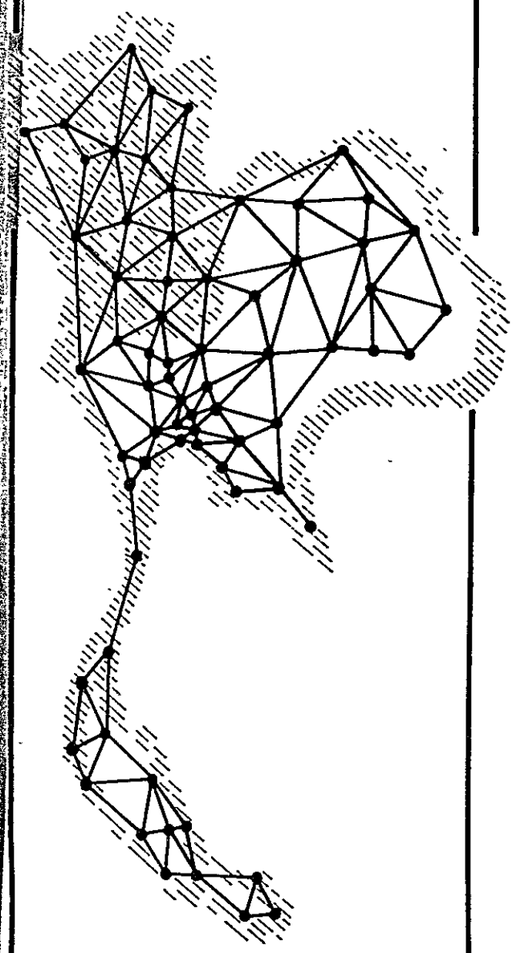
THE KINGDOM OF THAILAND
MINISTRY OF COMMUNICATIONS
DEPARTMENT OF HIGHWAYS

# ROAD DEVELOPMENT STUDY IN THE NORTHERN REGION



## PHASE 2
## FEASIBILITY STUDY

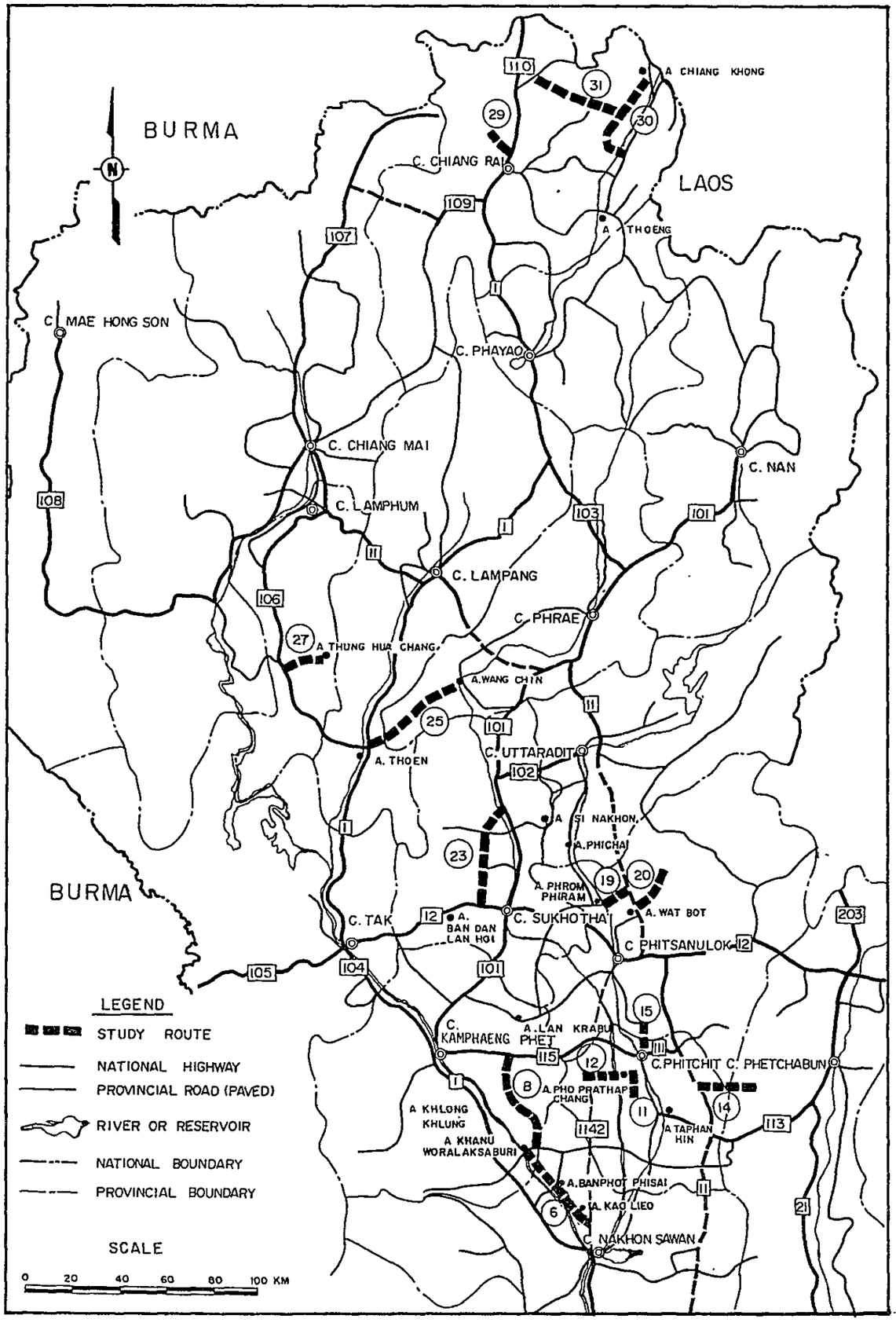
## FINAL REPORT
## VOLUME 2 ROUTE REPORT

MARCH 1982

JAPAN INTERNATIONAL
COOPERATION AGENCY

STUDY ROADS

| Study Road No. | Changwat | Origin - Destination | Route Pages | Description (Drawings) |
|---|---|---|---|---|
| 6 | Kamphaeng Phet/ Nakhon Sawan | Khanu Woralaksa Buri - Kao Lieo - Rt. 117 | 6-1 - 6-39 | (DWG. 6-1/6-6) |
| 8 | Kamphaeng Phet | Rt. 115 (B. Thung Mahachai) - B. Nong Takhian | 8-1 - 8-24 | (DWG. 8-1/8-6) |
| 11 | Phichit | Rt. 1068 - Pho Prathap Chang | 11-1 - 11-16 | (DWG. 11-1/ ) |
| 12 | Phichit | B. Wang Chik - Rt. 117 (B. Pa Daeng) | 12-1 - 12-17 | (DWG. 12-1/12-2) |
| 14 | Phichit/ Phetchabun | Rt. 11 (B. Nong Khanak) - B. Wang Pong | 14-1 - 14-18 | (DWG. 14-1/14-3) |
| 15 | Phichit/ Phitsanulok | B. Wang Tham - Rt. 1114 (B. Tha Makham) | 15-1 - 15-16 | (DWG. 15-1/ ) |
| 19 | Phitsanulok | Phrom Phiram - Rt. 11 (B. Nong Makhang) | 19-1 - 19-17 | (DWG. 19-1/19-2) |
| 20 | Phitsanulok | Wat Bot - B. Nakham | 20-1 - 20-18 | (DWG. 20-1/20-2) |
| 23 | Sukhothai | Rt. 12 (Muang Kao Sukhothai) - Si Satchanalai | 23-1 - 23-32 | (DWG. 23-1/23-6) |
| 25 | Lampang/Phrae | Toen - Wang Chin | 25-1 - 25-24 | (DWG. 25-1/25-6) |
| 27 | Lamphun | Rt. 106 (B. Mae Thoei) - Thung Hua Chang | 27-1 - 27-18 | (DWG. 27-1/27-2) |
| 29 | Chiang Rai | Rt. 110 (B. Rong Sua Ten - B. Huai Khom | 29-1 - 29-17 | (DWG. 29-1/29-2) |
| 30 | Chiang Rai | Rt. 1020 (B. Thung Ngiu) - Rt. 1020 (B. Chumphu) | 30-1 - 30-24 | (DWG. 30-1/30-6) |
| 31 | Chiang Rai | Rt. 1016 (B. Kiu Phrao) - Rt. 1174 (B. Kaen Tai) | 31-1 - 31-26 | (DWG. 31-1/31-7) |



# STUDY ROUTE NO. 6

Khanu Woralaksa Buri – Kao Lieo

-Rt.117 ( B. Don Doo )

L = 46.0 Km ( 6-4 )

Changwat : Kamphaeng Phet / Nakhon Sawan

1. GENERAL

1-1 Location of Route

The study route is located in the north-west of Muang Nakhon Sawan, stretching over two Changwat, Kamphaeng Phet and Nakhon Sawan. (see Figure 6-1-1)

The terrain traversed by the route is almost flat and the land is predominantly cultivated for sugarcane and rice.

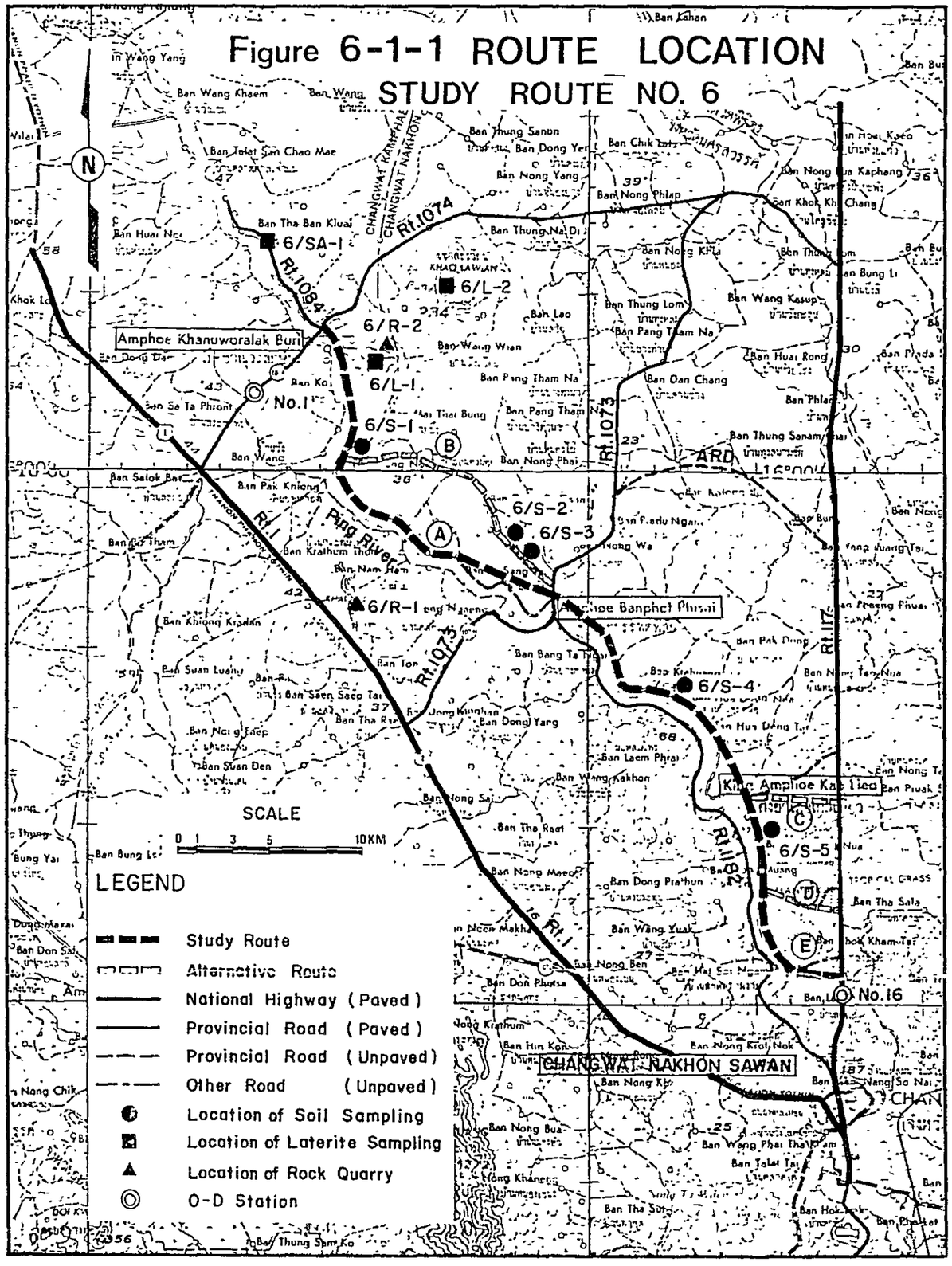
The existing road begins at the intersection with route 1074 at Ban Pa Phutsa in Amphoe Khanu Woralaksa Buri, and runs generally south-east along the east bank of the Ping river. The road passes through many villages and two Amphoe, Banphot Phisai and Kao Lieo in Changwat Nakhon Sawan and continues to the end of the study route reaching the national highway Rt.117, due north of Nakhon Sawan, with total length of about 45 Kilometres.

The population in the influence area of the road is about 50 thousand, 70 percent of which settle along the east bank of the Ping.

The whole route lies along the western edge of a large alluvial basin which extends from Bangkok up to Uttaradit.

Figure 6-1-1 ROUTE LOCATION

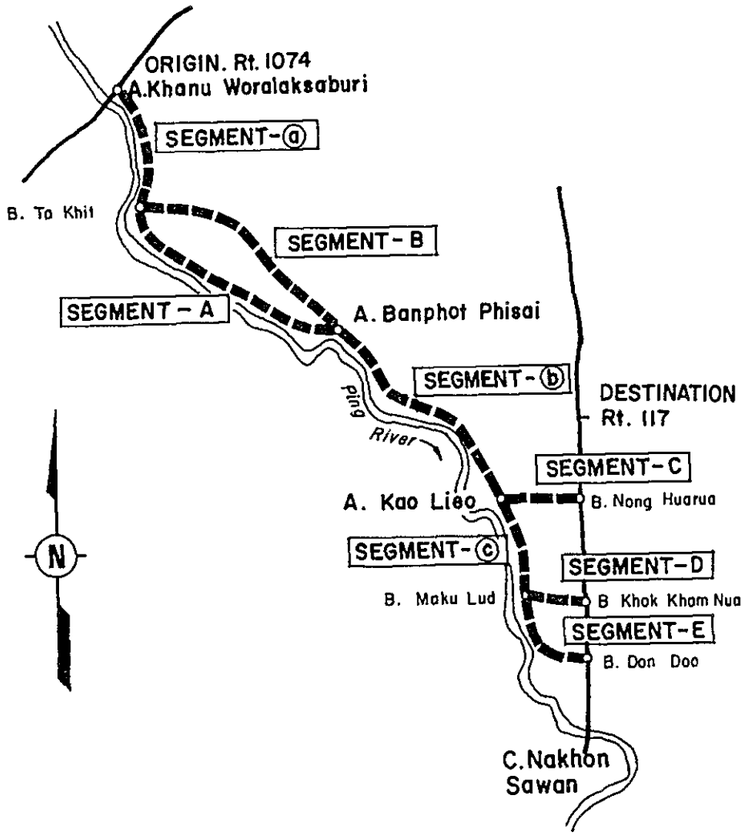
STUDY ROUTE NO. 6



## 1-2 Alternative Routes

In view of the availabilities of the existing roads in the area several alternative routes have come into the studies for the selection of the best route connecting A.Khanu W.Buri with Rt.117. All the alternatives were considered in the east side of the Ping with a view to raise agricultural and transportation benefits to the densely populated area. The routes considered for comparison are Segment A and B in the upper section between B.Ta Khit and A. Banphat Phisai and three Segments C,D and E in the lower section between A.Kao Lieo and Rt.117 as shown in the following illustration.

In the middle section between A.Banphot Phisai and A.Kao Lieo, no alternative routes were deemed necessary as the existing road connects those Amphoe with good alignments of short length.




Combining the Segments set out above,four alternative routes were planned for the comparative studies. The following are brief descriptions of the alternative routes.

Alternative Routes

| Alternative Route | Combination of Segment | Route Characteristics | |
|---|---|---|---|
| | | Segment A or B | Segment C,D or E |
| 6 - 1 | ⓐ - A - ⓑ - C | for the benefit of many residents living along bad road in Segment - A | the shortest access to the main road Rt. 117 |
| 6 - 2 | ⓐ - B - ⓑ - C | for the promotion of agricultural development around Segment-B | Same as Route 6-1 |
| 6 - 3 | ⓐ - A - ⓑ - ⓒ - D | Same as Route 6 - 1 | for the benefits of people along Segments ⓒ and of sugar cane factory located near B.Makulua |
| 6 - 4 | ⓐ - A - ⓑ - ⓒ - E | Same as Route 6 - 1 | for the benefits of residents along Segment ⓒ and E and of sugar cane factory located near B. Makulua |

## 1-3 Conditions of Existing Road

In table 6-1-1, main features of the existing roads are summarized from the results of the road inventory survey.

### Segment - ⓐ

The first 7.8 Km of road between the beginning point and B.Ta Khit runs in parallel with the Ping. First half is a 4-6 m wide laterite surfaced road in bad conditions and remaining section is a bad earth road of low embankment with the width of 3.5-4.0 meters. Horizontal and vertical alignments are fair in whole section.

Table 6-1-1 SUMMARY OF ROAD INVENTORY

| Segment | Changwat | Route Name | Route Section: Origin | Route Section: Destination | Length (km) | Terrain | Roadway Condition: Surface: Earth / Lat. / S.T. : Length (km) | Surface: Condition | Alignment: Horizontal | Alignment: Vertical | Road Cross Section: Width (m) | Road Cross Section: Emb. H. (m) | Road Cross Section: Cut D. (m) | Bridge: Nos. | Bridge: Width (m) | Bridge: ACC. Length (m) | Land Use | Overflow: Height X Length (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seg. ⓐ | Kamphaeng phet/ Nakhon Sawan | Rural road | A. Khanu-Woralaksa Buri | B. Ta Khit | 7.8 | Flat | E : 4.1<br>L : 3.6<br>ST. : 0.1 | Bad | Fair | Fair | 3.5 ~ 6.0 | 0 ~ 0.9 | - | - | - | - | Paddy | 0.3x1450 |
| Seg. A | Nakhon Sawan | Rural road | B. Ta Kit | A. Banphot Phisai | 14.5 | Flat | E : 9.5<br>L : 4.2<br>ST. : 0.8 | Bad | Fair | Fair | 3.0 ~ 8.6 | 0.1 ~ 0.8 | 0 ~ 0.2 | - | - | - | Paddy | - |
| Seg. B | Nakhon Sawan | Rural road | B. Ta Kit | A. Banphot Phisai | 15.9 | Flat | E : 4.4<br>L : 11.5 | Bad ~ Good | Fair | Good | 3.0 ~ 5.5 | 0 ~ 1.0 | - | Timber | 4.0 | 7.5 | Paddy<br>Sugar-cane | 0.3x500<br>1.2x3000 |
| Seg. ⓑ | Nakhon Sawan | Rural road | A. Banphot Phisai | A. Kao Lieo | 14.8 | Flat | E : 4.6<br>S : 9.9<br>ST. : 0.3 | Bad | Fair | Good | 4.5 ~ 8.7 | 0 ~ 1.5 | - | - | - | - | Sugar-cane<br>Plan-tation | 0.3x3440<br>0.2x40 |
| Seg. C | Nakhon Sawan | Rural road | A. Kao Lieo | Rt. 117 | 4.8 | Flat | L : 4.7<br>ST. : 0.1 | Fair | Fair | Good | 4.5 ~ 6.0 | 0.3 ~ 1.0 | - | - | - | - | Paddy<br>Sugar-Cane | - |
| Seg. D | Nakhon Sawan | Rural road | B. Makulua | Rt. 117 | 4.7 | Flat | L : 4.7 | Bad | Bad | Fair | 3.0 ~ 10.0 | 0.2 ~ 0.8 | - | - | - | - | Sugar-cane | - |
| Seg. ⓒ | Nakhon Sawan | Rural road | A. Kao Lieo | B. Makulua | 5.1 | Flat | L : 5.1 | Fair | Fair | Fair | 4.0 ~ 7.0 | 0 ~ 1.2 | - | Con-crete | 7.0 | 15.0 | Sugar-cane | 0.3x40 |
| Seg. E | Nakhon Sawan | Rural road | B. Makulua | Rt. 117<br>B. Don Doo | 4.5 | Flat | L : 4.5 | Bad | Bad ~ Fair | Fair | 4.0 ~ 5.0 | 0 ~ 0.9 | - | - | - | - | Sugar-cane | 1.2x2000 |

Segment - A

The route runs parallel to the Ping, about 150-200 m away from it. As the most villages are built-up to the riverside through this section,private houses and offices are not seen beside the road. About 70% of whole length of 14.5 Km is an earth road of very bad condition. The width is 3 - 6 m. with low embankment height.

Laterite surfaced section is about 4 Km. in both ends of this segment. Surface condition of it is fairly good.

Segment - B

Starting at B.Ta Khit, the route proceeds easterly for 4 Kms., then gradually directs to Banphot Phisai through flat sugarcane or paddy field. About 70% of the Segment is a fair to bad laterite surfaced road of 3.0 - 5.5 m. wide.

