STUDY ROUTE NO. 25

Toen

– Wang Chin

L= 54.0 Km

Changwt : Lampang / Phrae

1. GENERAL

1-1 Location of Route

The proposed provincial road, Rt.1124 links two Amphoe, A.Thoen in C.Lampang and A.Wang Chin in C.Phrae with the length of 55 Km. (see Figure 25-1-1)

The terrains traversed by the route range mountainous for first half to rolling in the remaining half. The mountain ranges are close to the route, thus resulting in the less cultivable land area. Major agricultural products are rice and maize in the rolling area but bush or forest occupy much in the mountainous area.

As the existing route runs closely to the meandering medium to small rivers the route passes timber bridges at more than 30 places.

The population served by the route is 20 thousand, the most of them are in Wang Chin side.

In geology, mountain section comprizes massive light gray limestone inter bedded with shale sandstone, mudstone and volcanic tuff, but latter half of paddy area is an alluvial soils.

1-2 Conditions of Existing Road

The conditions of the route are mentioned in Table 25-1-1, dividing it into 3 segments by topographic differences.

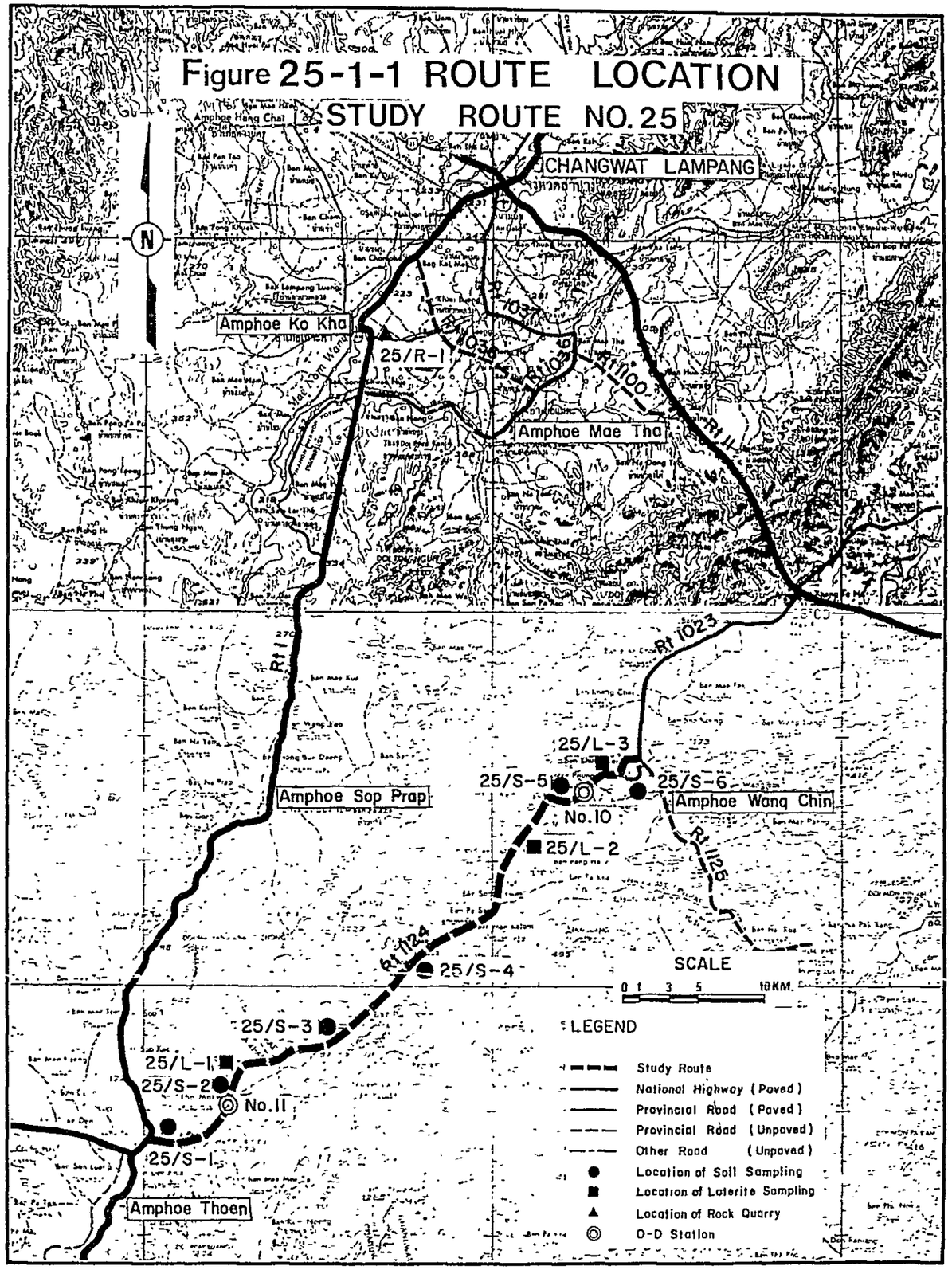


Table 25-1-1 SUMMARY OF ROAD INVENTORY

Segment	Changwat	Route Name	Route Section: Origin	Route Section: Destination	Length (km)	Terrain	Roadway Condition: Surface: Earth / Lat. / S.T.	Surface: 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. (a)	Lampang	R.1124	R.1 B. Thapha	B. Makwen	8.0	Rolling	L	7.8	Fair	Fair	Fair	3.5	0	0	3	3.0			0.1 x 200
							S.T.	0.2	⟩ Bad			⟩ 7.0	⟩ 0.5	⟩ 1.0	Timber	⟩ 5.0	66.4	Forest	1.2 x 200
Seg. (b)	Lampang/ Phrae	R.1124	B. Makwen	B. Maela	21.0	Montain-ous	L	20.5				3.4	0	0	14	4.0		Forest	0.1 x 100
							S.T.	0.5	Fair	Bad	Bad	⟩ 7.3	⟩ 0.6	⟩ 1.5	Timber	⟩ 4.5	141.6	Paddy Maize Plantation	0.3 x 200
Seg. (c)	Phrae	R.1124	B. Maela	B. Wang Chin	25.0	Rolling	L	19.7	Fair			4.2	0	0	18	3.0		Paddy	0.15 x 100
							S.T.	3.6	⟩	Fair	Fair	⟩	⟩	⟩	Timber	⟩	199.3	Plantation	0.2 x 500
							(New Const.	1.7	Bad			7.1	0.8	0.5		6.0		Forest	0.3 x 300 0.6 x 300

2. TRAFFIC

2-1 Traffic Zone and Road Links

Traffic zoning was made as shown in Figure 25-2-1

The area of influence was divided into 3 traffic zones, and total population in the area amounts approximately to 19800. The density in terms of the proposed road length is 370. Annual rate of population increase in the area is 13.5% in the past 3 years, which is much higher than the average of 2.2% in the Northern Region.

