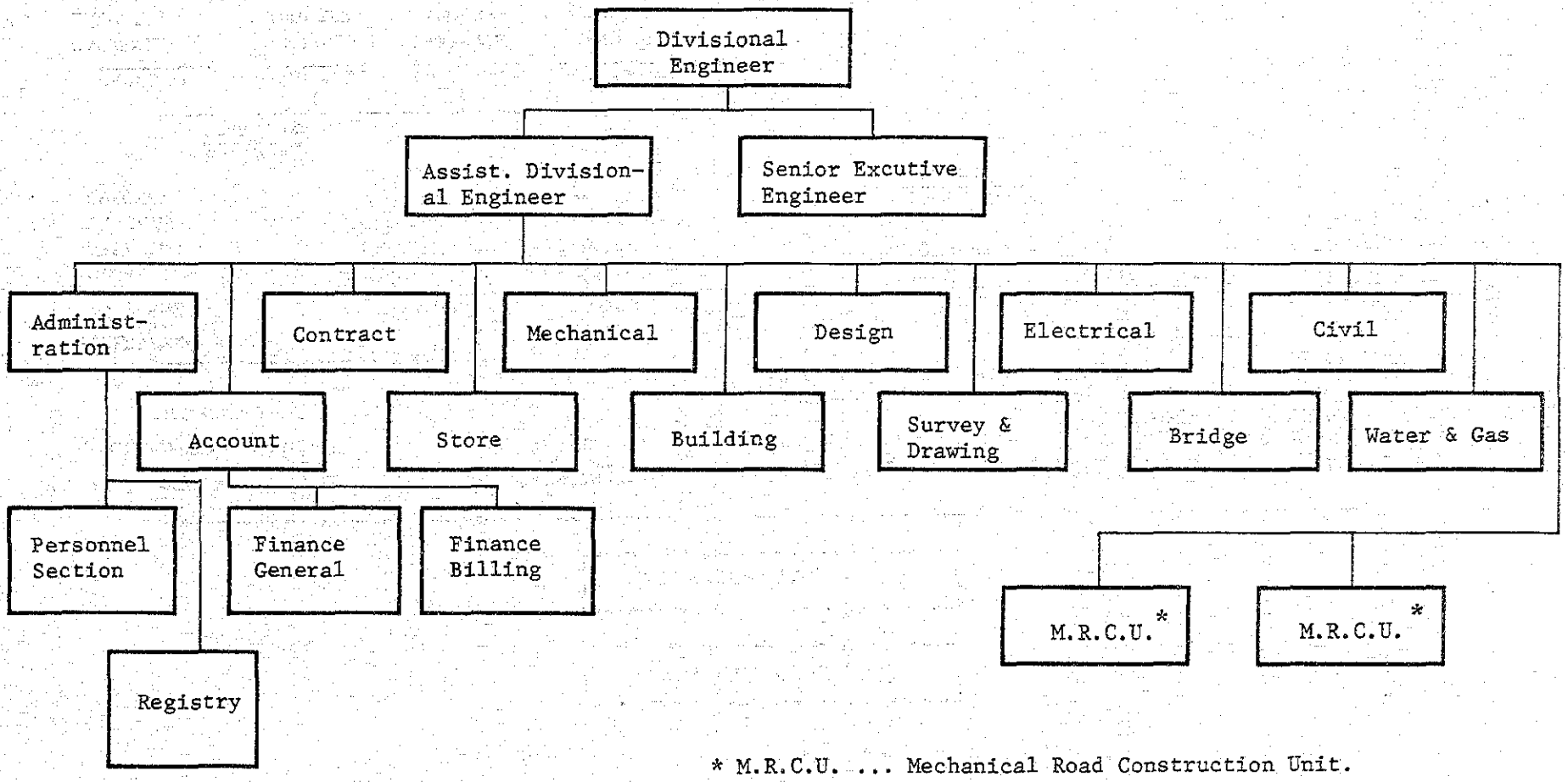


Fig. 9-2 ORGANIZATION OF DIVISIONAL OFFICE



* M.R.C.U. ... Mechanical Road Construction Unit.

Fig. 9-3 TYPICAL ORGANIZATION FOR MECHANICAL ROAD CONSTRUCTION UNIT (M.R.C.U.)