Vertical alignment is almost flat, but curved horizontal alignment in succession.

For 3 kms. close to Banphot Phisai, existing road has suffered overflows which sometimes exceed one meter above the road surface.

Segment -ⓑ

The route runs in the same situation as in the Segment - A. Laterite surfaced section which shares 70% of this Segment is fair to bad condition. Both vetical and horizontal alignments are fair.

For 3.5 Km in the middle part of the Segment is an earth road and suffered overflows 30 cm above the road surface.

Segment - C

The existing route directs north-east from Kao Lieo to Rt-117, taking the length of 4.8 Km. The laterite road is 4.5-6.0 m wide with good alignment.

Segment - D

The existing route starting at B.Makulua to Rt.117 is as narrow as 3.0 - 4.0 m, with the low embankment and curved alignment. It makes 2 Km detour between these two points.

Segment -ⓒ

This existing route between Kao Lieo and B.Makulua passes through the populated villages in full length. Private houses stand close to the shoulders,resulting in the shortage of right-of-way width.

The horizontal alignment with right angle curves is not good in general.

Segment - E

First half of this Segment follows the bank of the Ping, then proceeds to the east direction until Rt. 117. The riverside section passes through the villages and has the problem of the lack of right-or-way width. The sugarcane refinery factory by the road will be one of the matters in widening of the road.

## 2. TRAFFIC

### 2-1 Traffic Zone and Road Links

For four alternative routes, the traffic zoning was made as shown in Figure 6-2-1 to Figure 6-2-4.

The area of influence was divided into 4 traffic zones in cases of 6-1 and 6-2, while it was divided into 5 traffic zones in cases of 6-3 and 6-4.

The total population in the said area in 1981 amounts approximately to 39700, 36300, 48800 and 52200 for 6-1, 6-2, 6-3 and 6-4 alternatives, respectively. The densities in terms of population per unit Km of the proposed road length are 1010, 890, 1100 and 1130 for respective alternatives. Annual rate of population increase in the area is 1.0% in the past 3 years, which is lower than the averages of 2.2% in the Northern Region.

As the major destinations of transport demands originated in the area, four Amphoe of Muang Nakhon Sawan, Khanu Woralaksaburi, Banphot Phisai and Kao Lieo were chosen based on the O/D survey results. Characteristics of the traffic zones by route alternative are shown in Table 6-2-1, Table 6-2-3, Table 6-2-5 and Table 6-2-7, respectively.

The existing and proposed roads in the area together with surrounding roads concerned were divided into totaling 24 road links, 6 links in the proposed roads and 18 links in the surrounding roads for alternatives 6-1 and 6-2, while 7 links in the proposed route and 17 links in the surrounding roads for alternative 6-3 and 6-4.

The details by alternative are shown in Table 6-2-2, Table 6-2-4, Table 6-2-6 and Table 6-2-8, respectively.

### 2-2 Transportation Demands

#### a) Passenger

Passenger transportation demands by O/D pair in the opening year of the project were estimated in both cases of with and without project for each alternative route. The estimated demands in terms of number of trips per day are shown in the following tables:

Passenger O/D (Alternative 6-1) -1987

without project (Trip/Day)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 166 | 268 | 132 | 131 | 0 | 0 | 0 |
| 2 | 0 | 0 | 395 | 146 | 0 | 82 | 197 | 213 |
| 3 | 0 | 0 | 0 | 687 | 384 | 312 | 467 | 233 |
| 4 | 0 | 0 | 0 | 0 | 102 | 0 | 1021 | 171 |
| 11 | 0 | 0 | 0 | 0 | 0 | 54 | 122 | 150 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 145 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

with project (Trip/Day)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 466 | 643 | 282 | 178 | 0 | 0 | 0 |
| 2 | 0 | 0 | 762 | 471 | 0 | 194 | 471 | 503 |
| 3 | 0 | 0 | 0 | 950 | 385 | 479 | 818 | 451 |
| 4 | 0 | 0 | 0 | 0 | 157 | 0 | 1564 | 286 |
| 11 | 0 | 0 | 0 | 0 | 0 | 74 | 187 | 186 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Passenger O/D (Alternative 6-2) -1987

without project (Trip/Day)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 157 | 268 | 132 | 146 | 0 | 0 | 0 |
| 2 | 0 | 0 | 463 | 123 | 0 | 65 | 147 | 181 |
| 3 | 0 | 0 | 0 | 687 | 351 | 312 | 467 | 233 |
| 4 | 0 | 0 | 0 | 0 | 129 | 0 | 1021 | 171 |
| 11 | 0 | 0 | 0 | 0 | 0 | 73 | 173 | 186 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 145 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

with project (Trip/Day)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 284 | 599 | 269 | 180 | 0 | 0 | 0 |
| 2 | 0 | 0 | 463 | 278 | 0 | 117 | 282 | 294 |
| 3 | 0 | 0 | 0 | 950 | 377 | 479 | 818 | 430 |
| 4 | 0 | 0 | 0 | 0 | 178 | 0 | 1564 | 276 |
| 11 | 0 | 0 | 0 | 0 | 0 | 94 | 247 | 220 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 164 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure 6-2-1 ZONING AND ROAD NETWORK (6-1)

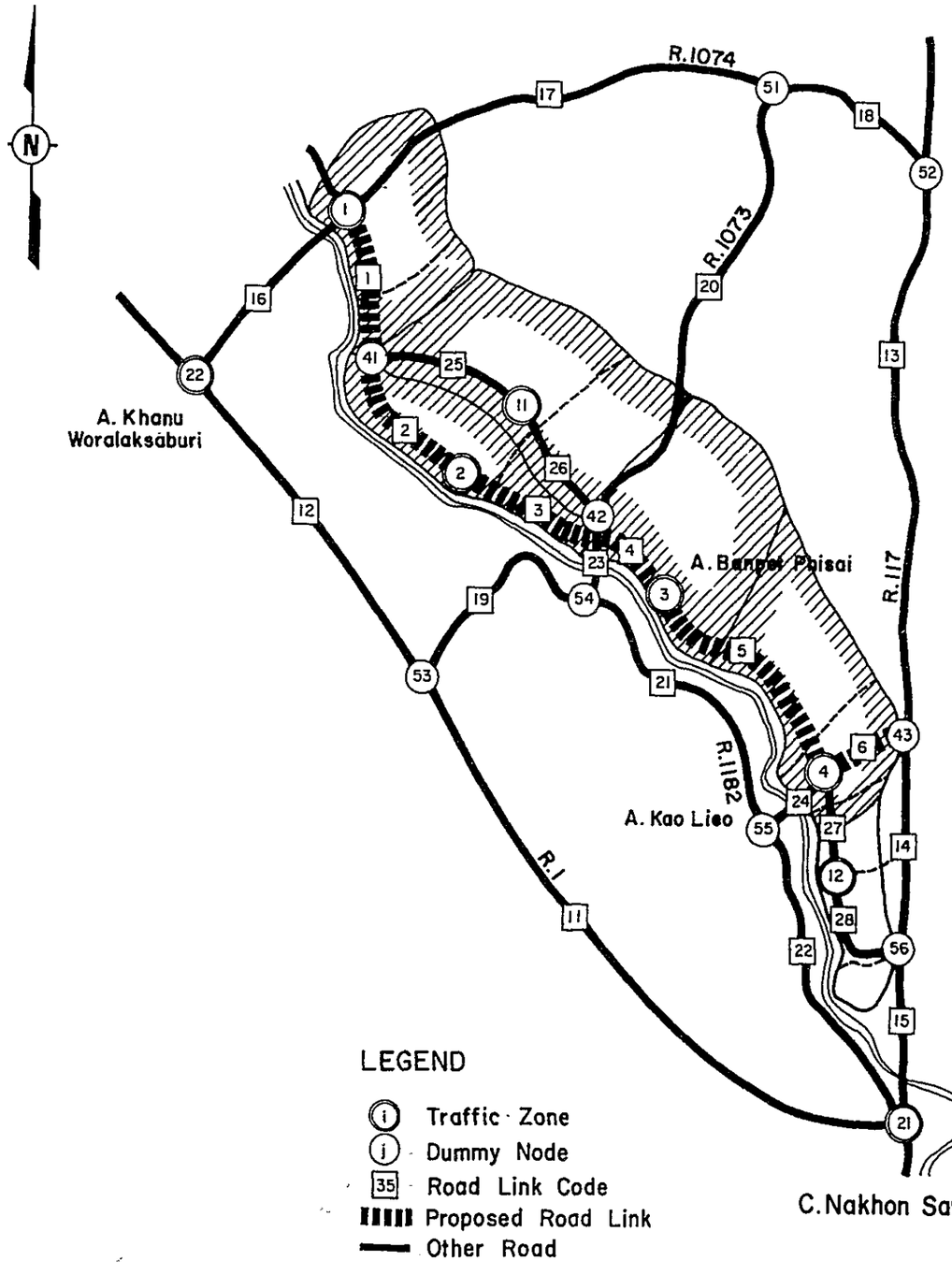



Table 6-2-1 ZONE CHARACTERISTICS (6-1)

| Traf. Zone | Relative Administrat. Div. Changwat | Amphoe | Tambon Code | % of Popul. in Traf. Zone | Popul. in 1981 ($10^3$) | Past Trend of Popul. Increase | Annual Rate of Increase 1981-1987 | Projected Population in 1987 Generation | Attraction |
|---|---|---|---|---|---|---|---|---|---|
| | K.P | Khanu | 150404(1) | 60 | 5.5 | | | | |
| | | Woralaksabiri | 150404(2) | 40 | 3.7 | | | | |
| 1 | N.S | Banphot Phisai | 010307 | 15 | 1.4 | | | | |
| | | | Total | - | 10.6 | 2.0 | 1.7 | 11.7 | 11.7 |
| 2 | N.S | Banphot Phisai | 010307 | 55 | 5.2 | | | | |
| | | | 010308 | 65 | 3.8 | | | | |
| | | | Total | - | 9.0 | 1.5 | 1.4 | 9.7 | 9.7 |
| 3 | N.S | Banphot Phisai | 010302 | 88 | 12.1 | 0.3 | 0.7 | 12.5 | 91.0 |
| | | Kad Leio | 010401 | 10 | 0.5 | | | | |
| 4 | N.S | | 010402 | 80 | 4.9 | | | | |
| | | | 010405 | 76 | 6.3 | | | | |
| | | | Total | - | 11.7 | 0.6 | 0.7 | 12.1 | 32.2 |
| 11 | N.S | Banphot | 010307 | 30 | 2.8 | | | | |
| | | Phisai | 010308 | 35 | 2.0 | | | | |
| | | | Total | - | 4.8 | 0.7 | 0.7 | 4.9 | 4.9 |
| | | M.Nakhon | 010109 | 41 | 2.0 | | | | |
| 12 | N.S | Sawan | 010110 | 50 | 4.2 | | | | |
| | | Kao Lieo | 010401 | 60 | 2.9 | | | | |
| | | | Total | - | 9.1 | 0.6 | 0.7 | 9.6 | 9.6 |
| 21 | N.S | - | 010000 | 100 | 981.4 | 1.2 | 1.1 | - | 1048.0 |
| 22 | K.P | Khanu Worala | 150400 | 100 | 111.0 | 2.0 | 1.7 | - | 122.4 |

Table 6-2-2 ROAD LINK CHARACTERISTICS (6-1)

| NO | SN | EN | LO | GOD | GOR | LW | GWD | GWR | TO | TW | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 41 | 7.7 | 8 | 11 | 7.7 | 4 | 4 | 11.6 | 6.6 | Rural |
| 2 | 2 | 41 | 7.2 | 13 | 15 | 7.2 | 4 | 4 | 21.5 | 6.2 | Rural |
| 3 | 2 | 42 | 7.3 | 13 | 15 | 6.1 | 4 | 4 | 21.8 | 5.2 | Rural |
| 4 | 3 | 42 | 2.0 | 8 | 11 | 2.0 | 4 | 4 | 3.0 | 1.7 | Rural |
| 5 | 3 | 4 | 12.8 | 8 | 11 | 12.8 | 4 | 4 | 19.2 | 11.0 | Rural |
| 6 | 4 | 43 | 4.8 | 8 | 11 | 3.7 | 4 | 4 | 7.2 | 3.2 | Rural |
| 11 | 21 | 53 | 31.0 | 1 | 1 | 31.0 | 1 | 1 | 23.8 | 23.8 | R.1 |
| 12 | 22 | 53 | 16.9 | 1 | 1 | 16.9 | 1 | 1 | 13.0 | 13.0 | R.1 |
| 13 | 43 | 52 | 25.0 | 1 | 1 | 27.8 | 1 | 1 | 19.2 | 21.4 | R.117 |
| 14 | 43 | 56 | 10.5 | 1 | 1 | 7.7 | 1 | 1 | 8.1 | 5.9 | R.117 |
| 15 | 21 | 56 | 9.0 | 1 | 1 | 9.0 | 1 | 1 | 6.9 | 6.9 | R.117 |
| 16 | 1 | 22 | 10.5 | 4 | 4 | 10.5 | 4 | 4 | 9.0 | 9.0 | R.1074 |
| 17 | 1 | 51 | 23.0 | 4 | 4 | 23.0 | 4 | 4 | 19.7 | 19.7 | R.1074 (OECF) |
| 18 | 51 | 52 | 10.0 | 4 | 4 | 10.0 | 4 | 4 | 8.6 | 8.6 | R.1074 |
| 19 | 53 | 54 | 11.9 | 4 | 4 | 11.9 | 4 | 4 | 10.2 | 10.2 | R.1073 |
| 20 | 42 | 51 | 24.0 | 4 | 4 | 24.0 | 4 | 4 | 20.6 | 20.6 | R.1073 |
| 21 | 54 | 55 | 15.5 | 4 | 4 | 15.5 | 4 | 4 | 13.3 | 13.3 | R.1182 (OECF) |
| 22 | 21 | 55 | 20.0 | 4 | 4 | 20.0 | 4 | 4 | 17.1 | 17.1 | R.1182 (OECF) |
| 23 | 42 | 54 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 24 | 4 | 55 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 25 | 11 | 41 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 26 | 11 | 42 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 27 | 4 | 12 | 5.1 | 9 | 12 | 5.1 | 9 | 12 | 10.3 | 10.3 | Rural |
| 28 | 12 | 56 | 6.1 | 9 | 12 | 6.1 | 9 | 12 | 12.3 | 12.3 | Rural |

Note SN Start Node, EN End Node, LO Link Length (W), GOD. Road Grade in Dry Season (W), GOR Road Grade in Rainy Season (W), LW: Link Length (W), GWD Road Grade in Dry Season (W), GWR: Road Grade in Rainy Season (W), TO Time (W), TW Time (W)

Figure 6-2-2 ZONING AND ROAD NETWORK (6-2)

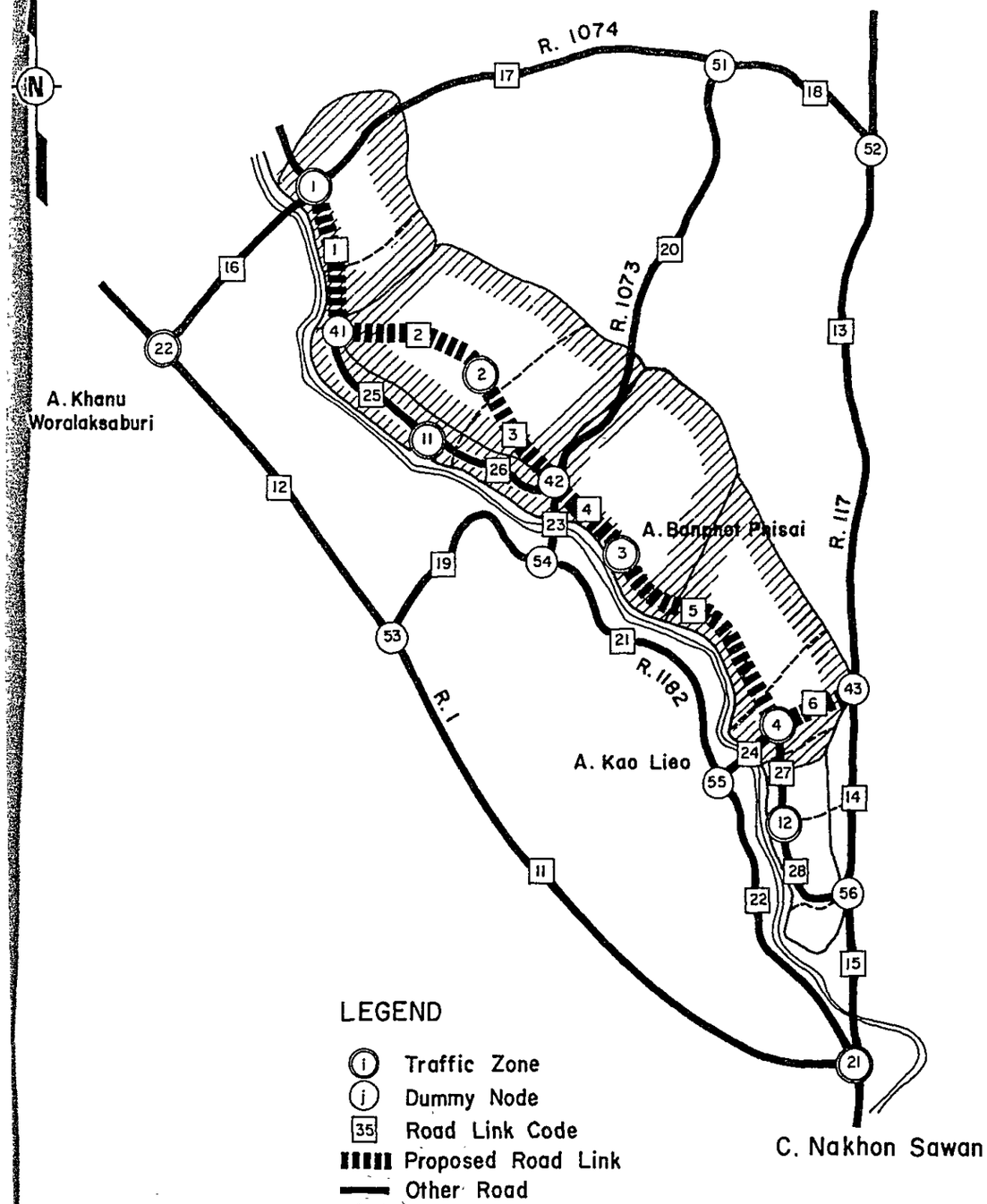



Table 6-2-3 ZONE CHARACTERISTICS (6-2)

| Traf. Zone | Relative Administrat. Div. Changwat | Amphoe | Tambon Code | % of Popul. in Traf. Zone | Popul. in 1981 ($10^3$) | Past Trend of Popul. Increase | Annual Rate of Increase 1981-1987 | Projected Population in 1987 Generation | Attraction |
|---|---|---|---|---|---|---|---|---|---|
| 1 | K.P | Khanu Worala | 150404(1) | 60 | 5.5 | | | | |
| | | | 150404(2) | 40 | 3.7 | | | | |
| | N.S | Bonphot Phisai | 010307 | 15 | 1.4 | | | | |
| | | | Total | - | 10.6 | 2.0 | 1.7 | 11.7 | 11.7 |
| 2 | N.S | Bonphot Phisai | 010307 | 35 | 3.3 | | | | |
| | | | 010308 | 40 | 2.3 | | | | |
| | | | Total | - | 5.6 | 1.2 | 1.1 | 5.9 | 5.9 |
| 3 | N.S | Bonphot Phisai | 010302 | 88 | 12.1 | 0.3 | 0.7 | 12.5 | 91.0 |
| 4 | N.S | Kao Lieo | 010401 | 10 | 0.5 | | | | |
| | | | 010402 | 80 | 4.9 | | | | |
| | | | 010405 | 76 | 6.3 | | | | |
| | | | Total | - | 11.7 | 0.6 | 0.7 | 12.1 | 32.2 |
| 11 | N.S | Babphot Phisai | 010307 | 50 | 4.7 | | | | |
| | | | 010308 | 60 | 3.5 | | | | |
| | | | Total | - | 8.2 | 0.9 | 0.9 | 8.5 | 8.5 |
| 12 | N.S | M. Nakhon Sawan Kao Lieo | 010109 | 41 | 2.0 | | | | |
| | | | 010110 | 50 | 4.2 | | | | |
| | | | 010401 | 60 | 2.9 | | | | |
| | | | Total | - | 9.1 | 0.6 | 0.7 | 9.6 | 9.6 |
| 21 | N.S | - | 01000 | 100 | 981.4 | 1.2 | 1.1 | - | 1048.0 |
| 22 | N.S | Khanu Worala | 15040 | 100 | 111.0 | 2.0 | 1.7 | - | 122.4 |