As the major destinations of transport demands originated in the area, seven Amphoe of Muang Phrae, Long, Muang Lampang, Mae Tha, Sop Prap, Wang Chin and Thoen were chosen based on the O/D survey. Characteristics of the traffic zones are shown in Table 25-2-1.

The existing and proposed roads in the area together with surrounding roads concerned were divided into totaling 16 road links, 4 links in the proposed roads and 12 links in the surrounding roads. The details are shown in Table 25-2-2.

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 projects as follows:

Passenger O/D (without project)-1987

(trip/day)

	1	2	3	11	12	21	22	23	24	25
1	0	150	26	640	72	93	177	138	106	48
2	0	0	45	118	75	41	61	56	43	43
3	0	0	0	27	249	16	20	39	25	65
11	0	0	0	0	143	0	0	0	0	119
12	0	0	0	0	0	111	133	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0

Passenger O/D (with project)-1987

(trip/day)

	1	2	3	11	12	21	22	23	24	25
1	0	255	49	640	130	99	199	149	114	73
2	0	0	88	204	139	48	78	68	52	63
3	0	0	0	49	249	21	30	42	26	75
11	0	0	0	0	257	0	0	0	0	153
12	0	0	0	0	0	148	197	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0

b) Agricultural Freight

The major destinations of agricultural freight originated in the influencial area were selected at A. Muang Lampang, A. Wang Chin (traffic zone 11) and A. Thoen (12), basing on the agro-economic survey results.

The estimated agricultural freight O/D valumes in 1987 for the both cases of with and without projects are as follows:

Agri. Freight O/D (without project)-1987

(1,000 ton/year)

	1	2	3	11	12	21	22	23	24	25
1	0.0	0.0	0.0	5.1	7.3	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	2.5	5.8	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.5	0.0	0.0	2.6	0.0	0.0
11	0.0	0.0	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	0.0	0.0
21	0.0	0.0	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	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 25-2-1 ZONING AND ROAD NETWORK

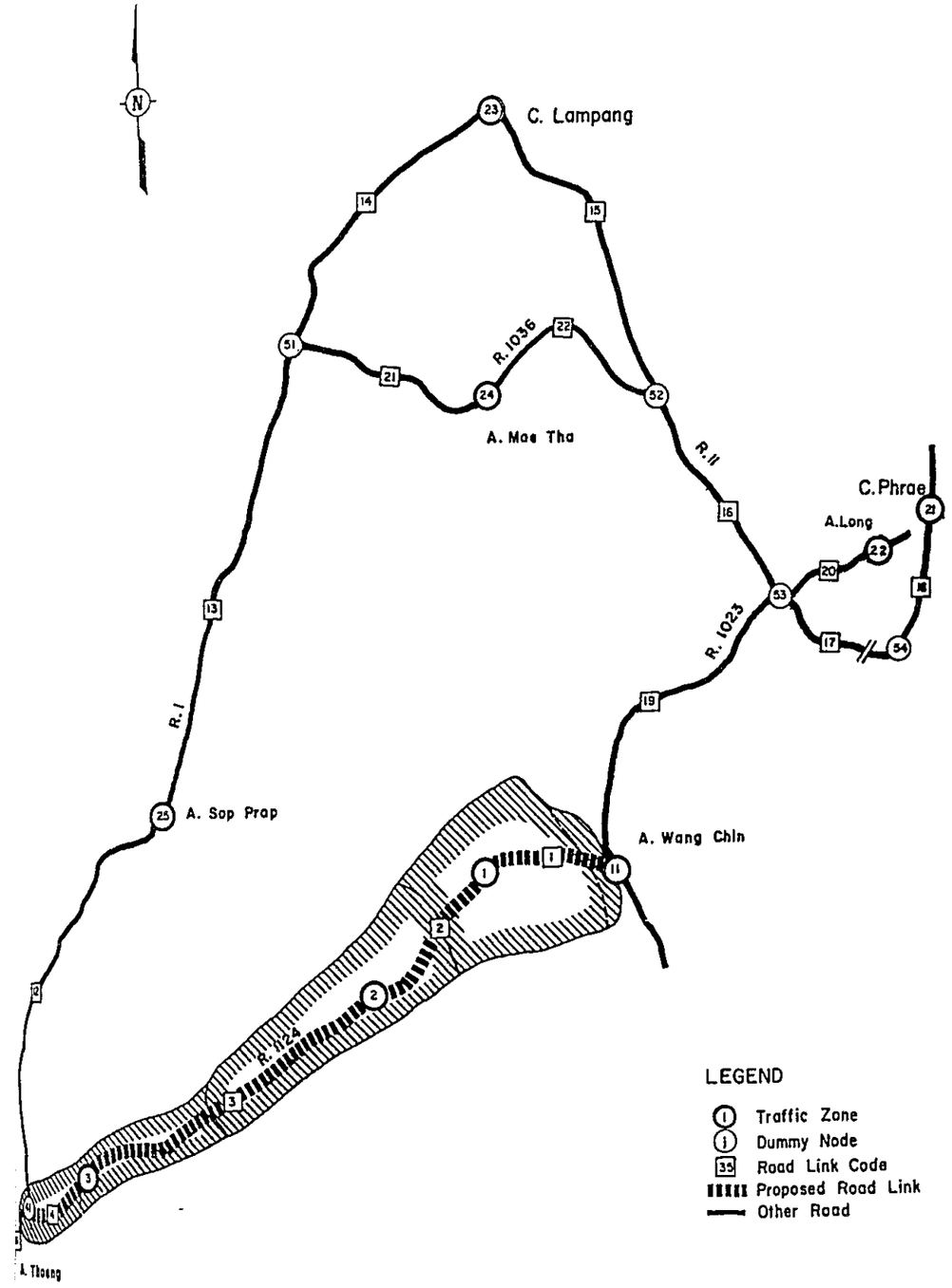


Table 25-2-1 ZONE CHARACTERISTICS

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	P.R	Wang Chin	050701	19	1.9				
			050705	100	8.0				
			Total	-	9.9	1.0	1.0	10.5	10.5
2	P.R	Wang Chin	050702	100	6.3	0.5	0.7	6.5	6.5
3	L.P	Thoen	060903	85	3.6	2.9	2.0	3.9	3.9
11	P.R	Wang Chin	050701	81	8.1				
			050703	100	9.4				
			050704	100	5.5				
			Total	100	23.0	1.2	1.1	24.4	24.4
12	L.P	Thoen	060901	100	15.9				
			060906	100	5.7				
			060908	100	6.8				
			Totel	-	28.4	0.7	0.7	29.6	29.6
21	P.R	M.Phrae	050100	100	115.4	0.9	0.9	-	121.3
22	P.R	Long	050500	100	54.2	1.0	1.0	-	57.6
23	L.P	M.Lampang	060100	100	181.9	0.8	0.8	-	191.8
24	L.P	Mae Tha	060700	100	63.7	1.4	1.3	-	69.4
25	L.P	Sob Prop	060800	100	25.8	0.1	0.7	-	27.0

Table 25-2-2 ROAD LINK CHARACTERISTICS

NO	SN	EN	LO	GOD	GOR	LW	GWD	GWR	TO	TW	REMARKS
1	1	11	7.3	8	11	7.0	5	5	11.0	7.0	R.1124
2	1	2	18.0	8	11	18.0	5	5	27.0	18.0	R.1124
3	2	3	21.0	9	12	21.0	6	6	42.3	25.2	R.1124
4	3	41	8.0	8	11	8.0	5	5	12.0	8.0	R.1124
11	12	41	2.0	1	1	2.0	1	1	1.5	1.5	R.1
12	25	41	33.0	2	2	33.0	2	2	29.1	29.1	R.1
13	25	51	44.1	2	2	44.1	2	2	38.9	38.9	R.1
14	23	51	9.0	1	1	9.0	1	1	6.9	6.9	R.1
15	23	52	24.0	2	2	24.0	2	2	21.2	21.2	R.11
16	52	53	17.0	3	3	17.0	3	3	17.6	17.6	R.11
17	53	54	32.0	3	3	32.0	3	3	33.1	33.1	R.11
18	21	54	30.0	1	1	30.0	1	1	23.1	23.1	R.101
19	11	53	21.0	5	5	21.0	5	5	21.0	21.0	R.1023(DOH)
20	22	53	15.0	5	5	15.0	5	5	15.0	15.0	R.1023(DOH)
21	24	51	15.0	8	11	15.0	8	11	22.5	22.5	R.1036
22	24	52	15.0	8	11	15.0	8	11	22.5	22.5	R.1036

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

Agri. Freight O/D (with project)-1987

(1,000 ton/year)

	1	2	3	11	12	21	22	23	24	25
1	0.0	0.0	0.0	5.1	7.3	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	2.5	5.8	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	1.5	0.0	0.0	2.6	0.0	0.0
11	0.0	0.0	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	0.0	0.0
21	0.0	0.0	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	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	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 DOHs' traffic records, the traffic composition on the exiting roads of the 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
No.10(Phase II)	.02	.12	.55	.31	.00	1.00	.56	.25	.19	.00	1.00
No.11(Phase II)	.12	.00	.48	.40	.00	1.00	.75	.08	.17	.00	1.00
R.1124 (DOH)	.24	.10	.57		.09	1.00	.58		.33	.09	1.00
Estimated	.07	.09	.50	.32	.02	1.00	.53	.23	.21	.03	1.00

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

Passenger 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	.07	.09	.50	.32	.02	.07	.09	.50	.32	.02
1987	.09	.11	.48	.30	.02	.10	.11	.44	.31	.04
1993	.11	.14	.45	.28	.02	.13	.12	.38	.30	.07
2001	.14	.17	.41	.26	.02	.17	.14	.30	.29	.10

Freight Traffic Composition

Year	Without Project				With Project			
	P/T	4/T	6/T	10/T	P/T	4/T	6/T	10/T
1981-2001	.53	.23	.21	.03	.63	.05	.29	.03

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, $\overline{W}$)	11.2
(1993, W)	12.6

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.($\overline{W}$)	-	-	1.1
(W)	-	-	1.1

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	6.6	6.4	1.08
Transportation price	3.6	3.6	-0.24
Population	1.1	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	7.4	7.1	154	266
Agri. Freight	0.4	0.3	102.4	105.2
Non-Agri. Freight	8.8	8.4	166	316

2-5 Forecasted Traffic

a) Forecasted Traffic by Vehicle Type

The forecasted traffic is summarized in the following table:

Forecasted Traffic

Year	P/C	L/B	M/B	H/B	P/P P/T	4/T	6/T	10/T	ADT	M/C
1987	14	62	44	6	97	6	38	4	270	391
1993	27	79	62	15	149	10	57	6	404	495
2001	60	105	102	35	269	17	101	10	700	644

b) Forecasted Traffic by Road Link

Details of the forecasted traffic by road link by traffic type are shown in the following table, taking a sample of the case of 1993:

Forecasted Traffic by Road Link

TRAFFIC VOLUME ON ROUTE 25 (1993)

LINK		1	2	3	4	AVR.
P/C	N+D	32	19	14	18	19
	I	7	10	8	7	9
	DV	0	0	0	0	0
	TOTAL	40	29	22	25	27
L/B	N+D	95	55	41	52	54
	I	22	29	24	20	25
	DV	0	0	0	0	0
	TOTAL	116	84	65	72	79
M/B	N+D	75	43	32	41	43
	I	17	23	19	16	20
	DV	0	0	0	0	0
	TOTAL	92	66	51	57	62
H/B	N+D	17	10	8	10	10
	I	4	5	4	4	5
	DV	0	0	0	0	0
	TOTAL	21	16	12	13	15
P/P&T	N+D	172	101	81	107	103
	I	43	54	43	36	45
	DV	0	0	0	0	0
	TOTAL	214	155	124	143	149
4/T	N+D	11	7	5	7	7
	I	3	4	3	2	3
	DV	0	0	0	0	0
	TOTAL	14	10	8	10	10
6/T	N+D	65	38	31	42	40
	I	16	21	16	14	17
	DV	0	0	0	0	0
	TOTAL	82	59	48	56	57
10/T	N+D	7	4	3	4	4
	I	2	2	2	1	2
	DV	0	0	0	0	0
	TOTAL	8	6	5	6	6
ADT	N+D	475	277	215	281	279
	I	113	148	119	100	125
	DV	0	0	0	0	0
	TOTAL	588	425	335	381	404
M/C	N+D	574	366	289	356	362
	I	105	155	134	107	133
	DV	0	0	0	0	0
	TOTAL	679	521	423	463	495
TOTAL	N+D	1049	643	504	637	641
	I	218	303	253	207	258
	DV	0	0	0	0	0
	TOTAL	1267	946	757	844	899

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

3. AGRICULTURAL DEVELOPMENT

3-1 Crop Production

The western portion of the area of influence is too mountainous to limit the lands for cultivation, while in the eastern side belonging to Amphoe Wang Chin planted areas are expanded over a relatively wide range along the road. Major crop is paddy followed by maize, fruit, ground nuts, vegetables, tobacco and sugar cane. Paddy is collected at both Thoen and Wang Chin for milling and for regional consumption. Maize is mostly sent to Nakhon Sawan area through Thoen. Tobacco is sent to curing station in Phrae through drying places in Wang Chin.