Table 6-2-4 ROAD LINK CHARACTERISTICS (6-2)

| NO | SN | EN | LO | GOD | GOR | LW | GWD | GWR | TO | TW | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 41 | 7.7 | 8 | 11 | 7.7 | 4 | 4 | 11.6 | 6.6 | Rural |
| 2 | 2 | 41 | 8.0 | 8 | 11 | 8.0 | 4 | 4 | 12.0 | 6.9 | Rural |
| 3 | 2 | 42 | 8.0 | 8 | 11 | 6.6 | 4 | 4 | 12.0 | 5.7 | Rural |
| 4 | 3 | 42 | 2.0 | 8 | 11 | 2.0 | 4 | 4 | 3.0 | 1.7 | Rural |
| 5 | 3 | 4 | 12.8 | 8 | 11 | 12.8 | 4 | 4 | 19.2 | 11.0 | Rural |
| 6 | 4 | 43 | 4.8 | 8 | 11 | 3.7 | 4 | 4 | 7.2 | 3.2 | Rural |
| 11 | 21 | 53 | 31.0 | 1 | 1 | 31.0 | 1 | 1 | 23.8 | 23.8 | R.1 |
| 12 | 22 | 53 | 16.9 | 1 | 1 | 16.9 | 1 | 1 | 13.0 | 13.0 | R.1 |
| 13 | 43 | 52 | 25.0 | 1 | 1 | 27.8 | 1 | 1 | 19.2 | 21.4 | R.117 |
| 14 | 43 | 56 | 10.5 | 1 | 1 | 7.7 | 1 | 1 | 8.1 | 5.9 | R.117 |
| 15 | 21 | 56 | 9.0 | 1 | 1 | 9.0 | 1 | 1 | 6.9 | 6.9 | R.117 |
| 16 | 1 | 22 | 10.5 | 4 | 4 | 10.5 | 4 | 4 | 9.0 | 9.0 | R.1074 |
| 17 | 1 | 51 | 23.0 | 4 | 4 | 23.0 | 4 | 4 | 19.7 | 19.7 | R.1074 (OECF) |
| 18 | 51 | 52 | 10.0 | 4 | 4 | 10.0 | 4 | 4 | 8.6 | 8.6 | R.1074 |
| 19 | 53 | 54 | 11.9 | 4 | 4 | 11.9 | 4 | 4 | 10.2 | 10.2 | R.1073 |
| 20 | 42 | 51 | 24.0 | 4 | 4 | 24.0 | 4 | 4 | 20.6 | 20.6 | R.1073 |
| 21 | 54 | 55 | 15.5 | 4 | 4 | 15.5 | 4 | 4 | 13.3 | 13.3 | R.1182 (OECF) |
| 22 | 21 | 55 | 20.0 | 4 | 4 | 20.0 | 4 | 4 | 17.1 | 17.1 | R.1182 (OECF) |
| 23 | 42 | 54 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 24 | 4 | 55 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 25 | 11 | 41 | 7.2 | 13 | 15 | 7.2 | 13 | 15 | 21.5 | 21.5 | Rural |
| 26 | 11 | 42 | 7.3 | 13 | 15 | 7.3 | 13 | 15 | 21.8 | 21.8 | Rural |
| 27 | 4 | 12 | 5.1 | 9 | 12 | 5.1 | 9 | 12 | 10.3 | 10.3 | Rural |
| 28 | 12 | 56 | 6.1 | 9 | 12 | 6.1 | 9 | 12 | 12.3 | 12.3 | Rural |

Note SN Start Node, EN End Node, LO Link Length (M), GOD Road Grade in Dry Season (M), GOR Road Grade in Rainy Season (M), LW Link Length (M), GWD Road Grade in Dry Season (M), GWR Road Grade in Rainy Season (M), TO Time (M), TW Time (M)

Figure 6-2-3 ZONING AND ROAD NETWORK (6-3)

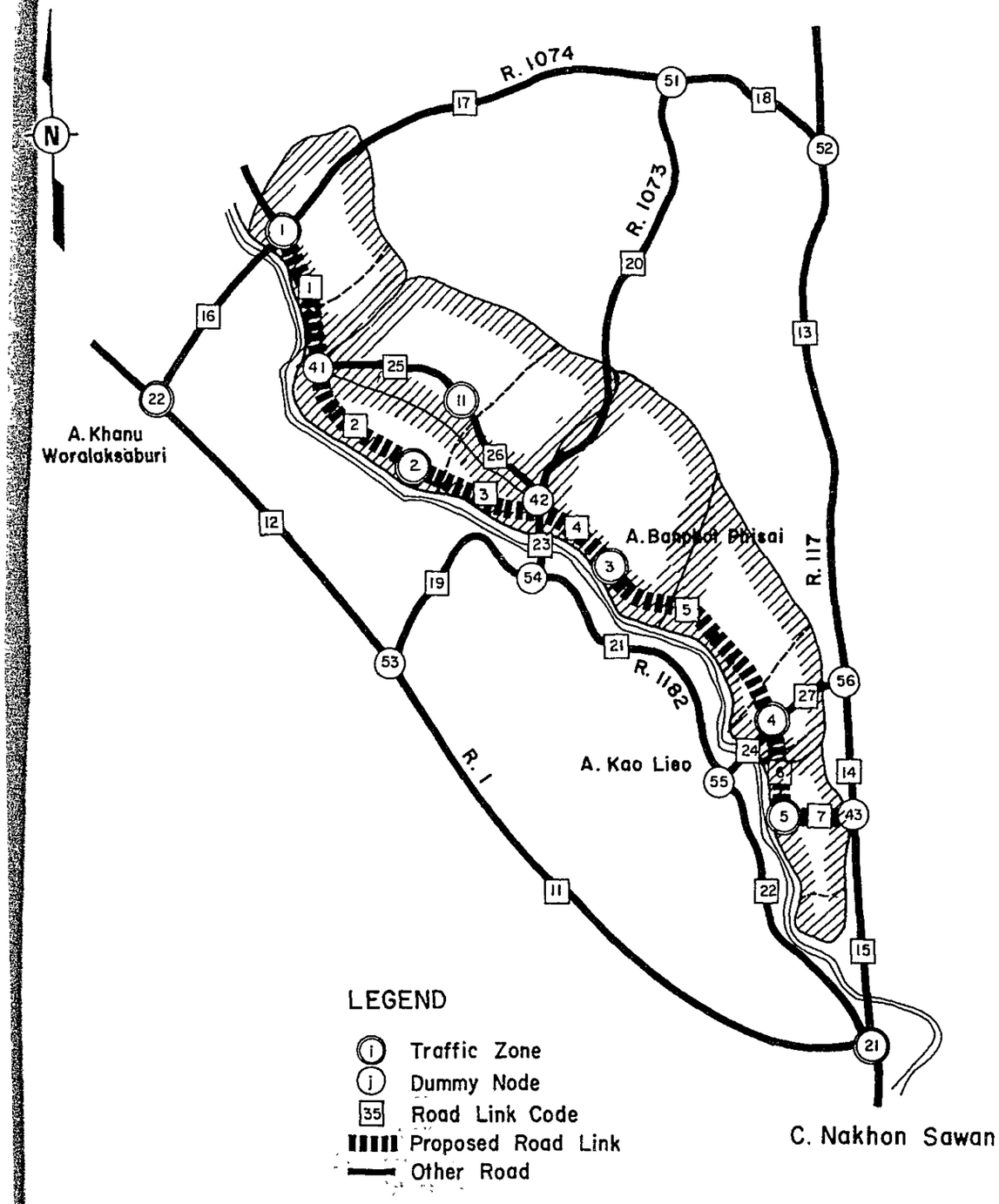



Table 6-2-5 ZONE CHARACTERISTICS (6-3)

| Traf. Zone | Relative Administrat. Div. Changwat | Amphoe | Tambon Code | % of Popul. in Traf. Zone | Popul. in 1981 ($10^3$) | Past Trend of Popul. Increase | Annual Rate of Increase 1981-1987 | Projected Population in 1987 Generation | Attraction |
|---|---|---|---|---|---|---|---|---|---|
| 1 | K.P | Khanu | 150404(1) | 60 | 5.5 | | | | |
| | | Woralasaburi | 150404(2) | 40 | 3.7 | | | | |
| | N.S | Banphot Phisai | 010307 | 15 | 1.4 | | | | |
| | | | Total | - | 10.6 | 2.0 | 1.7 | 11.7 | 11.7 |
| | | Banphot | 010307 | 55 | 5.2 | | | | |
| 2 | N.S | Phisai | 010308 | 65 | 3.8 | | | | |
| | | | Total | - | 9.0 | 1.5 | 1.4 | 9.7 | 9.7 |
| 3 | N.S | Banphot Phisai | 010302 | 88 | 12.1 | 0.3 | 0.7 | 12.5 | 91.0 |
| | | Kao Lieo | 010401 | 10 | 0.5 | | | | |
| 4 | N.S | | 010402 | 80 | 4.9 | | | | |
| | | | 010405 | 76 | 6.3 | | | | |
| | | | Total | - | 11.7 | 0.6 | 0.7 | 12.1 | 32.2 |
| | | M.Nakhon Sawan | 010109 | 41 | 2.0 | | | | |
| 5 | N.S | | 010110 | 50 | 4.2 | | | | |
| | | Kao Lieo | 010401 | 60 | 2.9 | | | | |
| | | | Total | - | 9.1 | 0.6 | 0.7 | 9.6 | 9.6 |
| 11 | N.S | Banpgit | 010307 | 30 | 2.8 | | | | |
| | | Phisai | 010308 | 35 | 2.0 | | | | |
| | | | Total | - | 4.8 | 0.7 | 0.7 | 4.9 | 4.9 |
| 21 | N.S | - | 010000 | 100 | 981.4 | 1.2 | 1.1 | - | 1048.0 |
| 22 | K.P | Khanu Worala | 150400 | 100 | 111.0 | 2.0 | 1.7 | - | 122.4 |

Table 6-2-6 ROAD LINK CHARACTERISTICS (6-3)

| NO | SN | EN | LO | GOD | GOR | LW | GWD | GWR | TO | TW | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 41 | 7.7 | 8 | 11 | 7.7 | 4 | 4 | 11.6 | 6.6 | Rural |
| 2 | 2 | 41 | 7.2 | 13 | 15 | 7.2 | 4 | 4 | 21.5 | 6.2 | Rural |
| 3 | 2 | 42 | 7.3 | 13 | 15 | 6.1 | 4 | 4 | 21.8 | 5.2 | Rural |
| 4 | 3 | 42 | 2.0 | 8 | 11 | 2.0 | 4 | 4 | 3.0 | 1.7 | Rural |
| 5 | 3 | 4 | 12.8 | 8 | 11 | 12.8 | 4 | 4 | 19.2 | 11.0 | Rural |
| 6 | 4 | 5 | 5.1 | 9 | 12 | 5.7 | 4 | 4 | 10.3 | 4.9 | Rural |
| 7 | 5 | 43 | 4.7 | 9 | 12 | 2.9 | 4 | 4 | 9.5 | 2.5 | Rural |
| 11 | 21 | 53 | 31.0 | 1 | 1 | 31.0 | 1 | 1 | 23.8 | 23.8 | R.1 |
| 12 | 22 | 53 | 16.9 | 1 | 1 | 16.9 | 1 | 1 | 13.0 | 13.0 | R.1 |
| 13 | 52 | 56 | 25.0 | 1 | 1 | 25.0 | 1 | 1 | 19.2 | 19.2 | R.117 |
| 14 | 43 | 56 | 7.3 | 1 | 1 | 8.3 | 1 | 1 | 5.6 | 6.4 | R.117 |
| 15 | 21 | 43 | 12.2 | 1 | 1 | 11.2 | 1 | 1 | 9.4 | 8.6 | R.117 |
| 16 | 1 | 22 | 10.5 | 4 | 4 | 10.5 | 4 | 4 | 9.0 | 9.0 | R.1074 |
| 17 | 1 | 51 | 23.0 | 4 | 4 | 23.0 | 4 | 4 | 19.7 | 19.7 | R.1074 (OECF) |
| 18 | 51 | 52 | 10.0 | 4 | 4 | 10.0 | 4 | 4 | 8.6 | 8.6 | R.1074 |
| 19 | 53 | 54 | 11.9 | 4 | 4 | 11.9 | 4 | 4 | 10.2 | 10.2 | R.1073 |
| 20 | 42 | 51 | 24.0 | 4 | 4 | 24.0 | 4 | 4 | 20.6 | 20.6 | R.1073 |
| 21 | 54 | 55 | 15.5 | 4 | 4 | 15.5 | 4 | 4 | 13.3 | 13.3 | R.1184 |
| 22 | 21 | 55 | 20.0 | 4 | 4 | 20.0 | 4 | 4 | 17.1 | 17.1 | R.1184 |
| 23 | 42 | 54 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 24 | 4 | 55 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 25 | 11 | 41 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 26 | 11 | 42 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 27 | 4 | 56 | 4.8 | 8 | 11 | 4.8 | 8 | 11 | 7.2 | 7.2 | Rural |

Note SN Start Node, EN End Node, LO Link Length (W), GOD Road Grade in Dry Season (W), GOR Road Grade in Rainy Season (W), LW: Link Length (W), GWD: Road Grade in Dry Season (W), GWR Road Grade in Rainy Season (W), TO Time (W), TW: Time (W)

Figure 6-2-4 ZONING AND ROAD NETWORK (6-4)

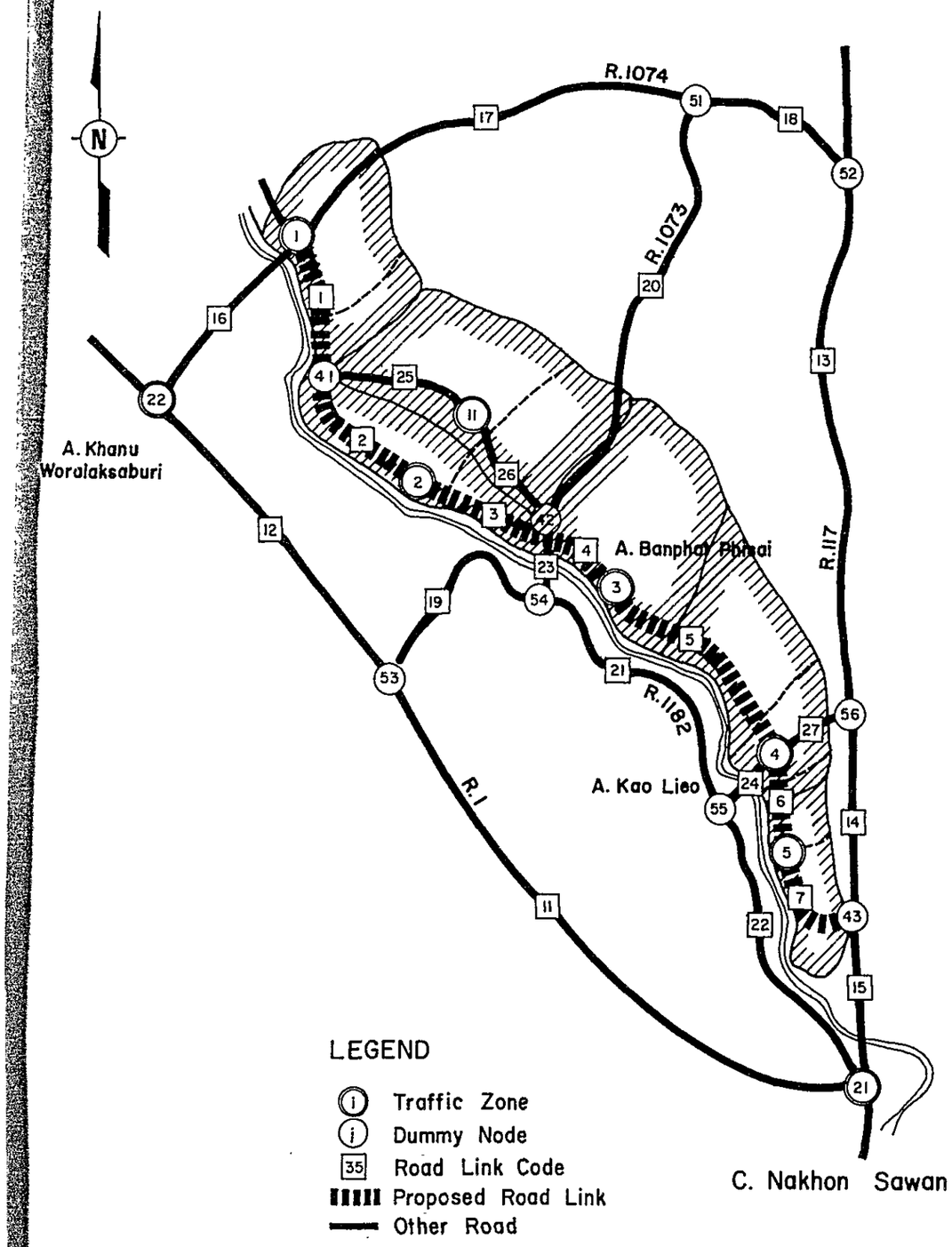



Table 6-2-7 ZONE CHARACTERISTICS (6-4)

| Traf. Zone | Relative Administrat. Div. Changwat | Amphoe | Tambon Code | % of Popul. in Traf. Zone | Popul. in 1981 ($10^3$) | Past Trend of Popul. Increase | Annual Rate of Increase 1981-1987 | Projected Population in 1987 Generation | Attraction |
|---|---|---|---|---|---|---|---|---|---|
| 1 | K.P | Khanu | 150404(1) | 60 | 5.5 | | | | |
| | | Woralaksaburi | 150404(2) | 40 | 3.7 | | | | |
| | N.S | Banphot Phisai | 010307 | 15 | 1.4 | | | | |
| | | | Total | - | 10.6 | 2.0 | 1.7 | 11.7 | 11.7 |
| 2 | N.S | Banphot Phisai | 010307 | 55 | 5.2 | | | | |
| | | | 010308 | 65 | 3.8 | | | | |
| | | | Total | - | 9.0 | 1.5 | 1.4 | 9.7 | 9.7 |
| 3 | N.S | Banphot Phisai | 010302 | 88 | 12.1 | 0.3 | 0.7 | 12.5 | 91.0 |
| | | | 010401 | 10 | 0.5 | | | | |
| 4 | N.S | Kao Lieo | 010402 | 60 | 4.9 | | | | |
| | | | 010405 | 76 | 6.3 | | | | |
| | | | Total | - | 11.7 | 0.6 | 0.7 | 12.1 | 32.2 |
| | | M.Nakhon Sawan | 010109 | 60 | 2.9 | | | | |
| | | | 010110 | 80 | 6.7 | | | | |
| 5 | N.S | Kao Lieo | 010401 | 60 | 2.9 | | | | |
| | | | Total | - | 12.5 | 0.6 | 0.7 | 13.1 | 13.1 |
| | | | 010307 | 30 | 2.8 | | | | |
| 11 | N.S | Banphot Phisai | 010308 | 35 | 2.0 | | | | |
| | | | Total | - | 4.8 | 0.7 | 0.7 | 4.9 | 4.9 |
| 21 | N.S | Nakhon Sawan | 010000 | 100 | 981.4 | 1.2 | 1.1 | - | 1048.0 |
| 22 | K.P | Khanu Worala | 150400 | 100 | 111.0 | 2.0 | 1.7 | - | 122.4 |

Table 6-2-8 ROAD LINK CHARACTERISTICS (6-4)

| NO | SN | EN | LD | GOD | GOR | LW | GWD | GWR | TD | TW | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 41 | 7.7 | 8 | 11 | 7.7 | 4 | 4 | 11.6 | 6.6 | Rural |
| 2 | 2 | 41 | 7.2 | 13 | 15 | 7.2 | 4 | 4 | 21.5 | 6.2 | Rural |
| 3 | 2 | 42 | 7.3 | 13 | 15 | 6.1 | 4 | 4 | 21.8 | 5.2 | Rural |
| 4 | 3 | 42 | 2.0 | 8 | 11 | 2.0 | 4 | 4 | 3.0 | 1.7 | Rural |
| 5 | 3 | 4 | 12.8 | 8 | 11 | 12.8 | 4 | 4 | 19.2 | 11.0 | Rural |
| 6 | 4 | 5 | 5.1 | 9 | 12 | 5.7 | 4 | 4 | 10.3 | 4.9 | Rural |
| 7 | 5 | 43 | 6.1 | 9 | 12 | 4.5 | 4 | 4 | 12.3 | 3.9 | Rural |
| 11 | 21 | 53 | 31.0 | 1 | 1 | 31.0 | 1 | 1 | 23.8 | 23.8 | R.1 |
| 12 | 22 | 53 | 16.9 | 1 | 1 | 16.9 | 1 | 1 | 13.0 | 13.0 | R.1 |
| 13 | 52 | 56 | 25.0 | 1 | 1 | 25.0 | 1 | 1 | 19.2 | 19.2 | R.117 |
| 14 | 43 | 56 | 10.5 | 1 | 1 | 11.5 | 1 | 1 | 8.1 | 8.8 | R.117 |
| 15 | 21 | 43 | 9.0 | 1 | 1 | 8.0 | 1 | 1 | 6.9 | 6.2 | R.117 |
| 16 | 1 | 22 | 10.5 | 4 | 4 | 10.5 | 4 | 4 | 9.0 | 9.0 | R.1074 |
| 17 | 1 | 51 | 23.0 | 4 | 4 | 23.0 | 4 | 4 | 19.7 | 19.7 | R.1074 (OECF) |
| 18 | 51 | 52 | 10.0 | 4 | 4 | 10.0 | 4 | 4 | 8.6 | 8.6 | R.1074 |
| 19 | 53 | 54 | 11.9 | 4 | 4 | 11.9 | 4 | 4 | 10.2 | 10.2 | R.1073 |
| 20 | 42 | 51 | 24.0 | 4 | 4 | 24.0 | 4 | 4 | 20.6 | 20.6 | R.1073 |
| 21 | 54 | 55 | 15.5 | 4 | 4 | 15.5 | 4 | 4 | 13.3 | 13.3 | R.1182 (OECF) |
| 22 | 21 | 55 | 20.0 | 4 | 4 | 20.0 | 4 | 4 | 17.1 | 17.1 | R.1182 (OECF) |
| 23 | 42 | 54 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 24 | 4 | 55 | 5.5 | 16 | 16 | 5.5 | 16 | 16 | 30.0 | 30.0 | Ferry |
| 25 | 11 | 41 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 26 | 11 | 42 | 8.0 | 8 | 11 | 8.0 | 8 | 11 | 12.0 | 12.0 | Rural |
| 27 | 4 | 56 | 4.8 | 8 | 11 | 4.8 | 8 | 11 | 7.2 | 7.2 | Rural |