Land use and capability in the area of influence is illustrated in Figure 25-3-2. Typical cropping calendar in Phrae area is also shown in Figure 25-3-1. 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 25-3-1.

3-2 Net Value Added

In accordance with the concept discusses in Chapter 4 of Summary Report, net value added was calculated for both cases, with project and without project. The agricultural development benefit, indicated by the increment of net value added of crop production in the with project case, attributable to the project is estimated at 5.8 , 7.2 and 9.1 in million Baht for 1987, 1993 and 2001 respectively.

Figure 25-3-1 TYPICAL CROPPING CALENDAR - Route 25

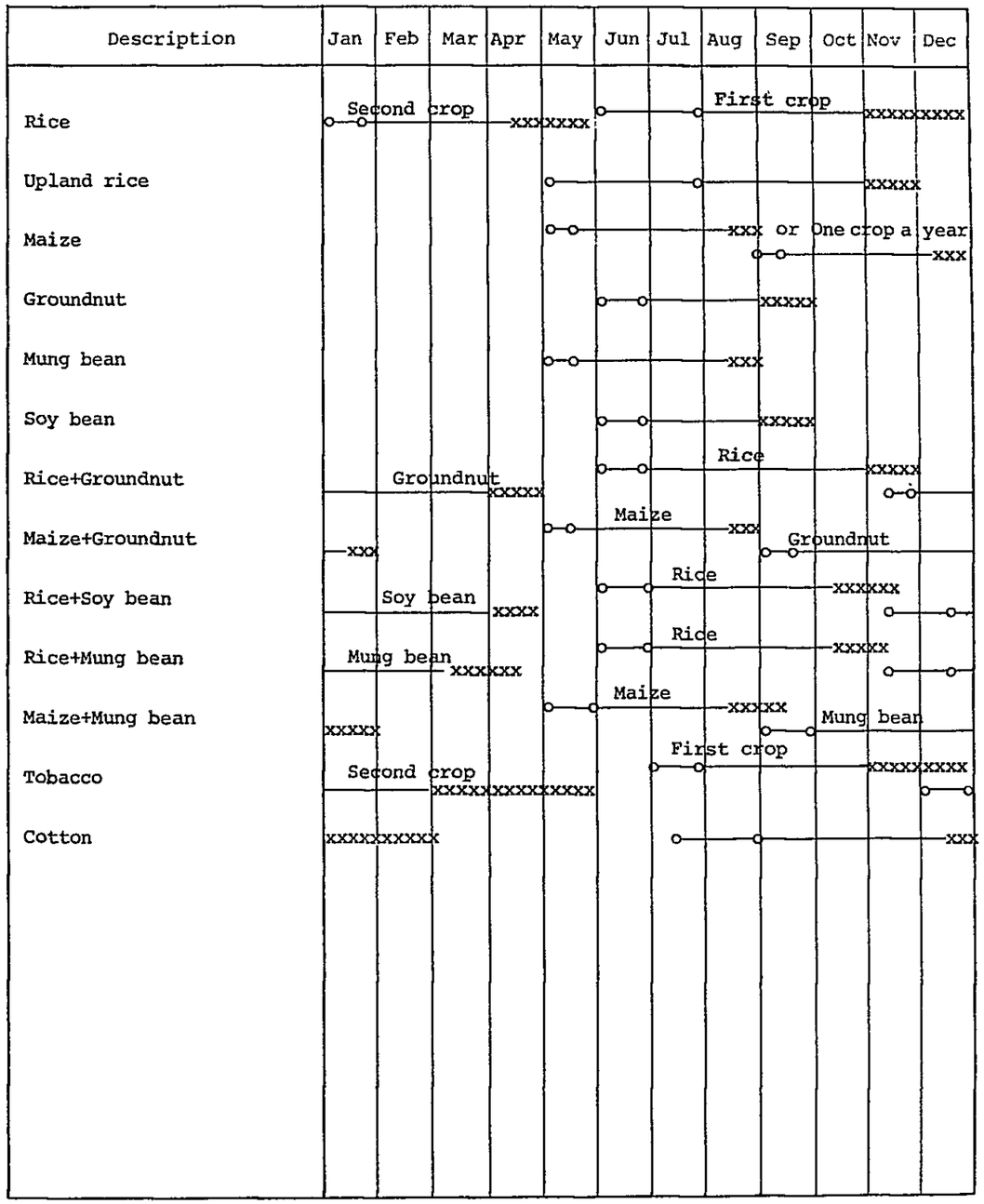


Figure 25-3-2 LAND USE AND CAPABILITY OF INFLUENCE AREA STUDY ROUTE NO. 25

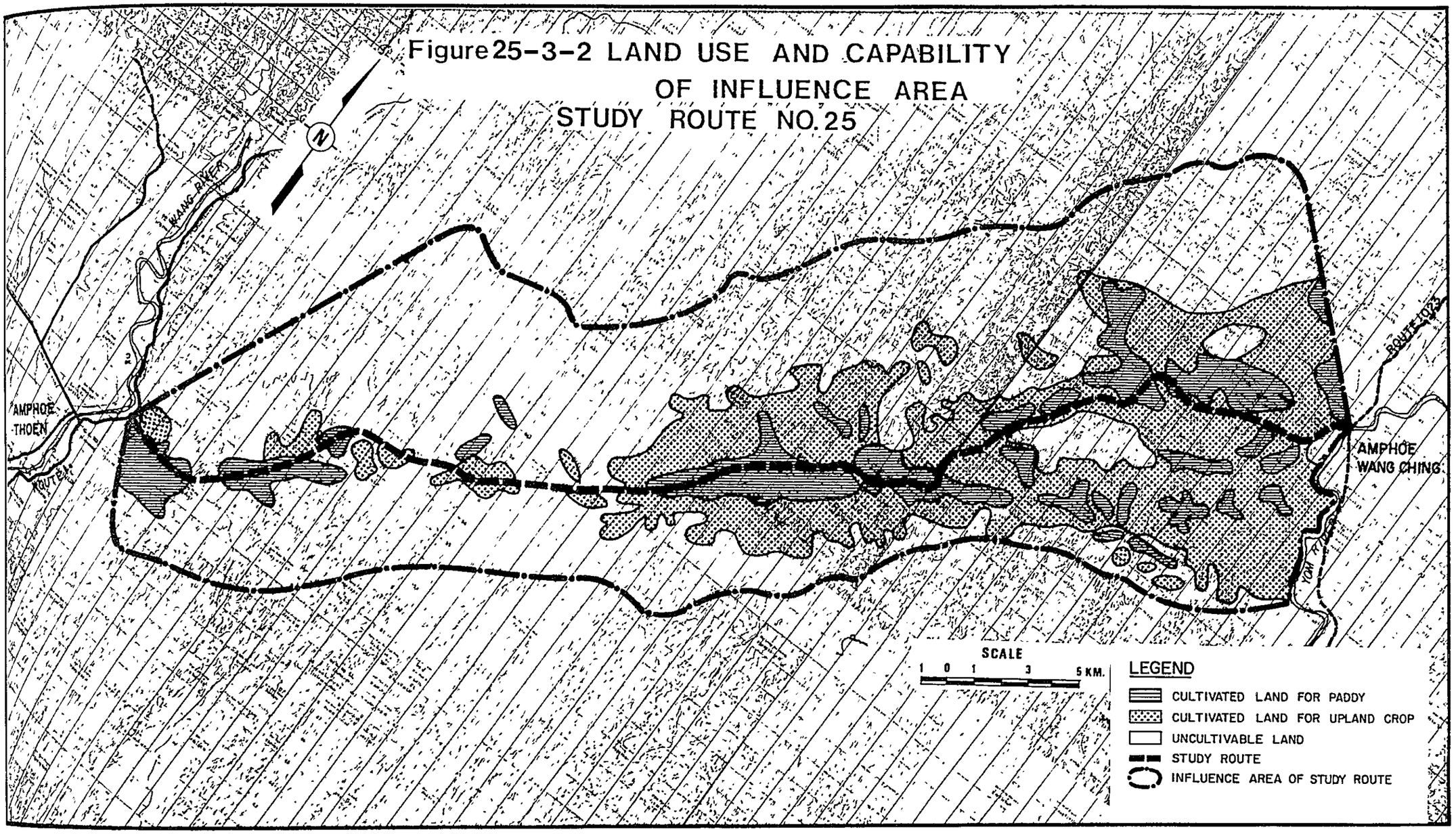


Table 25-3-1 CROP PRODUCTION - Route 25

(1000 TON)

CROP	1987		1993		2001	
	W/O	W	W/O	W	W/O	W
PADDY	18.2	18.2	18.2	18.4	18.3	18.7
MAIZE	5.7	5.7	5.7	5.8	5.7	5.9
MUNG BEAN	0.3	0.3	0.3	0.3	0.3	0.3
SOY BEAN	0.1	0.1	0.1	0.1	0.1	0.1
GROUND NUTS	2.2	2.2	2.2	2.3	2.2	2.4
SORGHUM	0.0	0.0	0.0	0.0	0.0	0.0
CASSAVA	0.4	0.4	0.5	0.6	0.6	0.7
SUGAR CANE	1.4	1.5	1.5	1.8	1.6	2.2
TOBACCO	1.6	1.6	1.6	1.6	1.6	1.6
COTTON	0.3	0.3	0.3	0.3	0.3	0.3
GARLIC	0.5	0.5	0.5	0.5	0.5	0.5
CHILLI	0.1	0.1	0.1	0.1	0.1	0.1
SESAME	0.0	0.0	0.0	0.0	0.0	0.0
VEGETABLES	1.6	1.6	1.6	1.6	1.6	1.6
FRUITS	4.8	4.8	4.8	4.8	4.8	4.8
OTHERS	0.0	0.0	0.0	0.0	0.0	0.0

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 woth 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 at 16.7, 26.6 and 48.6 in million Baht for 1987, 1993 and 2001 respectively.

5. ENGINEERING

5-1 Soils and Materials

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 25-5-1.

Location of samplings for the soil test done in this study are shown in the Location Map of Figure 25-1-1.

5-1-1 Subgrade Soils

Subgrade soils along the study route consist mainly of silty clay of low plasiticity index ranging from 6.0 to 15.0%. They are classified as A-4 and A-7 in the AASHTO Classification. CBR values are from 1.3 to 4.0%.

There are silty sand stone of N.P. in short section close to National Highway Route No. 1. CBR of this soil was about 15.0%.

5-1-2 Subbase and Shoulder Materials

Test results of laterite sampled along the study route indicated that the plasticity index of the portion passing the No. 4 sieve was from 13.0 to 20.0% and the soaked CBR was from 6.0 to 14.0%.

The laterite along the study route are not suitable for use in subbase and shoulder layer because of their high plasticity and low CBR value. They were, therefore, used as selected materials. The materials for subbase and shoulder were planned to carry from the laterite sources near A. Wang Chin and Route No. 1.

5-1-3 Rock Material

The rock quarry available for the proposed road is the source 25/R-1, at about km-post 580+00 along Rt. 1.

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 28%, far less than specified 40% in DOH specification. One test result indicated that the CBR value is 66% a little bit less than DOH specified value.

5-2 Preliminary Design

Engineering studies on the proposed road are described, dividing the route into three Segments ((a), (b) and (c)), due to its topographic differences.

Segment-(a) : Rt. 1, B. Thapha - B. Makweu (8.0 km, rolling)

Segment-(b) : B. Makweu - B. Maela (21.0 km, moutainous)

Segment-(c) : B. Maela - B. Wang Chin (25.0 km, rolling)

Design speeds employed in the studies are 60 and 45 km/hr for Segment a , c and Segment b , respectively according to F4 class of DOH Design Standard.

5-2-1 Alignment and Earthwork

As the horizontal and vertical alignments of Segment (a) are fair condition, no major improvements to the existing road are required. The widening width varies from 2.0 m to 5.5 m and the raising height of 0.5 m is required.

Segment (b) includes some gradients steeper than 10% and sharp curves. They are improved in accordance with the geometric design criteria. As the result, the cutting depth of 2.5 to 4.5 m in an accumulated length of 1.0 km arised. The widening of 1.7 m to 5.6 m together with raising up of 0.5 m is required through the remaining length.