Note SN Start Node, EN End Node, LD Link Length (M), GOD Road Grade in Dry Season (M), GOR Road Grade in Rainy Season (M), LW Link Length (M), GWD Road Grade in Dry Season (M), GWR Road Grade in Rainy Season (M), TD Time (M), TW Time (M)

Passenger O/D (Alternative 6-3)-1987

Without project (Trip/Day)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 166 | 268 | 132 | 0 | 131 | 0 | 0 |
| 2 | 0 | 0 | 395 | 146 | 82 | 0 | 197 | 213 |
| 3 | 0 | 0 | 0 | 687 | 312 | 384 | 467 | 233 |
| 4 | 0 | 0 | 0 | 0 | 588 | 102 | 1021 | 171 |
| 5 | 0 | 0 | 0 | 0 | 0 | 54 | 1004 | 146 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 122 | 150 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

with project (Trip/Day)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 466 | 643 | 282 | 0 | 178 | 0 | 0 |
| 2 | 0 | 0 | 762 | 471 | 256 | 0 | 471 | 503 |
| 3 | 0 | 0 | 0 | 950 | 701 | 385 | 819 | 451 |
| 4 | 0 | 0 | 0 | 0 | 588 | 157 | 1588 | 286 |
| 5 | 0 | 0 | 0 | 0 | 0 | 93 | 1752 | 195 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 188 | 186 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Passenger O/D (Alternative 6-4)-1987

Without project (Trip/Day)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 166 | 268 | 132 | 0 | 131 | 383 | 0 |
| 2 | 0 | 0 | 395 | 146 | 89 | 0 | 197 | 213 |
| 3 | 0 | 0 | 0 | 687 | 426 | 384 | 467 | 233 |
| 4 | 0 | 0 | 0 | 0 | 802 | 102 | 1021 | 171 |
| 5 | 0 | 0 | 0 | 0 | 0 | 59 | 1337 | 198 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 122 | 150 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

with project (Trip/Day)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 466 | 643 | 282 | 0 | 178 | 386 | 0 |
| 2 | 0 | 0 | 762 | 471 | 277 | 0 | 492 | 503 |
| 3 | 0 | 0 | 0 | 950 | 957 | 385 | 864 | 451 |
| 4 | 0 | 0 | 0 | 0 | 802 | 157 | 1704 | 286 |
| 5 | 0 | 0 | 0 | 0 | 0 | 100 | 1845 | 267 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 194 | 186 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

b) Agricultural Freight

According to the agro-economic survey, the major products of sugarcane in the area are mostly carried to the refinery factory located at 7 km south of Amphoe Kao Lieo, in traffic zone 12 for alternative 6-1 and 6-2 and 5 for alternative 6-3 and 6-4. The another major assembly market is Nakhon Sawan. The estimated agricultural freight O/D volumes, in a unit of 1,000 tons per year, for each alternatives are shown in the following tables:

Agri. Freight O/D (Alternative 6-1)-1987

without project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 2.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 74.7 | 22.9 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 | 3.1 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

with project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 2.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 74.7 | 22.9 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 | 3.1 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Agri. Freight O/D (Alternative 6-2)-1987

without project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 3.9 | 3.3 | 0.0 |
| 2 | 0.0 | 0.0 | 11.1 | 0.0 | 0.0 | 10.5 | 9.9 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 74.7 | 22.9 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 | 3.1 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

with project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 11 | 12 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 3.9 | 3.3 | 0.0 |
| 2 | 0.0 | 0.0 | 11.1 | 0.0 | 0.0 | 10.5 | 9.9 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 74.7 | 22.9 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.9 | 3.1 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Agri. Freight O/D (Alternative 6-3)-1987

without project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 2.0 | 0.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 59.7 | 0.0 | 21.8 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 23.5 | 0.0 | 2.1 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.8 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

with project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 2.0 | 0.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 59.7 | 0.0 | 21.8 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 23.5 | 0.0 | 2.1 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.8 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Agri. Freight O/D (Alternative 6-4)-1987

without project (1000 ton/ year)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 2.0 | 0.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 59.7 | 0.0 | 21.8 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 23.5 | 0.0 | 2.1 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 25.7 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

without project (1000 ton/year)

| | 1 | 2 | 3 | 4 | 5 | 11 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| 2 | 0.0 | 0.0 | 3.6 | 0.0 | 2.0 | 0.0 | 2.4 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 59.7 | 0.0 | 21.8 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 23.5 | 0.0 | 2.1 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 25.7 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

c) Non-agricultural Freight

The non-agricultural freight transportation demands are estimated based on the model described in 3-3-3 in the Summary Report. Their movements on each road link were obtained relating with the passenger movements which were derived from the assignment of the passenger O/D volumes shown in the above a).

## 2-3 Traffic Composition, Occupancy and Loading Ratio

a) Traffic Composition

In accordance with the examination of the classified traffic counts in the Phase I and II studies and DOH's traffic records, the traffic composition on the existing roads of the project area was estimated as follows:

Existing Traffic Composition

| Survey Points and Source | Passenger Traffic | | | | | | Freight Traffic | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | P/C | P/P | L/B | M/B | H/B | Total | P/T | 4/T | 6/T | 10/T | Total |
| OD-2(PhaseI) | .17 | .00 | .45 | .38 | .00 | 1.00 | .35 | .12 | .13 | .40 | 1.00 |
| M-12(PhaseI) | .21 | .34 | .42 | | .03 | 1.00 | .54 | | .21 | .25 | 1.00 |
| NO.1(PhaseII) | .19 | .37 | .13 | .07 | .24 | 1.00 | .54 | .03 | .25 | .19 | 1.00 |
| R. 1182(DOH) | .30 | .17 | .33 | | .20 | 1.00 | .40 | | .33 | .27 | 1.00 |
| R. 1073(DOH) | .50 | .05 | .36 | | .09 | 1.00 | .41 | | .55 | .04 | 1.00 |
| R. 1074(DOH) | .36 | .14 | .41 | | .09 | 1.00 | .61 | | .27 | .12 | 1.00 |
| Estimated | .21 | .24 | .31 | .15 | .09 | 1.00 | .37 | .11 | .28 | .24 | 1.00 |

Changes in traffic composition due to income growth and road surface condition were determined for the both cases of with and without projects as shown in the following tables:

Freight Traffic Composition

| Year | Without Project | | | | | With Project | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P/C | P/P | L/B | M/B | H/B | P/C | P/P | L/B | M/B | H/B |
| 1981 | .21 | .24 | .31 | .15 | .09 | .21 | .24 | .31 | .15 | .09 |
| 1987 | .23 | .26 | .29 | .14 | .08 | .26 | .24 | .27 | .12 | .11 |
| 1993 | .25 | .29 | .26 | .13 | .07 | .30 | .24 | .24 | .09 | .13 |
| 2001 | .28 | .32 | .23 | .11 | .06 | .36 | .24 | .19 | .05 | .16 |

Passenger Traffic Domposition

| Year | Without Project | | | | With Project | | | |
|---|---|---|---|---|---|---|---|---|
| | P/T | 4/T | 6/T | 10/T | P/T | 4/T | 6/T | 10/T |
| 1981-2001 | .37 | .11 | .28 | .24 | .33 | .02 | .35 | .25 |

b) Occupancy

Occupancy by vehicle type and the average were determined as follows:

Occupancy

| Vehicle Type | Person per Vehicle |
|---|---|
| P/C | 3.1 |
| P/P | 4.4 |
| L/B | 10.9 |
| M/B | 16.2 |
| H/B | 38.3 |
| Ave. (1993, $\overline{W}$) | 9.7 |
| (1993, W) | 11.0 |

c) Loading Ratio

Loading ratio by vehicle type and the average were determined as follows:

Loading Ratio

| Vehicle Type | Ave. Load of Loaded Truck | Rate of Loaded Trucks | Loading Ratio (ton) |
|---|---|---|---|
| P/T | 0.65 | .45 | 0.3 |
| 4/T | 2.0 | .50 | 1.0 |
| 6/T | 4.1 | .55 | 2.3 |
| 10/T | 12.6 | .60 | 7.6 |
| Ave.($\overline{W}$) | - | - | 2.7 |
| (W) | - | - | 2.8 |

## 2-4 Growth Rates of Transportation Demands

The growth rates of passenger, agricultural freight and non-agricultural freight transport demands for the periods of 1987-1993 and 1993-2001 were projected. The basis for the estimation of growth rate for passenger, and the projected rates are shown in the following tables:

The Basis for Estimation of Passenger Demands Growth

| Indicator | Annual Growth Rate (%) 1987 - 1993 | 1993 - 2001 | Elasticity |
|---|---|---|---|
| Per capita Income | 5.8 | 5.6 | 1.08 |
| Transportation price | 3.6 | 3.6 | -0.24 |
| Population | 1.0 | 1.1 | 1.00 |

Growth Rate of Transportation Demands

| Type of Demand | Annual Growth Rate (%) 1987 - 1993 | 1993 - 2001 | Index 1987=100 1993 | 2001 |
|---|---|---|---|---|
| Passenger | 6.4 | 6.3 | 145 | 237 |
| Agri. Freight | 0.1 | 0.1 | 100.6 | 101.4 |
| Non-Agri. Freight | 7.6 | 7.5 | 155 | 277 |

## 2-5 Forecasted Traffic

### a) Forecasted Traffic by Vehicle Type

The forecasted traffic by route alternative is summarized in the following table:

Forecasted Traffic

| Alter-tive | Year | P/C | L/B | M/B | H/B | P/P P/T | 4/T | 6/T | 10/T | ADT | M/C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | 87 | 91 | 40 | 37 | 132 | 3 | 48 | 34 | 471 | 552 |
| 6-1 | 1993 | 146 | 117 | 44 | 63 | 189 | 4 | 67 | 48 | 677 | 686 |
| | 2001 | 281 | 148 | 39 | 125 | 306 | 6 | 109 | 78 | 1092 | 831 |
| | 1987 | 75 | 78 | 35 | 32 | 120 | 3 | 47 | 33 | 423 | 492 |
| 6-2 | 1993 | 126 | 101 | 38 | 55 | 169 | 4 | 63 | 45 | 599 | 611 |
| | 2001 | 242 | 128 | 34 | 108 | 269 | 6 | 98 | 70 | 955 | 746 |
| | 1987 | 96 | 100 | 44 | 41 | 147 | 3 | 54 | 38 | 523 | 598 |
| 6-3 | 1993 | 161 | 129 | 48 | 70 | 210 | 4 | 75 | 54 | 751 | 740 |
| | 2001 | 309 | 163 | 43 | 138 | 340 | 7 | 123 | 88 | 1211 | 889 |
| | 1987 | 113 | 118 | 52 | 48 | 173 | 4 | 63 | 45 | 617 | 682 |
| 6-4 | 1993 | 189 | 151 | 57 | 82 | 249 | 5 | 90 | 64 | 887 | 840 |
| | 2001 | 365 | 193 | 51 | 162 | 404 | 8 | 148 | 105 | 1435 | 995 |

### b) Forecasted Traffic by Road Link

Details of the forecasted traffic by road link by traffic type for route alternatives are shown in Table 6-2-9, taking a sample of the case of 1993.

## Table 6-2-9 FORECASTED TRAFFIC BY ROAD LINK

TRAFFIC VOLUME ON ROUTE 6-1 (1993)

| LINK | | 1 | 2 | 3 | 4 | 5 | 6 | AVR. |
|---|---|---|---|---|---|---|---|---|
| P/C | N+D | 64 | 53 | 70 | 96 | 104 | 71 | 78 |
| | I | 62 | 58 | 78 | 83 | 75 | 49 | 68 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 125 | 111 | 147 | 179 | 179 | 120 | 146 |
| L/B | N+D | 51 | 42 | 56 | 77 | 83 | 57 | 62 |
| | I | 49 | 47 | 62 | 66 | 61 | 39 | 54 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 100 | 89 | 118 | 143 | 144 | 96 | 117 |
| M/B | N+D | 19 | 16 | 21 | 29 | 31 | 21 | 23 |
| | I | 18 | 17 | 23 | 25 | 23 | 15 | 20 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 38 | 33 | 44 | 54 | 54 | 36 | 44 |
| H/B | N+D | 28 | 23 | 30 | 42 | 45 | 31 | 34 |
| | I | 27 | 25 | 34 | 36 | 33 | 21 | 29 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 54 | 48 | 64 | 78 | 78 | 52 | 63 |
| P/P&T | N+D | 73 | 60 | 84 | 116 | 159 | 93 | 104 |
| | I | 76 | 71 | 97 | 105 | 96 | 60 | 85 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 149 | 131 | 180 | 221 | 256 | 153 | 189 |
| 4/T | N+D | 1 | 1 | 1 | 2 | 4 | 2 | 2 |
| | I | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 3 | 2 | 3 | 4 | 6 | 3 | 4 |
| 6/T | N+D | 21 | 16 | 26 | 36 | 70 | 33 | 39 |
| | I | 25 | 23 | 32 | 36 | 33 | 20 | 28 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 45 | 39 | 57 | 72 | 103 | 52 | 67 |
| 10/T | N+D | 15 | 12 | 18 | 26 | 50 | 23 | 28 |
| | I | 18 | 16 | 23 | 25 | 23 | 14 | 20 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 32 | 28 | 41 | 51 | 74 | 37 | 48 |
| ADT | N+D | 271 | 222 | 306 | 427 | 546 | 331 | 370 |
| | I | 275 | 259 | 349 | 379 | 347 | 218 | 307 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 546 | 481 | 656 | 802 | 893 | 549 | 677 |
| M/C | N+D | 348 | 296 | 379 | 492 | 537 | 390 | 416 |
| | I | 259 | 254 | 315 | 318 | 277 | 201 | 270 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 607 | 550 | 694 | 809 | 815 | 592 | 686 |
| TOTAL | N+D | 619 | 518 | 685 | 915 | 1084 | 722 | 786 |
| | I | 535 | 512 | 664 | 696 | 624 | 420 | 577 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 1153 | 1031 | 1349 | 1611 | 1709 | 1141 | 1363 |

TRAFFIC VOLUME ON ROUTE 6-2 (1993)

| LINK | | 1 | 2 | 3 | 4 | 5 | 6 | AVR. |
|---|---|---|---|---|---|---|---|---|
| P/C | N+D | 54 | 51 | 69 | 98 | 104 | 72 | 77 |
| | I | 43 | 41 | 45 | 51 | 60 | 44 | 49 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 107 | 92 | 114 | 149 | 164 | 115 | 126 |
| L/B | N+D | 51 | 41 | 55 | 78 | 83 | 57 | 62 |
| | I | 35 | 33 | 36 | 41 | 48 | 35 | 39 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 86 | 73 | 91 | 119 | 131 | 92 | 101 |
| M/B | N+D | 19 | 15 | 21 | 29 | 31 | 21 | 23 |
| | I | 13 | 12 | 13 | 15 | 18 | 13 | 15 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 32 | 27 | 34 | 45 | 49 | 35 | 38 |
| H/B | N+D | 28 | 22 | 30 | 42 | 45 | 31 | 33 |
| | I | 19 | 18 | 19 | 22 | 26 | 19 | 21 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 47 | 40 | 49 | 65 | 71 | 50 | 55 |
| P/P&T | N+D | 75 | 60 | 93 | 128 | 167 | 95 | 108 |
| | I | 53 | 49 | 55 | 65 | 76 | 54 | 60 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 128 | 109 | 148 | 193 | 243 | 149 | 169 |
| 4/T | N+D | 1 | 1 | 2 | 3 | 4 | 2 | 2 |
| | I | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 2 | 2 | 3 | 4 | 6 | 3 | 4 |
| 6/T | N+D | 22 | 17 | 35 | 46 | 77 | 35 | 43 |
| | I | 17 | 15 | 18 | 22 | 26 | 17 | 20 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 39 | 33 | 53 | 68 | 103 | 53 | 63 |
| 10/T | N+D | 16 | 12 | 25 | 33 | 55 | 25 | 31 |
| | I | 12 | 11 | 13 | 15 | 18 | 12 | 14 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 28 | 23 | 38 | 48 | 74 | 38 | 45 |
| ADT | N+D | 277 | 219 | 330 | 458 | 567 | 339 | 380 |
| | I | 193 | 179 | 199 | 233 | 275 | 195 | 219 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 469 | 398 | 529 | 691 | 842 | 534 | 599 |
| M/C | N+D | 351 | 290 | 382 | 504 | 541 | 393 | 415 |
| | I | 186 | 182 | 185 | 199 | 221 | 180 | 196 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 537 | 471 | 568 | 703 | 763 | 573 | 611 |
| TOTAL | N+D | 628 | 509 | 712 | 962 | 1109 | 731 | 795 |
| | I | 379 | 361 | 385 | 432 | 496 | 375 | 415 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 1006 | 870 | 1097 | 1393 | 1605 | 1107 | 1210 |

TRAFFIC VOLUME ON ROUTE 6-3 (1993)

| LINK | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | AVR. |
|---|---|---|---|---|---|---|---|---|---|
| P/C | N+D | 64 | 53 | 70 | 96 | 104 | 118 | 111 | 86 |
| | I | 63 | 59 | 81 | 87 | 89 | 75 | 63 | 75 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 126 | 112 | 151 | 183 | 193 | 193 | 174 | 161 |
| L/B | N+D | 51 | 42 | 56 | 77 | 83 | 95 | 99 | 69 |
| | I | 50 | 47 | 65 | 70 | 71 | 60 | 50 | 60 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 101 | 89 | 121 | 147 | 154 | 154 | 139 | 129 |
| M/B | N+D | 19 | 16 | 21 | 29 | 31 | 35 | 33 | 26 |
| | I | 19 | 18 | 24 | 26 | 27 | 22 | 19 | 22 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 38 | 34 | 45 | 55 | 58 | 58 | 52 | 48 |
| H/B | N+D | 28 | 23 | 30 | 42 | 45 | 51 | 48 | 37 |
| | I | 27 | 26 | 35 | 38 | 39 | 32 | 27 | 32 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 55 | 48 | 65 | 80 | 83 | 84 | 75 | 70 |
| P/P&T | N+D | 73 | 60 | 84 | 116 | 153 | 181 | 148 | 116 |
| | I | 77 | 72 | 101 | 111 | 113 | 95 | 80 | 94 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 150 | 132 | 185 | 227 | 266 | 277 | 228 | 210 |
| 4/T | N+D | 1 | 1 | 1 | 2 | 4 | 5 | 3 | 3 |
| | I | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 3 | 2 | 3 | 4 | 6 | 6 | 5 | 4 |
| 6/T | N+D | 21 | 17 | 26 | 36 | 65 | 80 | 55 | 44 |
| | I | 25 | 23 | 33 | 38 | 39 | 33 | 27 | 31 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 46 | 40 | 59 | 73 | 104 | 113 | 82 | 75 |
| 10/T | N+D | 15 | 12 | 18 | 26 | 46 | 57 | 39 | 31 |
| | I | 18 | 16 | 24 | 27 | 28 | 23 | 19 | 22 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 33 | 28 | 42 | 52 | 74 | 80 | 58 | 54 |
| ADT | N+D | 271 | 222 | 307 | 423 | 531 | 622 | 527 | 411 |
| | I | 280 | 263 | 365 | 398 | 407 | 343 | 287 | 339 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 551 | 486 | 672 | 821 | 938 | 965 | 813 | 751 |
| M/C | N+D | 348 | 295 | 379 | 492 | 535 | 595 | 559 | 450 |
| | I | 263 | 258 | 328 | 332 | 324 | 266 | 234 | 290 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 611 | 554 | 707 | 824 | 859 | 861 | 793 | 740 |
| TOTAL | N+D | 619 | 519 | 686 | 915 | 1066 | 1217 | 1036 | 861 |
| | I | 543 | 521 | 693 | 731 | 731 | 608 | 520 | 630 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 1162 | 1040 | 1378 | 1646 | 1797 | 1825 | 1606 | 1491 |

TRAFFIC VOLUME ON ROUTE 6-4 (1993)

| LINK | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | AVR. |
|---|---|---|---|---|---|---|---|---|---|
| P/C | N+D | 91 | 70 | 97 | 114 | 126 | 149 | 140 | 109 |
| | I | 63 | 60 | 93 | 90 | 99 | 90 | 77 | 91 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 144 | 130 | 171 | 204 | 225 | 239 | 217 | 189 |
| L/B | N+D | 65 | 56 | 70 | 91 | 101 | 119 | 112 | 86 |
| | I | 51 | 48 | 67 | 72 | 79 | 72 | 62 | 65 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 115 | 104 | 137 | 163 | 180 | 191 | 174 | 151 |
| M/B | N+D | 24 | 21 | 26 | 34 | 38 | 45 | 42 | 32 |
| | I | 19 | 18 | 25 | 27 | 30 | 27 | 23 | 24 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 43 | 39 | 51 | 61 | 67 | 72 | 65 | 57 |
| H/B | N+D | 35 | 30 | 38 | 49 | 54 | 65 | 60 | 47 |
| | I | 27 | 26 | 36 | 39 | 43 | 39 | 34 | 35 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 63 | 56 | 74 | 88 | 97 | 104 | 94 | 82 |
| P/P&T | N+D | 95 | 82 | 105 | 139 | 182 | 221 | 187 | 145 |
| | I | 79 | 74 | 105 | 115 | 128 | 117 | 100 | 104 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 174 | 156 | 211 | 254 | 310 | 338 | 287 | 249 |
| 4/T | N+D | 2 | 1 | 2 | 3 | 4 | 5 | 4 | 3 |
| | I | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 3 | 3 | 4 | 5 | 7 | 8 | 6 | 5 |
| 6/T | N+D | 28 | 24 | 33 | 44 | 75 | 94 | 69 | 54 |
| | I | 26 | 24 | 35 | 40 | 44 | 41 | 35 | 35 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 54 | 48 | 69 | 84 | 120 | 135 | 104 | 90 |
| 10/T | N+D | 20 | 17 | 24 | 31 | 54 | 67 | 50 | 39 |
| | I | 19 | 17 | 25 | 28 | 32 | 28 | 25 | 25 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 39 | 34 | 49 | 60 | 95 | 97 | 74 | 64 |
| ADT | N+D | 350 | 301 | 387 | 505 | 634 | 764 | 663 | 515 |
| | I | 286 | 270 | 378 | 413 | 457 | 418 | 358 | 372 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 636 | 570 | 765 | 919 | 1091 | 1183 | 1021 | 887 |
| M/C | N+D | 426 | 377 | 456 | 564 | 621 | 708 | 669 | 541 |
| | I | 255 | 250 | 324 | 330 | 344 | 302 | 271 | 299 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 681 | 626 | 779 | 895 | 965 | 1010 | 940 | 840 |
| TOTAL | N+D | 775 | 677 | 843 | 1070 | 1255 | 1473 | 1332 | 1056 |
| | I | 542 | 519 | 702 | 743 | 802 | 720 | 629 | 671 |
| | DV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 1317 | 1197 | 1545 | 1813 | 2056 | 2193 | 1961 | 1727 |

NOTE
N : NORMAL TRAFFIC D : DIVERTED TRAFFIC
DV : DEVELOPED TRAFFIC I : INDUCED TRAFFIC

## 3. AGRICULTURAL DEVELOPMENT

### 3-1 Crop Production

Sugar cane is the most predominant product in the area of influence. A big sugar refinery plant 3,000 ton per day, exists 7 km south of Amphoe Kao Lieo and collects about 350,000 tons of sugar cane annually from the surrounding sugar cane fields in Changwat Nakhon Sawan, Kamphaeng Phet and Uthai Thani. The factory still has enough capacity to absorb future increase of cane production in the area.