Table 25-5-1 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	25/S-1	1+200m (L.7m)	0.2-1.0	silty sand stone	A-1-b	100	90.6	84.9	69.3	56.7	48.4	41.9	17.8	N - P		8.3	2.110	15.0	0.93	9.6	
	25/S-2	8+300 (1.2.5)	0.15-1.0	dark brown clay	A-4	-	-	100	98.4	96.2	92.0	83.8	74.0	30.7	6.2	15.6	1.801	3.9	0.67	19.5	
	25/S-3	18+400 (L.5.)	0.2-1.0	silty clay	A-6	-	-	-	100	94.8	89.4	78.6	70.0	35.2	10.9	15.3	1.807	4.0	0.67	18.2	
	25/S-4	25+800 (R.7.)	0.1-1.0	light brown clay	A-7-5	-	-	100	96.4	78.4	59.6	48.2	43.0	41.2	13.8	17.5	1.629	1.3	0.81	17.3	
	25/S-5	43+200 (L.16.)	0.3-1.0	light brown silty clay	A-4	-	-	-	-	100	99.4	93.2	76.6	25.9	9.5	14.1	1.800	3.7	0.60	18.8	
	25/S-6	49+400 (R.7)	0.15-1.0	silty clay with gravel	A-6	-	-	100	98.4	94.2	85.0	73.2	64.8	37.2	12.4	14.1	1.788	3.1	0.66	16.4	
Subbase/ Shoulder Material	25/L-1	Km.9+400 (L.20)		lat brown	A-7-6	-	-	100	92.6	83.6	71.8	55.8	46.8	49.0	21.6	9.6*	2.013*	11.6	1.30		64.1
	25/L-2	Km.37+900 (R.10)		lat brown	A-6	100	67.8	54.0	40.8	31.6	27.0	23.2	19.8	39.0	13.8	13.2*	1.945*	13.8	1.20		67.7
	25/L-3	Km.47+200 (L.20)		lat brown	A-7-5	-	-	100	83.4	71.2	62.2	59.4	56.8	56.8	20.5	12.0*	1.987*	5.9	2.80		34.8
Crushed Rock	25/R-1	Km. Post 580+000 Rt. 1		lime stone	A-1-a	-	100	87.6	39.9	21.9	10.9	4.1	2.7	N - P		5.6*	2.243*	66.0	0.18		28.4

Note : * Compaction by DH-T-MOD

The existing road in Wang Chin passes the narrow residential area by the Yom. Considering the present situation, it is judged that the widening together with the acquisition of 20 m wide right-of-way is quite difficult. Therefore new route bypassing Wang Chin was planned as shown in Dwg. 25-6.

The length of the bypass is 1.9 km, shortening by 0.3 km to the existing road. The height of embankment is 1.5 m in paddy area and cutting depth varies from 1.5 m to 3.5 m at small hills.

In the remaining section, small cutting and widening arised.

5-2-2 Pavement Design (F4 Class)

1) Design Traffic Number (DTN)

The basic data on traffic volume for DTN calculation are as follows:

	Heavy Truck	Medium Truck	Heavy Bus	Total	Remarks
Average Number of Heavy Vehicles	4	37	6	47	ADT in 1987

Using the traffic analysis chart, DTN obtained for DTN7 (7 years design period) and DTN15 (15 years) were 2.0 and 6.0, respectively.

2) Design CBR

Design CBR of 30 percentile value was calculated at 3.5 % from the following test results.

Sample No.	1	2	3	4	5	6	Design CBR
CBR Testing Values	(15.0)1/	3.9	4.0	1.3	3.7	3.1	3.5

Note: 1/ Subgrade soil with high value of CBR exists in short section only along the route. Therefore this value was not employed in the calculation of design CBR.

A lot of sources of laterite suitable for the selected material can be found along the route.

To reduce the pavement thickness, 200 mm thick layer of selected material with the CBR value of 10% was considered on the subgrade soil. As the result, the design CBR obtained from the formula described in Volume 1 was 4.2.

3) Thickness of Pavement

Thickness of full-depth asphaltic concrete were obtained from the Thickness Design Chart as 140 mm and 170 mm for TA7 (7 years design period) and TA15 (15 years), respectively.

Thickness of pavement structures of SBST was determined from calculated TA7 140 mm full-depth asphaltic concrete as follows:

SBST	12 mm
Crushed stone base CBR≧80	150 mm
Soil aggregate subbase CBR≧20	180 mm
Selected material layer CBR≧6	200 mm

Thickness of overlay required at 7th year is 30 mm (TA15 - TA7) in case of asphaltic concrete. If it is planned with SBST, the layer composition is as follows:

SBST	12 mm
Crushed stone base CBR≥80	60 mm

5-2-3 Drainage

1) Pipe Culverts

Pipe culverts (ø1.0 m) were installed at every sag points along the proposed road.

2) Box Culvert

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 as shown in the following

Station	Existing Structure	Catchment Area (km^3)	Intensity (mm/h)	Discharge (m^3/sec)	Proposed Structure 1/	Capacity (m^3/sec)	
10+600	BR-T (4.0x6.0)	3	110	50	C-B 2(2.4x2.4)	50	
18+800	BR-T (4.0x4.2)	4	122	77	C-B 2(2.4x2.4)	50	100
18+950	BR-T (4.0x6.0)				C-B 2(2.4x2.4)	50	
20+200	BR-T (4.0x5.0)	2	145	42	C-B 2(2.4x2.4)	50	
23+500	BR-T (4.0x6.5)	6	114	95	C-B 2(2.4x2.4)	50	100
23+900	BR-T (4.0x7.0)				C-B 2(2.4x2.4)	50	

Note: 1/ Length of culvert is 10.0 m.

List of Box Culvert

Station	Existing Structure	Catchment Area (km^3)	Intensity (mm/h)	Discharge (m^3/sec)	Proposed Structure 1/	Capacity (m^3/sec)	
27+500	BR-T (4.0x5.5)	3	103	47	C-B 2(2.4x2.4)	50	
31+400	BR-T (4.0x2.3)	2	111	35	C-B 2(2.4x2.4)	50	
32+800	BR-T (4.0x6.0)	3	103	47	C-B 2(2.4x2.4)	50	
37+200	BR-T (4.0x7.0)	4	137	94	C-B 2(2.4x2.4)	50	150
37+300	BR-T (4.0x9.5)				C-B 2(2.4x2.4)	50	
37+950	BR-T (4.0x4.5)				C-B 2(2.4x2.4)	50	
44+700	BR-T (4.0x10.0)	22	96	322	C-B 2(2.4x2.4)	50 [297]	347
48+100	BR-T (4.0x4.0)	3	103	47	C-B 2(2.4x2.4)	50	

Note: 1/ Length of culvert is 10.0 m.
[ ] - capacity of the bridge of station 44+600.

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.

List of Bridge

Station	Existing Structure	Catchment Area (km^3)	Intensity (mm/h)	Discharge (m^3/sec)	Proposed Structure 1/	Capacity (m^3/sec)	
2+800	BR-T (5.0x30.0)	151	75	192	BR-C-34.0	213	
2+900	BR-T (3.0x25.0)	-	-	-	BR-C-27.0	165	
5+400	BR-T (4.0x11.4)	5	114	78	BR-C-12.0	81	
7+300	-	102	73	131	BR-C-27.0	165	
9+800	-	4	104	66	BR-C-14.0	76	
10+200	BR-T (4.0x9.0)	3	125	54	BR-C-10.0	63	
11+300	BR-T (4.0x12.5)	14	90	196	BR-C-20.0	217	
12+000	BR-T (4.0x6.0)	4	122	81	BR-C-12.0	81	
13+800	BR-T (7.0x25.0)	11	82	137	BR-C-25.0	151	
15+500	BR-T (4.0x10.0)	35	65	335	BR-C-18.0	347	
21+300	BR-T (4.0x5.0)	5	125	104	BR-C-12.0	114	
26+000	BR-T (4.0x20.0)	18	98	275	BR-C-20.0	281	
28+100	BR-T (4.0x20.0)	17	99	262	BR-C-20.0	281	
30+700	BR-T (4.0x14.6)	38	81	470	BR-C-16.0	213	494
31+300	-				BR-C-20.0	281	
33+050	BR-T (4.0x8.5)	4	125	80	BR-C-12.0	81	
35+500	BR-T (4.0x5.0)	4	125	80	BR-C-14.0	81	
39+300	BR-T (3.0x6.0)	23	90	316	BR-C-10.0	64	341
39+800	BR-T (4.0x15.5)				BR-C-16.0	213	
39+850	BR-T (4.0x5.5)				BR-C-10.0	64	

Note: 1/ Length of culvert is 10.0 m.

List of Bridge (Cont'd)

Station	Existing Structure	Catchment Area (km^3)	Intensity (mm/h)	Discharge (m^3/sec)	Proposed Structure 1/	Capacity (m^3/sec)	
43+100	BR-T (4.0x14.0)	13	96	191	BR-C-14.0	98	196
43+300	BR-T (4.0x12.0)				BR-C-14.0	98	
44+600	BR-T (4.0x21.0)	22	96	322	BR-C-21.0	297 [50]	347
46+800	BR-T (6.0x46.0)	40	74	436	BR-C-46.0	547	
48+400	-	62	64	574	BR-C-40.0	629	
49+700	BR-T (4.0x8.0)	4	140	93	BR-C-14.0	98	
52+750	-	4	126	80	BR-C-12.0	81	
53+050	-	43	68	422	BR-C-30.0	454	

Total length = 540.0

Note: 1/ Length of culvert is 7.0 m.

[ ] - capacity of the box culvert at station 44+700.

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, base course and structure works were supposed to be transported from rock quarry 25/R-1 with a hauling distance of 85 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 25-6-1.

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 25

(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	14.5	13.4	36.3	33.5	21.8	20.1	72.6	67.0	139.6
Price Contingency[3/]	4.7	2.1	16.5	7.7	13.1	6.3	34.3	16.1	50.4
Total	19.2	15.5	52.8	41.2	34.9	26.4	106.9	83.1	190.0
							(4.66)	(3.62)	(8.28)

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 (1 US$ = 22.63 Baht)

Table 25-6-1 CONSTRUCTION COST - Route 25 (F- 4 / 54.0 Km)

Description	Unit of Quantity	Financial Unit Rate (Baht)	Quantity	Economic Cost (10^3 ฿)
Clearing & Grubbing	ha	17,000	98	1,516
Roadway Excavation-Classified Earth	m^3	36	43,700	1,416
Roadway Excavation-Classified Soft Rock	m^3	80	0	0
Embankment-Side Borrow	m^3	45	315,200	12,907
Embankment-Borrow Pit	m^3	60	0	0
Embankment-Selected Material	m^3	80	115,800	8,245
Subbase-Soil Aggregate	m^3	106	96,800	9,133
Base-Crushed Rock	m^3	393	52,700	19,054
Shoulder-Soil Aggregate	m^3	170	22,700	3,435
Asphaltic Prime Coat	m^2	11.0	351,000	3,552
Single Bituminous Surface Treatment	m^2	28.4	297,000	7,592
R.C. Pipe Culvert	m	2,500	1,450	3,335
R.C. Box Culvert	m	18,300	280	4,612
R.C. Bridge-Short Span	m	40,400	540	19,416
P.C. Bridge-Long Span	m	70,200	0	0
Sub-Total				94,213
Miscellaneous Works[1/]				6,595
Total Direct Construction Cost				100,808
PHYSICAL CONTINGENCY[2/]				15,121
DESIGN AND CONSTRUCTION SUPERVISION[3/]				10,081
Total				126,010
Land Acquisition				
Highly Devel'd Land	ha	50,000	0	0
Less Devel'd Land	ha	15,000	0	0
Grand Total				126,010
FINANCIAL COST (10^3 Baht)				(139,607)

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 Chapter 8 of Summary Report and economic costs and benefits estimated as in the foregoing sections, internal rate of return of the proposed road project was calculated at 16.2%. This implies that the proposed project is economically viable, assuming that the opportunity cost of capital is 12%.

Details of costs and benefits stream are given in Table 25-7-1.