Second major products is paddy. Other crops share only 10% of the total production in the area.

Land use and capability in the area of influence is illustrated in Figure 6-3-2. Typical cropping calendar in Nakhon Sawan area is also shown in Figure 6-3-1. Based on the estimated planted area and yields, the future crop production in the area of influence after opening of the proposed road is given in the following Table 6-3-1 to 6-3-4.

### 3-2 Net Value Added

In accordance with the concept discussed in Chapter 4 of Summary Report, net value added was calculated for both cases, with project and without project. The agricultural development benefits, indicated by the increment of net value added of crop production in the with project case, attributable to the project are estimated as follows:

Agricultural Benefits
(Million Baht)

| Alternative | 1987 | 1993 | 2001 |
|---|---|---|---|
| 6-1 | 7.47 | 8.60 | 10.11 |
| 6-2 | 10.49 | 12.05 | 14.13 |
| 6-3 | 7.91 | 9.12 | 10.76 |
| 6-4 | 8.44 | 9.77 | 11.56 |

Figure 6-3-1 TYPICAL CROPPING CALENDAR - Route 6

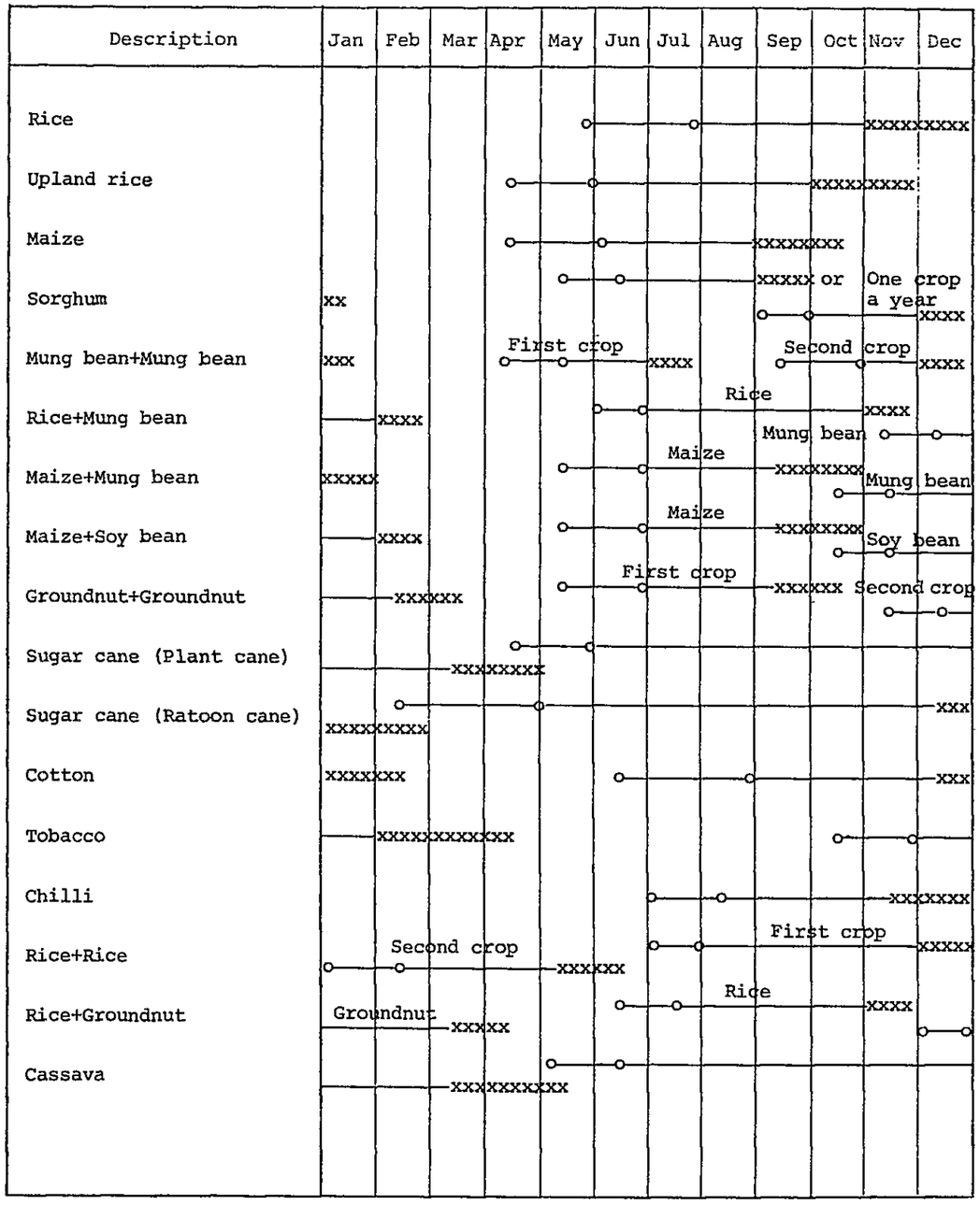


Figure 6-3-2 LAND USE AND CAPABILITY OF INFLUENCE AREA STUDY ROUTE NO. 6

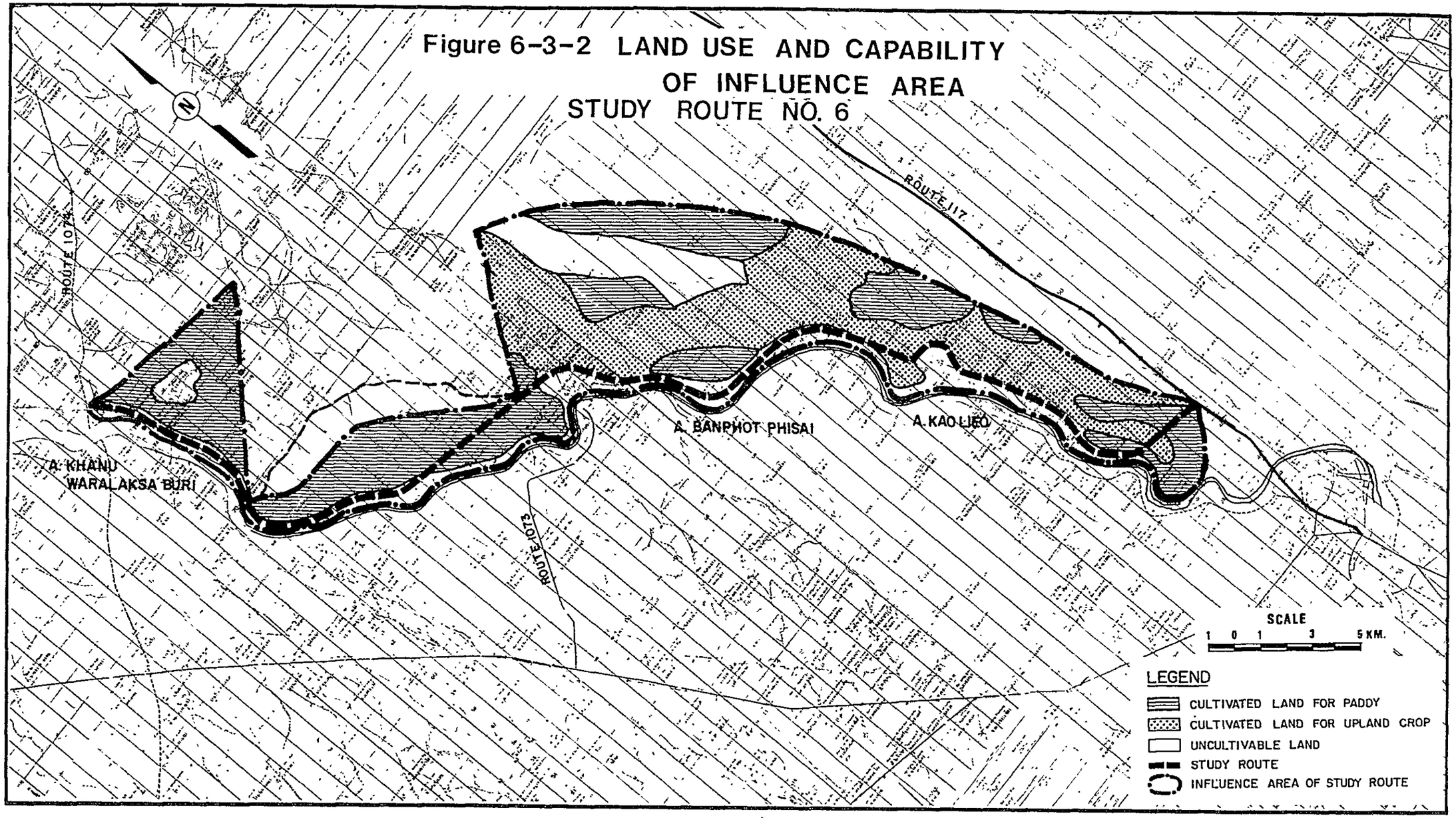


Table 6-3-1 CROP PRODUCTION - Route 6-1

(1000 TON)

| CROP | 1987 | | 1993 | | 2001 | |
|---|---|---|---|---|---|---|
| | W/O | W | W/O | W | W/O | W |
| PADDY | 29.9 | 29.9 | 30.0 | 30.5 | 30.3 | 31.3 |
| MAIZE | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| MUNG BEAN | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 2.0 |
| SOY BEAN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GROUND NUTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SORGHUM | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CASSAVA | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SUGAR CANE | 105.9 | 105.9 | 105.9 | 106.0 | 105.9 | 106.1 |
| TOBACCO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| COTTON | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GARLIC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CHILLI | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| SESAME | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| VEGETABLES | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| FRUITS | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| OTHERS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 6-3-2 CROP PRODUCTION - Route 6-2

(1000 TON)

| CROP | 1987 | | 1993 | | 2001 | |
|---|---|---|---|---|---|---|
| | W/O | W | W/O | W | W/O | W |
| PADDY | 41.0 | 41.1 | 41.3 | 41.9 | 41.6 | 42.9 |
| MAIZE | 2.9 | 2.9 | 2.9 | 3.0 | 2.9 | 3.0 |
| MUNG BEAN | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 | 3.5 |
| SOY BEAN | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| GROUND NUTS | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| SORGHUM | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CASSAVA | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| SUGAR CANE | 116.1 | 116.1 | 116.1 | 116.3 | 116.1 | 116.5 |
| TOBACCO | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| COTTON | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GARLIC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CHILLI | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| SESAME | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| VEGETABLES | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| FRUITS | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| OTHERS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 6-3-3 CROP PRODUCTION - Route 6-3

(1000 TON)

| CROP | 1987 | | 1993 | | 2001 | |
|---|---|---|---|---|---|---|
| | W/O | W | W/O | W | W/O | W |
| PADDY | 29.9 | 30.0 | 30.1 | 30.6 | 30.3 | 31.4 |
| MAIZE | 1.6 | 1.6 | 1.6 | 1.7 | 1.6 | 1.7 |
| MUNG BEAN | 2.1 | 2.1 | 2.1 | 2.2 | 2.1 | 2.2 |
| SOY BEAN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| GROUND NUTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SORGHUM | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| CASSAVA | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| SUGAR CANE | 100.5 | 100.5 | 100.5 | 100.7 | 100.5 | 100.9 |
| TOBACCO | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| COTTON | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GARLIC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CHILLI | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| SESAME | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| VEGETABLES | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 |
| FRUITS | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| OTHERS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Table 6-3-4 CROP PRODUCTION - Route 6-4

(1000 TON)

| CROP | 1987 | | 1993 | | 2001 | |
|---|---|---|---|---|---|---|
| | W/O | W | W/O | W | W/O | W |
| PADDY | 30.1 | 30.2 | 30.3 | 30.8 | 30.6 | 31.6 |
| MAIZE | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| MUNG BEAN | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| SOY BEAN | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| GROUND NUTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SORGHUM | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| CASSAVA | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| SUGAR CANE | 103.2 | 103.2 | 103.2 | 103.4 | 103.2 | 103.8 |
| TOBACCO | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| COTTON | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GARLIC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CHILLI | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| SESAME | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| VEGETABLES | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| FRUITS | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| OTHERS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

## 4. ROAD USERS COST SAVINGS

In accordance with the concept and basic data described in Chapter 5 of Summary Report, sums of VOC on each road link concerned were calculated in both cases of with project and without project.

Road users cost savings, defined as the difference of total link VOC in the case of with project and that in the without project case, were estimated as follows:

Road Users Cost Savings
(Million Baht/Year)

| Alternative | 1987 | 1993 | 2001 |
|---|---|---|---|
| 6-1 | 21.68 | 32.10 | 55.90 |
| 6-2 | 19.27 | 28.03 | 48.36 |
| 6-3 | 26.83 | 39.18 | 67.21 |
| 6-4 | 31.40 | 45.98 | 78.99 |

## 5. ENGINEERING

### 5-1 Soils and Materials[1/]

Test results of subgrade soil, materials for subbase and shoulders and crushed rocks along the route or in the vicinity of the project area are shown in Table 6-5-1.

Location of samplings for the tests above in this study are shown in the Location Map of Figure 6-1-1.

#### 5-1-1 Subgrade Soils

Subgrade soils along the study route consist mainly of silty clay and clayey silt of low and medium plasticity index ranging from 10.0 to 18.0%. They are classified as A-4 and A-7-6 in the AASHTO Classification. CBR values are from 2.0 to 3.5%.

#### 5-1-2 Subbase and Shoulder Materials

Since the study route lies in a flat area of recent alluvial basin, laterite deposits are not found along the route.

Materials for subbase and shoulder were planned to carry from the laterite deposits adjacent to project area. The nearest sources are Khao Kalon located 4 km southeast of B. Pa Phutsa and Khao I-Kok, 8 km northeast of B. Pa Phutsa as shown in the location map.

Test results of the laterites in these sources indicated that the plasticity index of the portion passing No. 4 sieve was from N.P. to 6.0% and the soaked CBR was from 60.0% to 90.0%. The laterites from these sources are suitable for use for subbase and shoulder.

Note: 1/ Some testing data in this section are extracted from the following source; "MATERIALS INVESTIGATION REPORT" Kamphaeng Phet - Tha Makhua - Pa Phutsa - Khanu Woralaksa Buri - Route 1 June 1979, Louis Berger International, Inc.

#### 5-1-3 Rock Material

Two rock quarries are available for the proposed road.
The rock source 6/R-1 is from Khao Rok Kachan, adjacent to national highway Rt. 1, about 30 km North - West from Nakhon Sawan. The aggregate is found to be sound durable limestone of good quality for pavement or concrete aggregates. The fine aggregates passing #40 sieve is non-plastic and Los Angeles abrasion loss was around 26%, far less than specified 40% in DOH specification. One test result indicated that the CBR value is 78%, a little bit less than DOH specified value.

Another rock source R-2 is from Khao Kalon, about 4 km East of Ban Pa Phutsa, beginning point of the proposed road. The rock is a blue-grey limestone with the specific gravity of 2.56. One CBR test showed a high value of 120%, but the abrasion loss was between 44 and 63 per cent.

### 5-2 Preliminary Design

Engineering studies on the proposed road are described by alternative route (6-1, 6-2, 6-3 and 6-4) formulated in Chapter 1.

Each alternative route comprises several segments as referred to the figure and table in Chapter 1:

| Alternative Route | Segments | Origin - Destination |
|---|---|---|
| 6-1 | ⓐ-A-ⓑ-C | Khanu W. Buri-Rt. 117 (B. Nong Huarua) |
| 6-2 | ⓐ-B-ⓑ-C | Khanu W. Buri-Rt. 117 (B. Nong Huarua) |
| 6-3 | ⓐ-A-ⓑ-ⓒ-D | Khanu W. Buri-Rt. 117 (B. Khok Kham Nua) |
| 6-4 | ⓐ-A-ⓑ-ⓒ-E | Khanu W. Buri-Rt. 117 (B. Don Doo) |

Table 6-5-1 TEST RESULTS OF SOILS AND MATERIALS

| Description | Sample No. | Location of Source (KM) | Depth (m) | Description of Sample | AASHO Classification | Sieve Analysis (% Passing) 50.0 | 25.0 | 19.0 | 9.5 | #4 | #10 | #40 | #200 | Plasticity LL (%) | PI (%) | Compaction DH-T STD. Opt. Mc.(%) | γd gm/cc. | Lab. CBR CBR (%) | Swell (%) | Moisture Content (After Soaked) (%) | Abrasion (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subgrade Soil | 6/S-1 | $6^{KM}$+700 (L.10m) | 0.2-1.0 | silty clay | A-4 | - | - | - | - | - | 100 | 98.6 | 92.8 | 33.0 | 10.2 | 17.8 | 1.684 | 2.8 | 1.24 | 19.9 | |
| | 6/S-2 | 19+500 (L.10) | 0.2-1.0 | silty clay | A-4 | - | - | - | - | - | 100 | 98.8 | 94.6 | 33.0 | 9.7 | 17.8 | 1.689 | 2.3 | 1.14 | 19.8 | |
| | 6/S-3 | 21+000 (L.10) | 0.3-1.0 | clayey silt | A-7-6 | - | - | - | - | - | 100 | 99.6 | 98.2 | 44.8 | 18.5 | 27.8 | 1.465 | 2.2 | 2.30 | 28.1 | |
| | 6/S-4 | 32+500 (L.7) | 0.15-1.0 | clayey silt | A-6 | - | - | - | - | 100 | 99.6 | 97.0 | 90.8 | 35.2 | 11.0 | 20.4 | 1.632 | 3.3 | 1.12 | 22.8 | |
| | 6/S-5 | 41+200 (L.7) | 0.3-1.0 | clayey silt | A-6 | - | - | - | - | 100 | 99.4 | 97.6 | 86.0 | 34.7 | 10.6 | 19.4 | 1.687 | 3.5 | 1.02 | 20.8 | |
| Subbase/ Shoulder Material[1] | 6/L-1 | Kao Kalom 4Km from B. Pa Phutsa | | | GM* | - | 100 | 97 | 79 | 46 | 21 | 16 | 14 | N - P | | 6.7 | 2.21 | 98.2 | 0 | 5.5 | |
| | 6/L-2 | Kao I KoK 8Km from B. Pa Phutsa | | | GM-GC* | - | 93 | 87 | 63 | 45 | 28 | 18 | 16 | 21 | 6 | 7.0 | 2.23 | 58.0 | 0 | 6.3 | |
| | 6/SA-1 | 15 Km upstream of B. Pa Phutsa | | coarse sand | - | - | - | - | - | - | #16 | #50 | #100 | N - P | | | | | | | |
| | | | | | - | - | - | - | 100 | 96.7 | 74.1 | 10.7 | 0.8 | | | | | | | | |
| Crushed Rock | 6/R-1 | Khao Rok Kachan Rt.1, Km. 274+500(R) | | lime stone | A-1-a | 100 | 94.7 | 91.5 | 76.0 | 51.3 | 30.9 | 10.5 | 4.7 | N - P | | 7.3** | 2.260** | 78.0 | - | | 27.4 |
| | 6/R-2 | Khao Kalom 4Km from B. Pa Phutsa | | lime stone | A-1-b | 100 | 93.1 | 87.0 | 73.7 | 63.2 | 44.6 | 26.5 | 20.5 | N - P | | 6.3** | 2.203** | 120.0 | 0.22 | | 63/0 |

Note: 1/ Extracted from "Materials Investigation Report", op. cit.

* Classification by Unified Method.

** Compaction by DH-T-MOD.

The design standards adopted for the preliminary designs is Class F4 of DOH Design Standard.

As the terrain is flat all along the proposed road, the design speed of 80 km/hr is taken except for villages sections where it is reduced to 40 km/hr.

5-2-1 Alignment and Earthwork

1) Alternative Route 6-1

As the horizontal and vertical alignments of this route are in fair condition, no major improvements of alignments to the existing road was required. However, the roads width is not enough for Design Standard. Widening required for this route varies from 0.3 to 6.0 m.

The raising up of the existing embankment is also necessary, the height of which ranges from 0.5 m to 1.5 m. The raising up section is indictaed in the Drawings.

A. Banphot Phisai and A. Kao Lieo where the existing road passes through, are densely populated with many houses close to the road. It was judged from the situation that the acquisition of right-of-way width of 20 m is difficult from the economical and social view points.

Bypasses were thus planned in these two Amphoe centers of populated areas, length of 7.0 km and 1.2 km, respectively.

The planned bypass at A. Banphot Phisai takes the route on swampy area. The embankment height proposed in the section was 2.0 m. For Kao Lieo bypass, 1.5 m high embankment was proposed.



The existing road of Segment C takes the route of north-eastern direction from A. Kao Lieo, thus constituting an unfavorable detoured route to Nakhon Sawan. For prompt access to/from Nakhon Sawan, a new alignment was planned on the extension of a part of the bypass proposed above. The new alignment section is 3,3 km long, with an average embankment height of 1.5 m.

2) Alternative Route 6-2

The alternative route 6-2 takes the route of Segment B instead of Segment A in the route 6-1.

The existing road in Segment B passes through flat area but rather curved horizontal alignment. But no major improvement of horizontal alignment was required.

Widening required for this route varies from 0.3 m to 6.0 m. and required raising up of the existing embankment ranges 0.5 m to 2.0 m.

For 2.9 km of the end section of this route, a new alignment was introduced to detour A. Banphot Phisai. As the new alignment takes the route on swampy area, 2.0 m high embankment was proposed for this section.

Other design features are referred to the descriptions mentioned in 1) above.

3) Alternative Route 6-3

The alternative route 6-3 takes the same route as Route 6-1 between the origin point and A. Kao Lieo.

Segment Ⓒ between Kao Lieo and B. Makulua passes through populated villages in full length. Private houses stand close to the shoulders, resulting in the the shortage of right-of-way width. Judging from the present situation, Bypass of 2.1 km long was planned in the east side of the existing road aovid-ing the houses. The embankment height of the bypass section is 1.5 m.

Segment D is a newly planned route in the route 6-3, connecting B. Makulua with Rt. 117 with short distance. The new alignment section is 2.9 km long, with an average embankment height of 1.5 m.

Other design features of this route are referred to the descriptions mentioned in alternative route 6-1.

4) Alternative Route 6-4

The alternative route 6-4 takes the route of Segment E instead of Segment D in the route 6-3.

The design features on the route until B. Makulua from the origin point are referred to the descriptions mentioned in 1) and 3) above.

Segment E was planned as new alignment section, The first 2.5 km is a bypass to avoid B. Makulua, B. Sra Ngam and B. Yang En along the existing road, and the remaining 2.0 km, as new access road to Rt. 117. Average embank-ment height in the new alignment section is 1.5 m.

5) Summary of Route Length

The length of route by alternative routes is summarized as follows:

(km)

| Alter-native Route | Improve-ment Section | New Construction Section | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | By-pass | | | Access Road | total | |
| | | Ban Phot Phisai | Kao Lieo | B. Ma-klua | | | |
| 6-1 | 27.6 | 7.0 | 1.2 | - | 3.7 | 11.9 | 39.5 |
| 6-2 | 33.0 | 2.9 | 1.2 | - | 3.7 | 7.8 | 40.8 |
| 6-3 | 29.6 | 7.0 | 2.8 | 2.1 | 2.9 | 14.8 | 44.4 |
| 6-4 | 29.7 | 7.0 | 2.8 | 2.5 | 4.0 | 16.3 | 46.0 |

## 5-2-2 Pavement Design

Pavement structures for F4 class road were designed in accordance with DOH Method introduced in Volume 1.

There is a sugar cane refinery factory at about 7.0 km south of A. Kao Lieo along the study road. For transportation of the sugar cane, traffic of over-loading heavy trucks which are about 30,000 kg in gross weight is expected. Therefore, in about 8.6 km long section near the sugar cane factory, the asphalt concrete pavement was designed taking this into considerations.

A) SBST

1) Design Traffic Number

There is no significant difference in ADT among the four alternative routes. Design traffic number was, therefore estimated based on ADT in 6-4 alter-native route as follows:

| Item | H/T | M/T | H/B | Total | Remark |
|---|---|---|---|---|---|
| Average number of Heavy Truck | 39 | 54 | 41 | 134 | ADT |
| at 1981 | 19.5 | 27 | 20.5 | 67 | One direction |
| Traffic Component (%) (a) | 29 | 40 | 31 | 100 | |
| Gross Weight (kg) (b) | 15,400 | 6,150 | 12,300 | | |
| Average Gross Weight (kg) (a) x (b) | 4,466 | 2,460 | 3,813 | 10,739 | |

Note: H/T : Heavy Truck
M/T : Medium Truck
H/B : Heavy Bus

When single-axle load limit is 8,200 kg, from the traffic analysis chart, (ITN) = 1.9.

As traffic growth rate is 6.0%.

Design Traffic Numbers (DTN) are ;

DTN 7 (7 years design period) = 19 x 0.42 ≒ 8

DTN 15 (15 year design period) = 19 x 1.16 ≒ 22

2) Design CBR

Design CBR (80% percentile value) was calculated corresponding to the number of tests.

| Test Value of CBR (%) | | | | | Design CBR |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | (%) |
| 2.8 | 2.3 | 2.2 | 3.3 | 3.5 | 2.5 |

3) Thickness of Pavement

i) Thickness of Full-Depth Asphalt Concrete

Entering the thickness design chart with DTN and Design CBR;

Pavement thickness for 7 years design period.

(TA7) = 220 mm

Pavement thickness for 15 years design period.

(TA15) = 250 mm

ii) Thickness of SBST Pavement

Assuming that substitution factor is 2.0 for crushed stone base and 2.7 for laterite subbase. Thickness of pavement structures of SBST was determined from calculated TA7 250 mm full depth asphalt concrete as follows.

| | | |
|---|---|---|
| SBST | | 12 mm |
| Crushed stone base | CBR ≧ 80 | 150 mm |
| Soil aggregate subbase | CBR ≧ 20 | 390 mm |

iii) Thickness of Overlay

TA15 - TA7 = 250 mm - 220 mm = 30 mm

When overlay is planned by SBST pavement, the thickness is:

| | | |
|---|---|---|
| SBST | | 12 mm |
| Crushed stone base | CBR ≧ 80 | 60 mm |

B) Asphalt Concrete Pavement

1) Design Traffic Number

Design of pavement was carried out based on ADT of link No. 6 in the alternative route 6-3.

According to forecasted O/D of agricultural products, 25% of heavy trucks are used for the transportation of agricultural and 95% of them is estimated to be used for the transportation of sugar cane.

The average gross weight of the heavy truck for the transportation of the sugar cane was estimated as follows:

Average Gross Weight of Heavy Truck for Sugar Cane

| Description | Gross Weight (kg) | Empty Rate (%) | Average Gross Weight (kg) |
|---|---|---|---|
| Laden | 30.000 | 60 | |
| Empty | 7.000 | 40 | 20,800 |

For the gross weights of other traffic, the values estimated in Volume 1 were applied.

Design traffic number was calculated by the following procedures:

| Item | Heavy Truck For Sugar Cane | Heavy Truck Others | Medium Truck | Heavy Bus | Total | Remark |
|---|---|---|---|---|---|---|
| Number of Heavy Truck at 1989 | 15 | 46 | 86 | 49 | 196 | ADT |
| | 7.5 | 23 | 43 | 29.5 | 98 | One Direction |
| Traffic Composition % (a) | 8 | 23 | 44 | 25 | 100 | |
| Gross Weight (kg) (b) | 20,800 | 15,400 | 6,150 | 12,300 | | |
| Average Gross Weight (kg) (a) x (b) | 1,664 | 3,542 | 2,706 | 3,075 | 10,987 | |

When single-axle load limit is 8,200 kg, from the traffic analysis chart, (ITN) = 33

As traffic growth rate is 6.0%,

Design Traffic Number (DTN) are;

DTN 7 (7 years design period) = 33 x 0.42 = 14

DTN 15 (15 years design period) = 33 x 1.16 = 38.5

2) Design CBR

Design CBR is the same value as used for the design of SBST.

3) Thickness of Pavement

i) Thickness of Full-Depth Asphat Concrete

Entering the thickness design chart with DTN and Design CBR;

Pavement thickness for 7 years design period.

(TA7) = 240 mm

Pavement thickness for 15 years design period.

(TA15) = 270 mm

ii) Thickness of Asphalt Concrete Pavement

Considering workability, the thickness of the asphalt concrete surface was determined at 50 mm.

Where the thickness of the crushed stone base is 150 mm, the pavement structures are as follows:

| | | |
|---|---|---|
| Asphalt concrete surface | | 50 mm |
| Crushed stone base | CBR $\geq$ 80 | 150 mm |
| Soil aggregate subbase | CBR $\geq$ 20 | 330 mm |

iii) Thickness of Overlay

TA15 - TA7 = 270 mm - 240 mm = 30 mm

30 m thickness of overlay was calculated theoretically. However 40 mm thickness of overlay by asphalt concrete was finally designed considering workability.

5-2-3 Drainage

Pipe culverts with the diameter of 1 m were installed at the intervals of 200 m for all alternative routes, except for segment ⓑ and ⓒ, where intervals of 500 m were proposed.

Box culvert (2.4m x 2.4m) was planned at the water course having small catchment area. The number of cells of culvert was determined by comparing discharge with flow capacity.

Box culvert was proposed only in one place of Segment ⓒ related to the alternative route 6-3 and 6-4 as follows:

List of Box Culvert

| Station | Existing Structure | Catchment Area ($km^2$) | Intensity (mm/h) | Discharge ($m^3$/sec) | Proposed Structure | Capacity ($m^3$/sec) |
|---|---|---|---|---|---|---|
| 41+300 | - | 3 | 60 | 40 | C-B-2 (2.4x2.4) -10.0 | 50 |

5-2-4 Bridge

Short span concrete bridges were planned where the river is relatively narrow and shallow. The length of bridges was determined by comparing discharge with flow capacity of bridge opening.

The proposed bridges are shown in the following tables by route alternative.

Study Route No. 6-1

List of Bridge

| Station | Existing Structure | Catchment Area ($km^3$) | Intensity (mm/h) | Discharge ($m^3$/sec) | Proposed Structure | Capacity ($m^3$/sec) |
|---|---|---|---|---|---|---|
| 15+800 | C-B-4 (1.8x1.8) -4.0 | 5 | 57 | 62 | BR-C (7.0x10.0) | 63 |
| 22+200 | - | 10 | 45 | 97 | BR-C (7.0x14.0) | 98 |

Total length = 24.0 m

Study Route No. 6-2

List of Bridge

| Station | Existing Structure | Catchment Area ($km^3$) | Intensity (mm/h) | Discharge ($m^3$/sec) | Proposed Structure | Capacity ($m^3$/sec) |
|---|---|---|---|---|---|---|
| 15+700 | BR-T (4.0x7.5) | 4 | 70 | 62 | BR-C (7.0x10.0) | 63 |
| 22+200 | - | 10 | 45 | 97 | BR-C (7.0x14.0) | 98 |

Total length = 24.0 m

Study Route No. 6-3/6-4

List of Bridge

| Station | Existing Structure | Catchment Area ($km^3$) | Intensity (mm/h) | Discharge ($m^3$/sec) | Proposed Structure | Capacity ($m^3$/sec) |
|---|---|---|---|---|---|---|
| 15+800 | BR-T ((1.8x1.8) -4.0 | 5 | 57 | 62 | BR-C (7.0x10.0) | 63 |
| 22+200 | - | 10 | 45 | 97 | BR-C (7.0x14.0) | 98 |
| 36+800 | - | 13 | 37 | 102 | BR-C (7.0x15.0) | 106 |

Total length = 39.0 m

## 6. CONSTRUCTION COST

Construction costs were obtained by applying the unit rates to the respective work quantities calculated on the basis of the engineering studies.

Rock materials used for SBST, asphaltic concrete, base course and structure works were supposed to be transported from rock quarries 6/R-1 and 6/R-2 with a weighted average hauling distance of 36 km. The transportation cost for this hauling distance was reflected to each unit rate.

The construction cost together with land acquisition cost are given in Table 6-6-1.

The construction period for the proposed road was estimated to be 3 years. Yearly disbursements of construction cost together with price contingency are shown in the following table.

YEARLY COST DISBURSEMENT - Route 6-4

(Million Baht)

| | 1984 | | 1985 | | 1986 | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | L/C[1/] | F/C[2/] | L/C | F/C | L/C | F/C | L/C | F/C | Total |
| Construction Cost | 11.5 | 10.5 | 28.7 | 26.4 | 17.2 | 15.9 | 57.4 | 52.8 | 110.2 |
| Price Contingency[3/] | 3.7 | 1.7 | 13.0 | 6.2 | 10.3 | 4.9 | 27.0 | 12.8 | 39.8 |
| Total | 15.2 | 12.2 | 41.7 | 32.6 | 27.5 | 20.8 | 84.4 | 65.6 | 150.0 |
| | | | | | | | (3.68) | (2.85) | (6.53) |

Note: 1/ Local Currency

2/ Foreign Currency

3/ At assumed annual escalation rates as follows (% p.a.):

| | Local C. | Foreign C. |
|---|---|---|
| 1981 - 1983 | 15 | 7.5 |
| 1983 - 1987 | 10 | 6.5 |

( ) Million US$ Equivalent (1US$ = 22.63 Baht)

Table 6.6.1 CONSTRUCTION COST - Route 6

| Description | Unit of quantity | Financial Unit Rate (Baht) | 6-1 (F-4/39.5 KM) Quantity | 6-1 Economic Cost ($10^3$ ฿) | 6-2 (F-4/40.8 KM) Quantity | 6-2 Economic Cost ($10^3$ ฿) | 6-3 (F-4/44.4 KM) Quantity | 6-3 Economic Cost ($10^3$ ฿) | 6-4 (F-4/46.0 KM) Quantity | 6-4 Economic Cost ($10^3$ ฿) |
|---|---|---|---|---|---|---|---|---|---|---|
| Clearing & Grubbing | ha | 17,000 | 93 | 1,439 | 92 | 1,423 | 106 | 1,640 | 110 | 1,702 |
| Roadway Excavation - Classified Earth | $m^3$ | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Road Excavation - Classified Soft Rock | $m^3$ | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Embankment - Side Borrow | $m^3$ | 45 | 421,200 | 17,248 | 389,700 | 15,958 | 467,300 | 19,136 | 499,300 | 20,466 |
| Embankment - Borrow Pit | $m^3$ | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Embankment - Selected Material | $m^3$ | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subbase - Soil Aggregate | $m^3$ | 106 | 159,900 | 15,085 | 165,200 | 15,585 | 179,700 | 16,953 | 186,200 | 17,566 |
| Base - Crushed Rock | $m^3$ | 309 | 38,500 | 10,945 | 39,800 | 11,314 | 43,300 | 12,309 | 44,900 | 12,764 |
| Shoulder - Soil Aggregate | $m^3$ | 170 | 16,600 | 2,512 | 17,100 | 2,587 | 18,600 | 2,814 | 19,300 | 2,920 |
| Asphaltic Prime Coat | $m^2$ | 10.8 | 256,800 | 2,552 | 265,200 | 2,635 | 288,600 | 2,868 | 299,000 | 2,971 |
| Single Bituminous Surface Treatment | $m^2$ | 27.6 | 217,300 | 5,398 | 224,400 | 5,574 | 244,200 | 6,066 | 253,000 | 6,285 |
| R.C. Pipe Culvert | m | 2,400 | 1,880 | 4,151 | 1,880 | 4,151 | 2,090 | 4,514 | 2,210 | 4,880 |
| R.C. Box Culvert | m | 18,000 | 0 | 0 | 0 | 0 | 20 | 324 | 20 | 324 |
| R.C. Bridge - Short Span | m | 39,500 | 24 | 844 | 24 | 844 | 39 | 1,371 | 39 | 1,371 |
| P.C. Bridge - Long Span | m | 68,700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-total | | | | 60,174 | | 60,071 | | 67,995 | | 71,229 |
| Miscellaneous Works[1/] | | | | 4,212 | | 4,205 | | 4,760 | | 4,986 |
| Total Direct Construction Cost | | | | 64,386 | | 64,276 | | 72,755 | | 76,215 |
| PHYSICAL CONTINGENCY[2/] | | | | 9,658 | | 9,641 | | 10,913 | | 11,432 |
| DESIGN AND CONSTRUCTION SUPERVISION[3/] | | | | 6,439 | | 6,428 | | 7,276 | | 7,622 |
| Total | | | | 80,483 | | 80,345 | | 90,944 | | 95,269 |
| Land Acquisition | | | | | | | | | | |
| Highly Devel'd Land | ha | 50,000 | 85 | 4,250 | 77 | 3,850 | 96 | 4,800 | 102 | 5,100 |
| Less Devel'd Land | ha | 15,000 | 1 | 15 | 1 | 15 | 1 | 15 | 1 | 15 |
| Grand Total | | | | 84,748 | | 84,210 | | 95,759 | | 100,384 |
| FINANCIAL COST ($10^3$ Baht) | | | | (93,118) | | (92,587) | | (105,606) | | (110,306) |

Note: 1/ 7% of direct construction cost of major work items.
2/ 15% of direct construction cost.
3/ 10% of direct construction cost.

## 7. EVALUATION

In accordance with the basic conditions of economic evaluation discussed in Summary Report and economic costs and benefits as estimated in the foregoing sections, internal rate of return was calculated for each alternative as follows:

| | | IRR |
|---|---|---|
| Alternative | 6-1 | 25.8 % |
| " | 6-2 | 25.8 % |
| " | 6-3 | 26.7 % |
| " | 6-4 | 28.5 % |

Details of costs and benefit streams are given in Table 6-7-1 to 6-7-5 Having the highest IRR, Alternative 6-4 is recommendable to be selected. Furthermore, Alternative 6-4 is most desirable in view of the better services to the local population, while Alternative 6-3 is best positioned to serve for sugar cane transportation during only a limitted period in a year.

Considering that it is usual practice for sugar cane transportation to load more than 20 tons per truck, asphalt concrete pavement was planned for a section of 8.6 km which is used to have heavy sugar cane traffic. Due to this measure, construction cost was raised up 3.3% and IRR was reduced to 27.9% from 28.5%.

Table 6-7-1 COSTS AND BENEFITS STATEMENT - Route 6-1

(1000 BAHT)

| | COST | BENEFITS | | | | DISCOUNTED(12%) | |
|---|---|---|---|---|---|---|---|
| YEAR | CONST. COST | AGRI. BENEFIT | VOC SAVING | RMC SAVING | TOTAL | COST | BENEFIT |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 16,950 | 0 | 0 | 0 | 0 | 23,814 | 0 |
| 1985 | 42,370 | 0 | 0 | 0 | 0 | 53,149 | 0 |
| 1986 | 25,428 | 0 | 0 | 0 | 0 | 28,479 | 0 |
| 1987 | 0 | 7,470 | 21,683 | -11 | 29,142 | 0 | 26,020 |
| 1988 | 0 | 7,659 | 23,419 | 18 | 31,096 | 0 | 24,789 |
| 1989 | 0 | 7,848 | 25,155 | 47 | 33,049 | 0 | 23,524 |
| 1990 | 0 | 8,037 | 26,890 | 76 | 35,003 | 0 | 22,245 |
| 1991 | 0 | 8,225 | 28,626 | 105 | 36,956 | 0 | 20,970 |
| 1992 | 0 | 8,414 | 30,362 | 134 | 38,910 | 0 | 19,713 |
| 1993 | 0 | 8,603 | 32,098 | 162 | 40,863 | 0 | 18,485 |
| 1994 | 27,111 | 8,792 | 35,073 | 212 | 44,077 | 12,264 | 17,802 |
| 1995 | 0 | 8,981 | 38,048 | 262 | 47,291 | 0 | 17,054 |
| 1996 | 0 | 9,170 | 41,023 | 312 | 50,504 | 0 | 16,261 |
| 1997 | 0 | 9,359 | 43,998 | 361 | 53,718 | 0 | 15,443 |
| 1998 | 0 | 9,547 | 46,973 | 411 | 56,931 | 0 | 14,613 |
| 1999 | 0 | 9,736 | 49,948 | 461 | 60,145 | 0 | 13,784 |
| 2000 | 0 | 9,925 | 52,923 | 511 | 63,359 | 0 | 12,964 |
| 2001 | -41,287 | 10,114 | 55,898 | 560 | 66,572 | -7,543 | 12,163 |
| TOTAL | 70,572 | 131,879 | 552,117 | 3,621 | 687,617 | 110,162 | 275,828 |

| | |
|---|---|
| DISCOUNTED ECONOMIC COSTS : | 110,162 |
| DISCOUNTED ECONOMIC BENEFITS : | 275,828 |
| AGRICULTURAL DEVELOPMENT BENEFIT | 57,283 |
| VOC SAVING | 217,456 |
| RMC SAVING | 1,090 |
| NET PRESENT VALUE : | 165,666 |
| BENEFIT COST RATIO : | 2.50 |
| INTERNAL RATE OF RETURN : | 25.8 % |

Table 6-7-2 COSTS AND BENEFITS STATEMENT - Route 6-2

(1000 BAHT)

| YEAR | COST | BENEFITS | | | | DISCOUNTED(12%) | |
|---|---|---|---|---|---|---|---|
| | CONST. COST | AGRI. BENEFIT | VOC SAVING | RMC SAVING | TOTAL | COST | BENEFIT |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 16,840 | 0 | 0 | 0 | 0 | 23,659 | 0 |
| 1985 | 42,100 | 0 | 0 | 0 | 0 | 52,810 | 0 |
| 1986 | 25,270 | 0 | 0 | 0 | 0 | 28,302 | 0 |
| 1987 | 0 | 10,490 | 19,265 | 20 | 29,774 | 0 | 26,584 |
| 1988 | 0 | 10,750 | 20,725 | 40 | 31,515 | 0 | 25,123 |
| 1989 | 0 | 11,010 | 22,186 | 59 | 33,255 | 0 | 23,670 |
| 1990 | 0 | 11,270 | 23,646 | 79 | 34,995 | 0 | 22,240 |
| 1991 | 0 | 11,530 | 25,106 | 99 | 36,736 | 0 | 20,845 |
| 1992 | 0 | 11,790 | 26,567 | 119 | 38,476 | 0 | 19,493 |
| 1993 | 0 | 12,050 | 28,027 | 139 | 40,216 | 0 | 18,192 |
| 1994 | 27,870 | 12,310 | 30,569 | 174 | 43,052 | 12,607 | 17,388 |
| 1995 | 0 | 12,570 | 33,110 | 209 | 45,889 | 0 | 16,548 |
| 1996 | 0 | 12,829 | 35,651 | 245 | 48,725 | 0 | 15,688 |
| 1997 | 0 | 13,089 | 38,192 | 280 | 51,562 | 0 | 14,823 |
| 1998 | 0 | 13,349 | 40,734 | 315 | 54,398 | 0 | 13,963 |
| 1999 | 0 | 13,609 | 43,275 | 351 | 57,234 | 0 | 13,117 |
| 2000 | 0 | 13,868 | 45,816 | 386 | 60,071 | 0 | 12,292 |
| 2001 | -40,824 | 14,128 | 48,357 | 421 | 62,907 | -7,458 | 11,493 |
| TOTAL | 71,256 | 184,641 | 481,226 | 2,937 | 668,804 | 109,920 | 271,458 |

DISCOUNTED ECONOMIC COSTS : 109,920

DISCOUNTED ECONOMIC BENEFITS : 271,458

| | |
|---|---|
| AGRICULTURAL DEVELOPMENT BENEFIT | 80,263 |
| VOC SAVING | 190,252 |
| RMC SAVING | 943 |

NET PRESENT VALUE : 161,538

BENEFIT COST RATIO : 2.47

INTERNAL RATE OF RETURN : 25.8 %

Table 6-7-3 COSTS AND BENEFITS STATEMENT - Route 6-3

(1000 BAHT)

| YEAR | COST | BENEFITS | | | | DISCOUNTED(12%) | |
|---|---|---|---|---|---|---|---|
| | CONST. COST | AGRI. BENEFIT | VOC SAVING | RMC SAVING | TOTAL | COST | BENEFIT |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 19,150 | 0 | 0 | 0 | 0 | 26,904 | 0 |
| 1985 | 47,880 | 0 | 0 | 0 | 0 | 60,061 | 0 |
| 1986 | 28,729 | 0 | 0 | 0 | 0 | 32,176 | 0 |
| 1987 | 0 | 7,910 | 26,832 | -13 | 34,729 | 0 | 31,008 |
| 1988 | 0 | 8,114 | 28,890 | 18 | 37,022 | 0 | 29,514 |
| 1989 | 0 | 8,317 | 30,947 | 49 | 39,314 | 0 | 27,983 |
| 1990 | 0 | 8,521 | 33,005 | 81 | 41,607 | 0 | 26,442 |
| 1991 | 0 | 8,725 | 35,063 | 112 | 43,899 | 0 | 24,910 |
| 1992 | 0 | 8,928 | 37,120 | 143 | 46,192 | 0 | 23,402 |
| 1993 | 0 | 9,132 | 39,178 | 174 | 48,484 | 0 | 21,932 |
| 1994 | 30,470 | 9,336 | 42,682 | 228 | 52,246 | 13,783 | 21,101 |
| 1995 | 0 | 9,540 | 46,186 | 282 | 56,008 | 0 | 20,197 |
| 1996 | 0 | 9,744 | 49,690 | 335 | 59,769 | 0 | 19,244 |
| 1997 | 0 | 9,948 | 53,194 | 389 | 63,531 | 0 | 18,264 |
| 1998 | 0 | 10,152 | 56,698 | 443 | 67,293 | 0 | 17,272 |
| 1999 | 0 | 10,356 | 60,202 | 497 | 71,055 | 0 | 16,284 |
| 2000 | 0 | 10,560 | 63,706 | 550 | 74,817 | 0 | 15,309 |
| 2001 | -46,649 | 10,764 | 67,210 | 604 | 78,579 | -8,523 | 14,356 |
| TOTAL | 79,580 | 140,047 | 670,605 | 3,892 | 814,544 | 124,402 | 327,218 |

DISCOUNTED ECONOMIC COSTS : 124,402

DISCOUNTED ECONOMIC BENEFITS : 327,218

| | |
|---|---|
| AGRICULTURAL DEVELOPMENT BENEFIT | 60,785 |
| VOC SAVING | 265,265 |
| RMC SAVING | 1,168 |

NET PRESENT VALUE : 202,816

BENEFIT COST RATIO : 2.63

INTERNAL RATE OF RETURN : 26.7 %

Table 6-7-4 COSTS AND BENEFITS STATEMENT - Route 6-4

(1000 BAHT)

| YEAR | COST | BENEFITS | | | | DISCOUNTED(12%) | |
|---|---|---|---|---|---|---|---|
| | CONST. COST | AGRI. BENEFIT | VOC SAVING | RMC SAVING | TOTAL | COST | BENEFIT |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 20,080 | 0 | 0 | 0 | 0 | 28,211 | 0 |
| 1985 | 50,190 | 0 | 0 | 0 | 0 | 62,958 | 0 |
| 1986 | 30,114 | 0 | 0 | 0 | 0 | 33,728 | 0 |
| 1987 | 0 | 8,440 | 31,399 | -19 | 39,820 | 0 | 35,553 |
| 1988 | 0 | 8,661 | 33,829 | 13 | 42,503 | 0 | 33,883 |
| 1989 | 0 | 8,882 | 36,258 | 46 | 45,186 | 0 | 32,163 |
| 1990 | 0 | 9,103 | 38,688 | 78 | 47,869 | 0 | 30,422 |
| 1991 | 0 | 9,324 | 41,118 | 111 | 50,553 | 0 | 28,685 |
| 1992 | 0 | 9,545 | 43,548 | 143 | 53,236 | 0 | 26,971 |
| 1993 | 0 | 9,766 | 45,978 | 175 | 55,919 | 0 | 25,295 |
| 1994 | 31,570 | 9,987 | 50,104 | 232 | 60,323 | 14,281 | 24,364 |
| 1995 | 0 | 10,209 | 54,231 | 288 | 64,727 | 0 | 23,341 |
| 1996 | 0 | 10,430 | 58,357 | 344 | 69,131 | 0 | 22,258 |
| 1997 | 0 | 10,651 | 62,484 | 401 | 73,535 | 0 | 21,140 |
| 1998 | 0 | 10,872 | 66,610 | 457 | 77,939 | 0 | 20,005 |
| 1999 | 0 | 11,094 | 70,737 | 514 | 82,344 | 0 | 18,871 |
| 2000 | 0 | 11,315 | 74,863 | 570 | 86,748 | 0 | 17,750 |
| 2001 | -48,939 | 11,536 | 78,990 | 626 | 91,152 | -8,941 | 16,653 |
| TOTAL | 83,015 | 149,814 | 787,191 | 3,980 | 940,985 | 130,237 | 377,354 |

| | |
|---|---|
| DISCOUNTED ECONOMIC COSTS : | 130,237 |
| DISCOUNTED ECONOMIC BENEFITS : | 377,354 |
| AGRICULTURAL DEVELOPMENT BENEFIT | 64,982 |
| VOC SAVING | 311,192 |
| RMC SAVING | 1,181 |
| NET PRESENT VALUE : | 247,118 |
| BENEFIT COST RATIO : | 2.90 |
| INTERNAL RATE OF RETURN : | 28.5 % |

Table 6-7-5 COSTS AND BENEFITS STATEMENT - ROUTE 6-4 (with Asphalt Concrete)

(1000 BAHT)

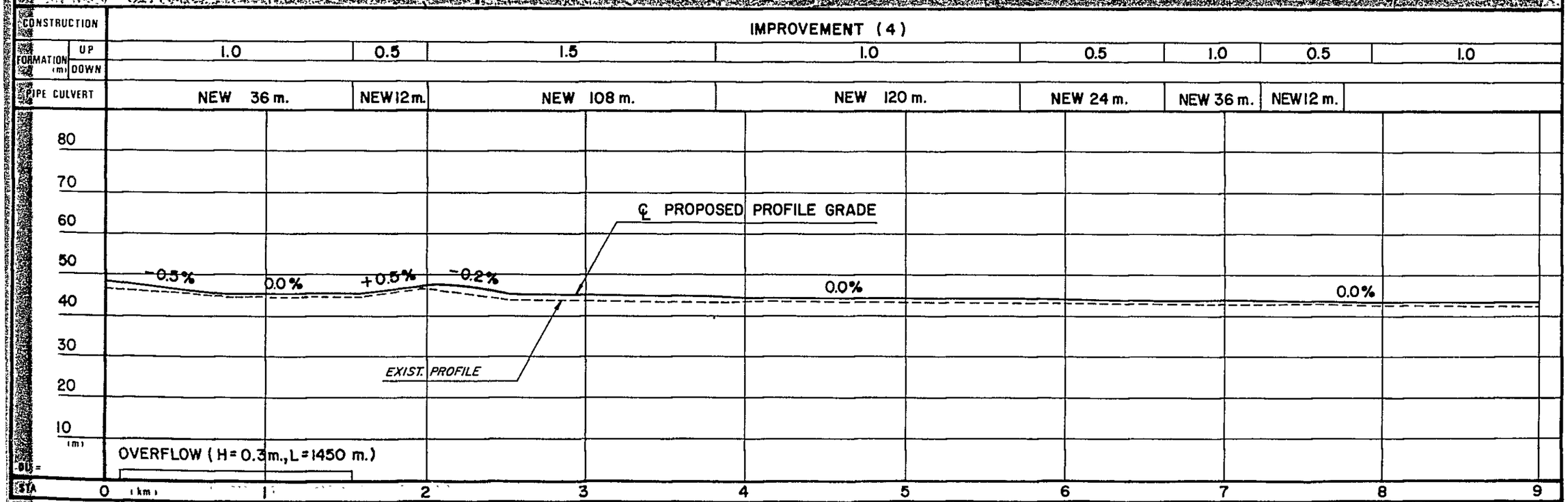
| YEAR | COST | BENEFITS | | | | DISCOUNTED(12%) | |
|---|---|---|---|---|---|---|---|
| | CONST. COST | AGRI. BENEFIT | VOC SAVING | RMC SAVING | TOTAL | COST | BENEFIT |
| 1983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 20,742 | 0 | 0 | 0 | 0 | 29,141 | 0 |
| 1985 | 51,855 | 0 | 0 | 0 | 0 | 65,047 | 0 |
| 1986 | 31,113 | 0 | 0 | 0 | 0 | 34,847 | 0 |
| 1987 | 0 | 8,440 | 31,399 | -19 | 39,820 | 0 | 35,553 |
| 1988 | 0 | 8,661 | 33,829 | 13 | 42,503 | 0 | 33,883 |
| 1989 | 0 | 8,882 | 36,258 | 46 | 45,186 | 0 | 32,163 |
| 1990 | 0 | 9,103 | 38,688 | 78 | 47,869 | 0 | 30,422 |
| 1991 | 0 | 9,324 | 41,118 | 111 | 50,553 | 0 | 28,685 |
| 1992 | 0 | 9,545 | 43,548 | 143 | 53,236 | 0 | 26,971 |
| 1993 | 0 | 9,766 | 45,978 | 175 | 55,919 | 0 | 25,295 |
| 1994 | 30,795 | 9,987 | 50,104 | 232 | 60,323 | 13,930 | 24,364 |
| 1995 | 0 | 10,209 | 54,231 | 288 | 64,727 | 0 | 23,341 |
| 1996 | 0 | 10,430 | 58,357 | 344 | 69,131 | 0 | 22,258 |
| 1997 | 0 | 10,651 | 62,484 | 401 | 73,535 | 0 | 21,140 |
| 1998 | 0 | 10,872 | 66,610 | 457 | 77,939 | 0 | 20,005 |
| 1999 | 0 | 11,094 | 70,737 | 514 | 82,344 | 0 | 18,871 |
| 2000 | 0 | 11,315 | 74,863 | 570 | 86,748 | 0 | 17,750 |
| 2001 | -50,469 | 11,536 | 78,990 | 626 | 91,152 | -9,221 | 16,653 |
| TOTAL | 84,036 | 149,814 | 787,191 | 3,980 | 940,985 | 133,744 | 377,354 |

| | |
|---|---|
| DISCOUNTED ECONOMIC COSTS : | 133,744 |
| DISCOUNTED ECONOMIC BENEFITS : | 377,354 |
| AGRICULTURAL DEVELOPMENT BENEFIT | 64,982 |
| VOC SAVING | 311,192 |
| RMC SAVING | 1,181 |
| NET PRESENT VALUE : | 243,610 |
| BENEFIT COST RATIO : | 2.82 |
| INTERNAL RATE OF RETURN : | 27.9 % |

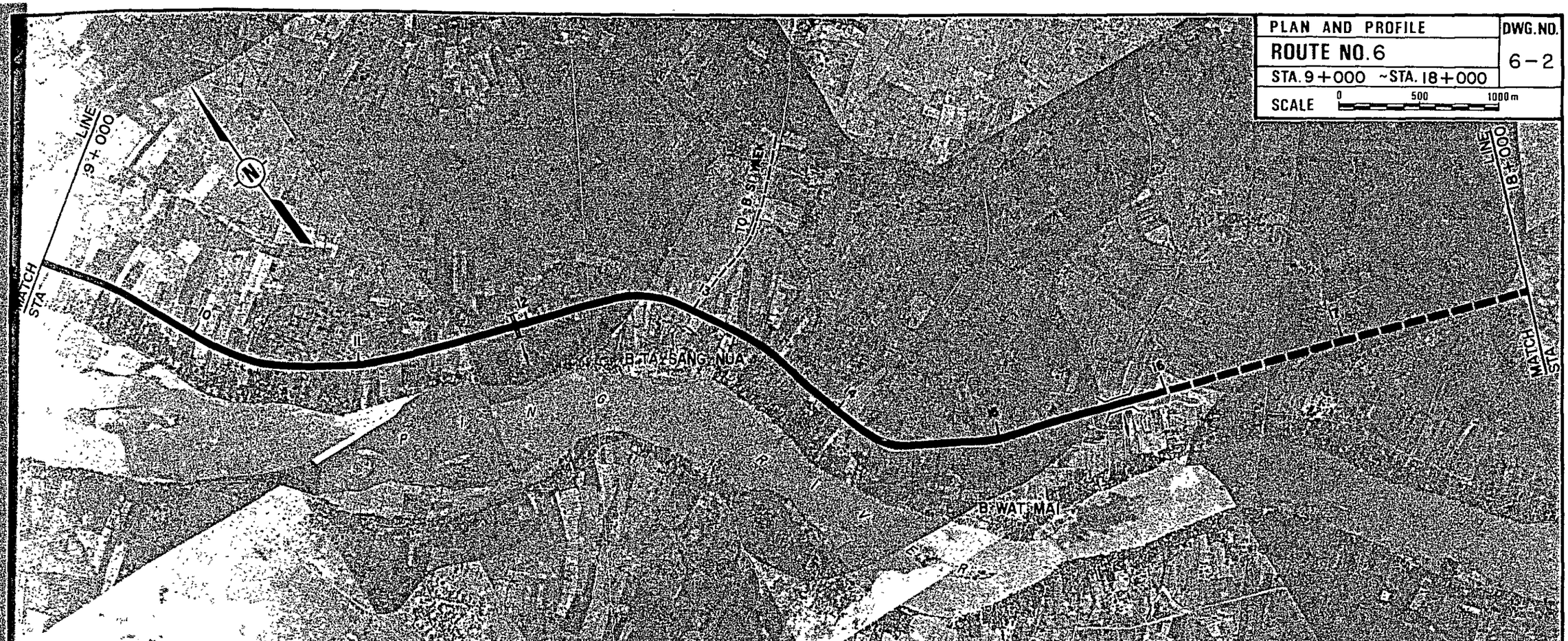
## ABBREVIATIONS for PLAN and PROFILE

| | |
|---|---|
| C-P-nøa - $\ell$ | EXISTING PIPE CULVERT, n (ROW), ø a (DIAMETER, M), $\ell$ (LENGTH, M) |
| C-B-n (a x b) - $\ell$ | EXISTING (below grade line) and PROPOSED (above grade line) BOX CULVERT, n (NOS. OF TUBE), a x b (LATERAL x VERTICAL, M), $\ell$ (LENGTH, M) |
| BR-T (a x $\ell$) (n) | EXISTING (below grade line) and PROPOSED (above grade line) TIMBER BRIDGE, a x $\ell$ (WIDTH x LENGTH, M), n (NOS. OF SPAN) |
| BR-C (a x $\ell$) (n) | EXISTING (below grade line) and PROPOSED (above grade line) CONCRETE BRIDGE, a x $\ell$ (CARRIAGE WAY WIDTH x LENGTH, M), n (NOS. OF SPAN) |

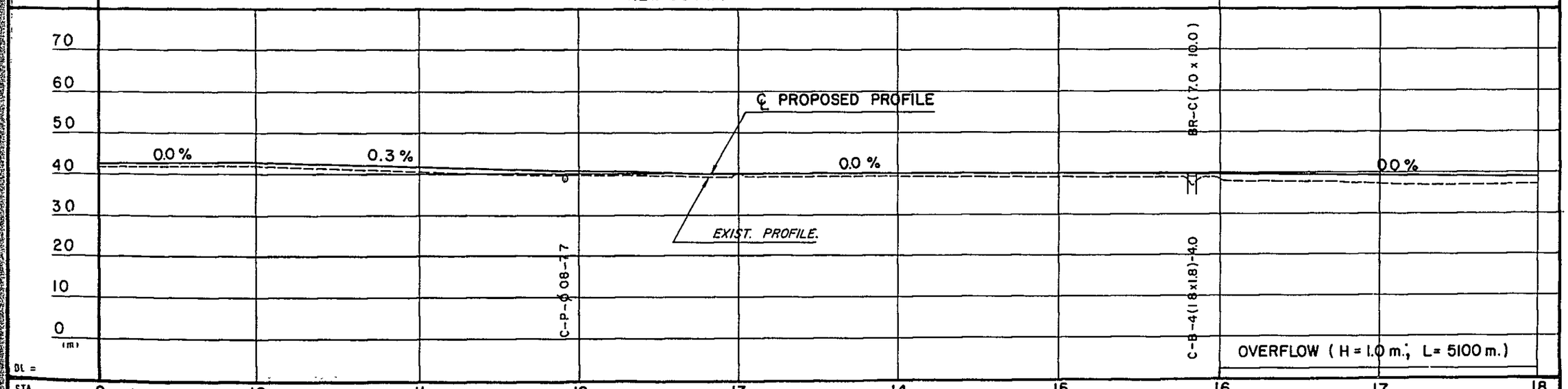
| PLAN AND PROFILE | DWG. NO. |
|---|---|
| ROUTE NO. 6 | 6 - 1 |
| STA 0+000 ~STA. 9+000 | |
| SCALE 0 500 1000 m | |

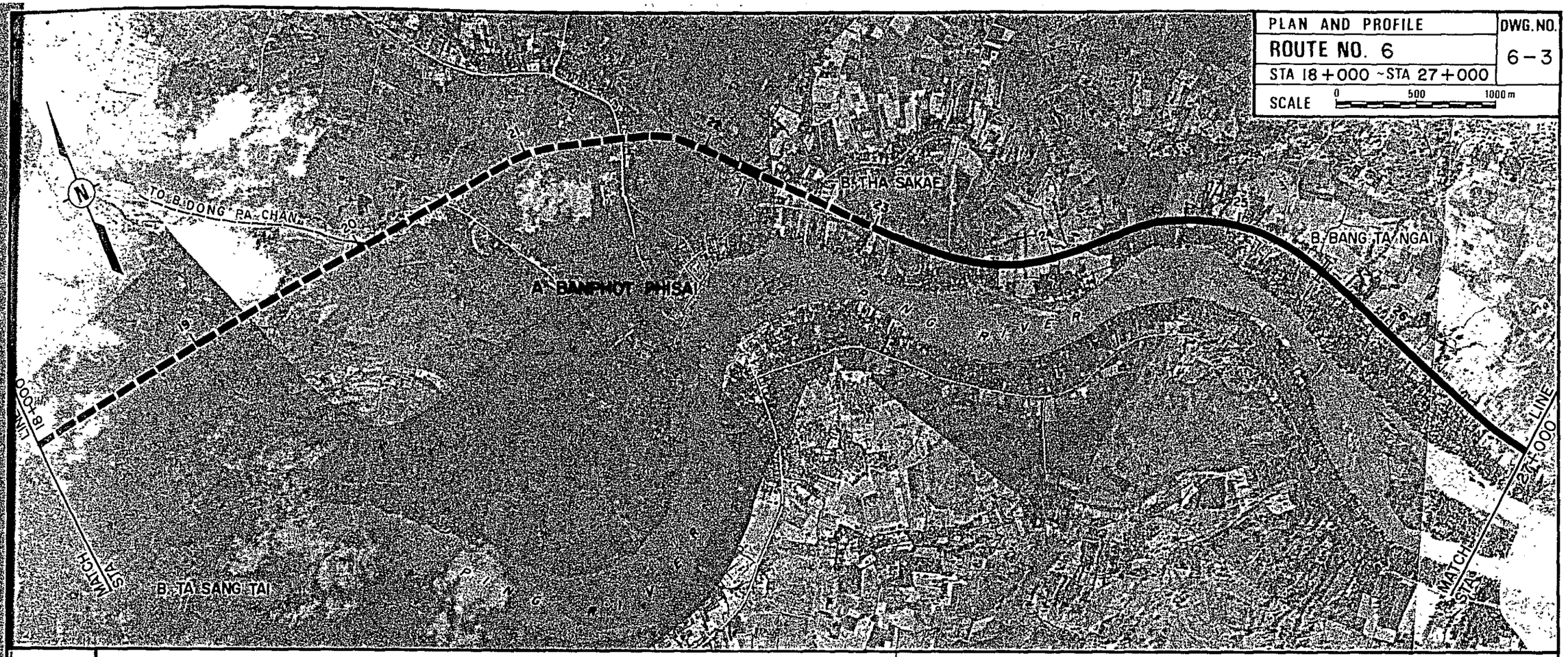
| PLAN AND PROFILE | DWG.NO. |
|---|---|
| ROUTE NO.6 | 6-2 |
| STA.9+000 ~STA.18+000 | |
| SCALE 0 500 1000m | |

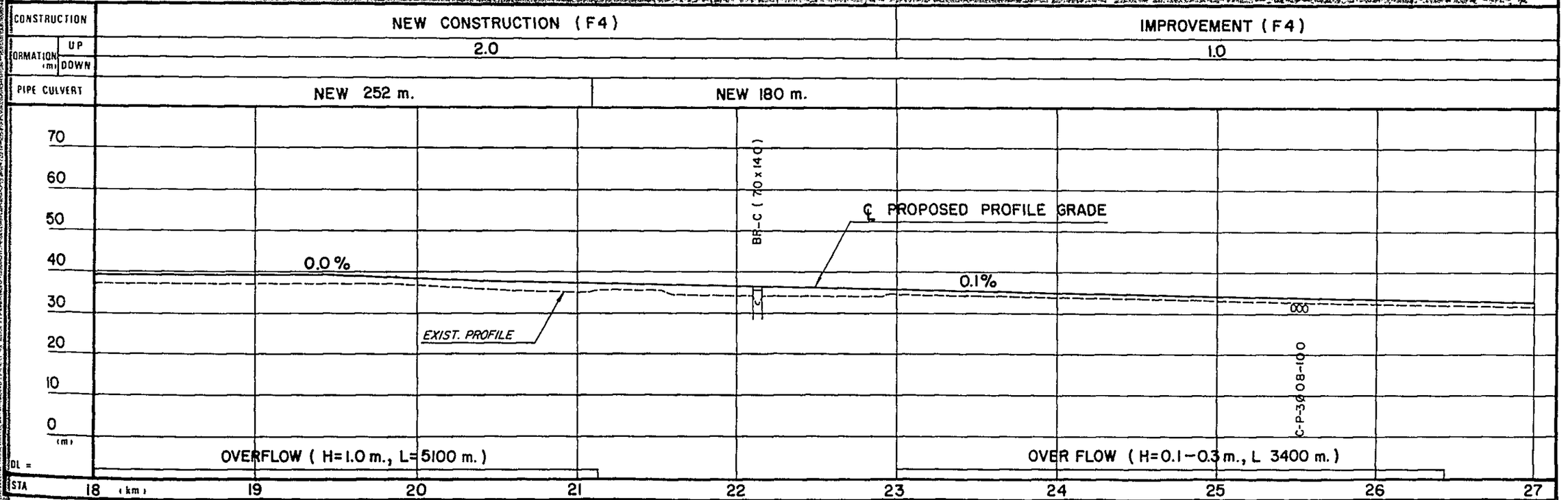



| CONSTRUCTION | | IMPROVEMENT ( F4 ) | | | NEW CONSTRUCTION ( F4 ) |
|---|---|---|---|---|---|
| FORMATION (m) | UP | 1.0 | 0.5 | 1.0 | 2.0 |
| | DOWN | | | | |
| PIPE CULVERT | | NEW 564 m. | | | |

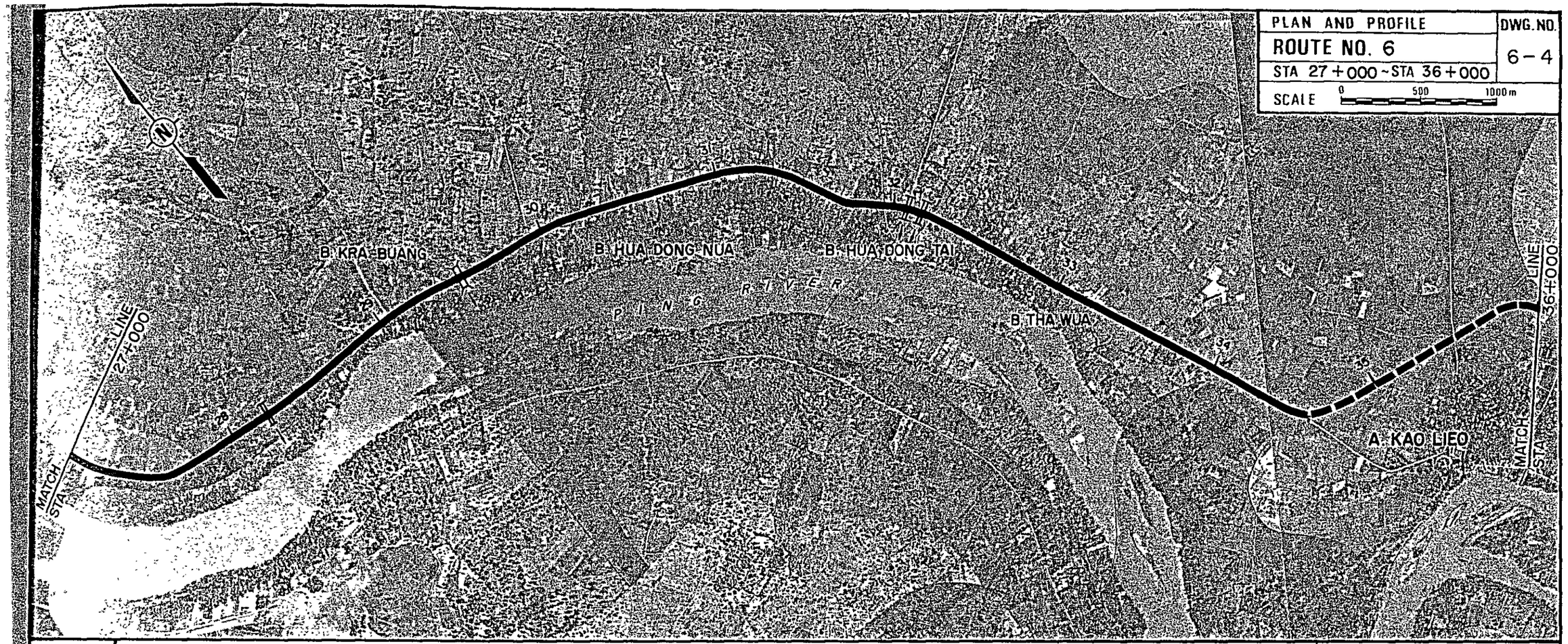


| PLAN AND PROFILE | DWG. NO. |
|---|---|
| ROUTE NO. 6 | 6-3 |
| STA 18+000 ~STA 27+000 | |
| SCALE 0 500 1000 m | |

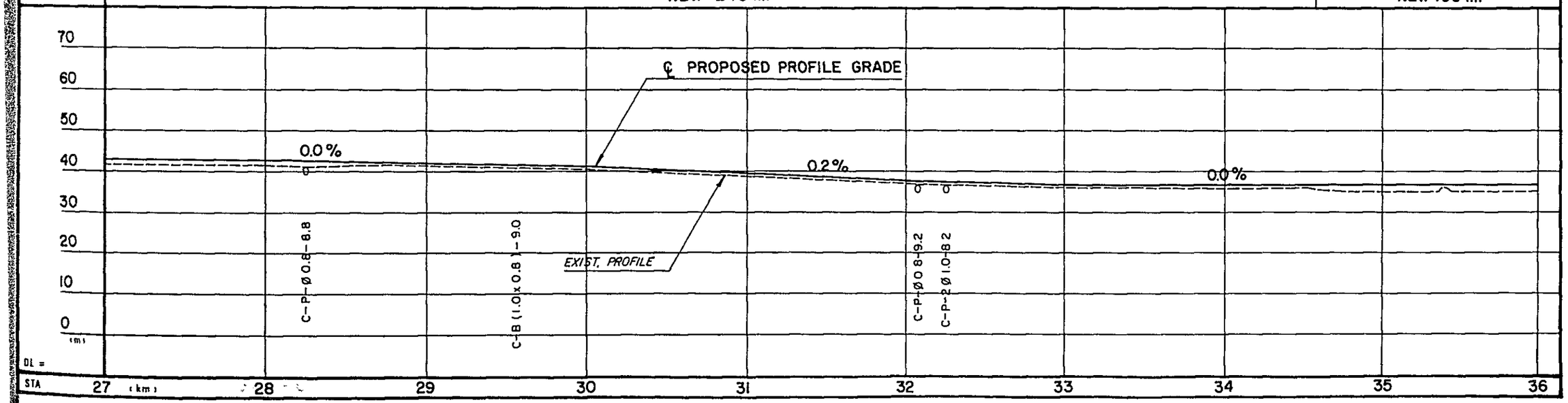


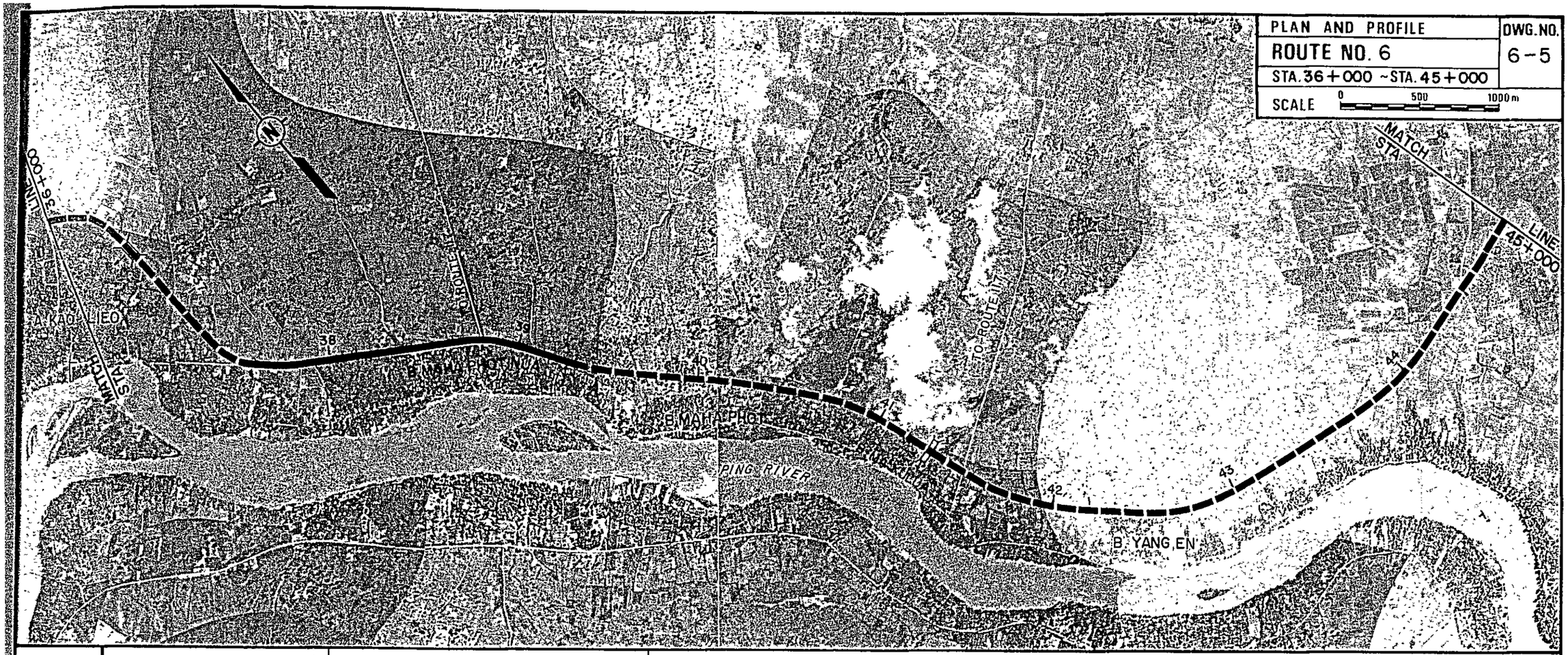
| PLAN AND PROFILE | DWG. NO. |
|---|---|
| ROUTE NO. 6 | 6-4 |
| STA 27+000 ~ STA 36+000 | |
| SCALE 0 500 1000 m | |



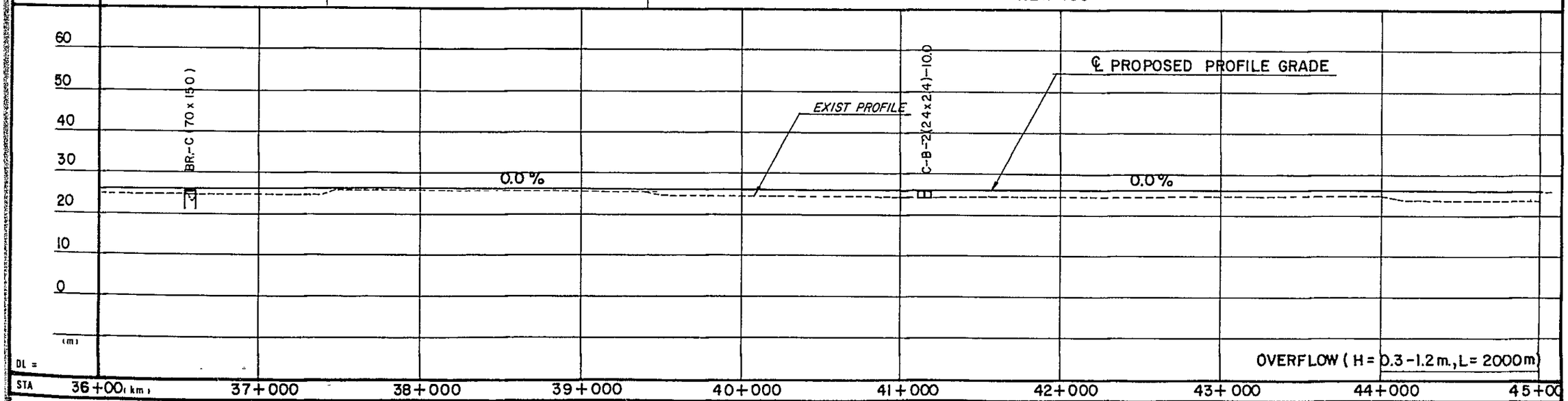

| CONSTRUCTION | | IMPROVEMENT (F4) | | NEW CONSTRUCTION (F4) |
|---|---|---|---|---|
| FORMATION (m) | UP | 1.0 | 0.5 | 1.5 |
| | DOWN | | | |
| PIPE CULVERT | | NEW 240 m. | | NEW 168 m. |



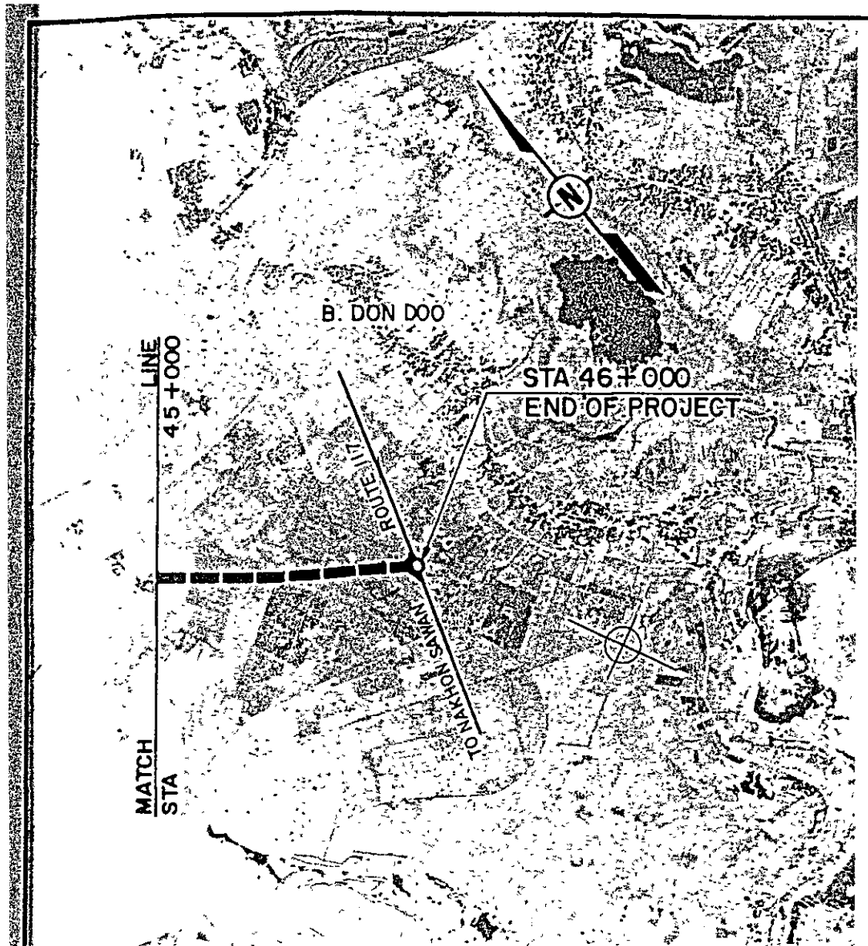
| PLAN AND PROFILE | DWG.NO. |
|---|---|
| ROUTE NO. 6 | 6-5 |
| STA. 36+000 ~STA. 45+000 | |
| SCALE 0 500 1000 m | |




| CONSTRUCTION | | NEW CONSTRUCTION ( F4 ) | IMPROVEMENT ( F4 ) | NEW CONSTRUCTION ( F4 ) | |
|---|---|---|---|---|---|
| FORMATION (m) | UP | 1.5 | 0.5 | 1.5 | 2.0 |
| | DOWN | | | | |
| PIPE CULVERT | | | NEW 60 | NEW 408 | |



| PLAN AND PROFILE | DWG.NO. |
|---|---|
| ROUTE NO.6 | 6-6 |
| STA. 45+000 ~STA. 46+000 | |
| SCALE 0 500 1000 m | |




| | | |
|---|---|---|
| CONSTRUCTION | | NEW CONSTRUCTION (F4) |
| FORMATION (m) | UP | 2.0 |
| | DOWN | |
| PIPE CULVERT | | |

60
50
40
30
20
10
0
(m)

℄ PROPOSED PROFILE GRADE
EXIST PROFILE
0.0%

DL = OVER FLOW (H=0.3-1.2 m., L=2000 m.)

STA 45+00 (km) 46+000