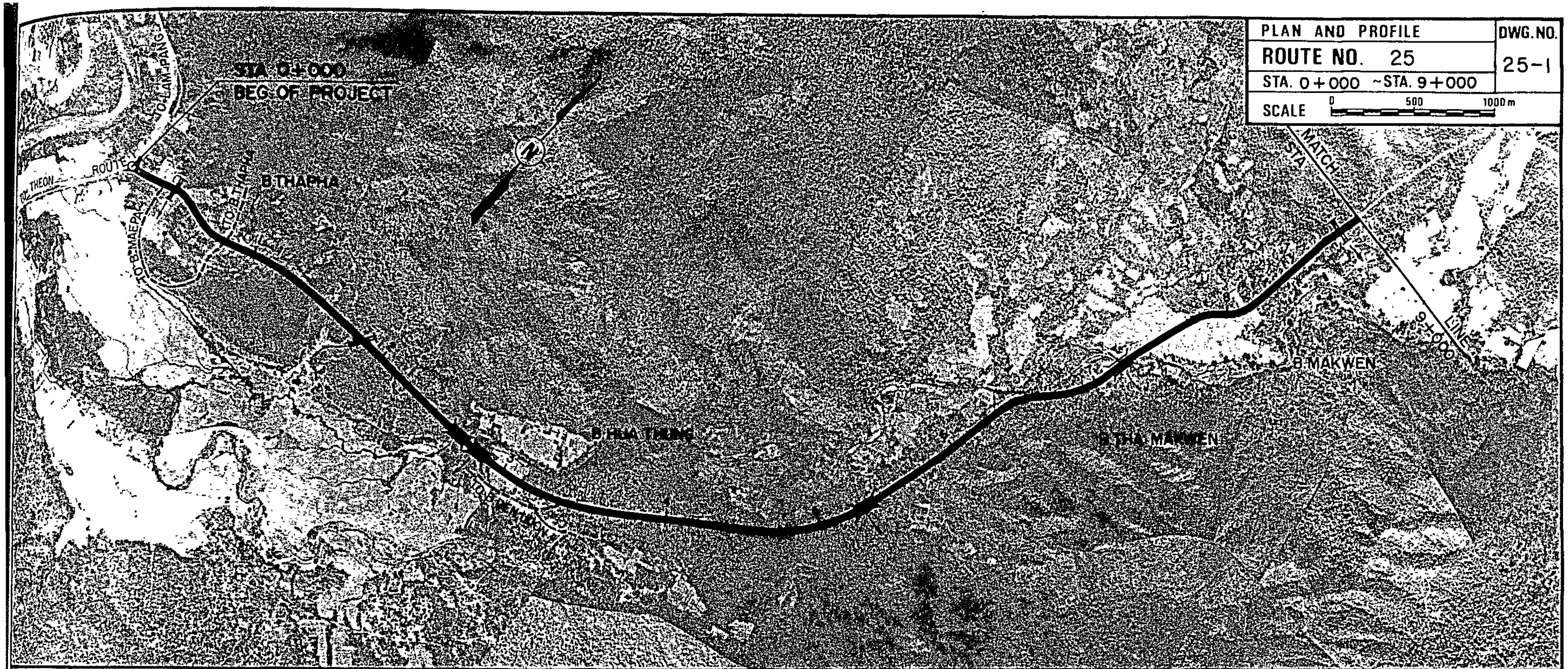
Table 25-7-1 COSTS AND BENEFITS STATEMENT - Route 25

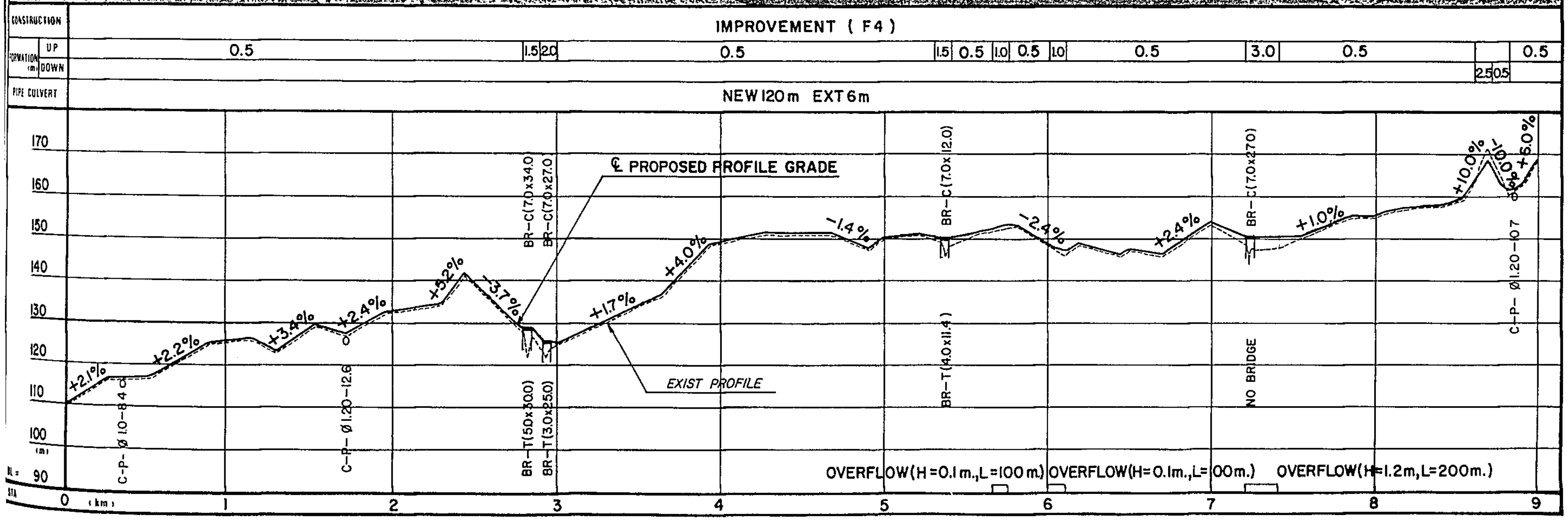
(1000 BAHT)

	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	25,200	0	0	0	0	35,404	0
1985	63,000	0	0	0	0	79,027	0
1986	37,810	0	0	0	0	42,347	0
1987	0	5,822	16,658	-140	22,339	0	19,946
1988	0	6,054	18,321	-123	24,252	0	19,333
1989	0	6,286	19,984	-105	26,165	0	18,623
1990	0	6,518	21,647	-87	28,077	0	17,844
1991	0	6,749	23,310	-69	29,990	0	17,017
1992	0	6,981	24,973	-51	31,903	0	16,163
1993	0	7,213	26,636	-33	33,815	0	15,296
1994	39,600	7,445	29,382	-3	36,824	17,913	14,873
1995	0	7,676	32,128	28	39,833	0	14,364
1996	0	7,908	34,875	59	42,841	0	13,794
1997	0	8,140	37,621	89	45,850	0	13,181
1998	0	8,371	40,368	120	48,858	0	12,541
1999	0	8,603	43,114	150	51,867	0	11,887
2000	0	8,834	45,860	181	54,876	0	11,229
2001	-57,965	9,066	48,607	211	57,884	-10,590	10,575
TOTAL	107,645	111,665	463,481	227	575,374	164,102	226,665

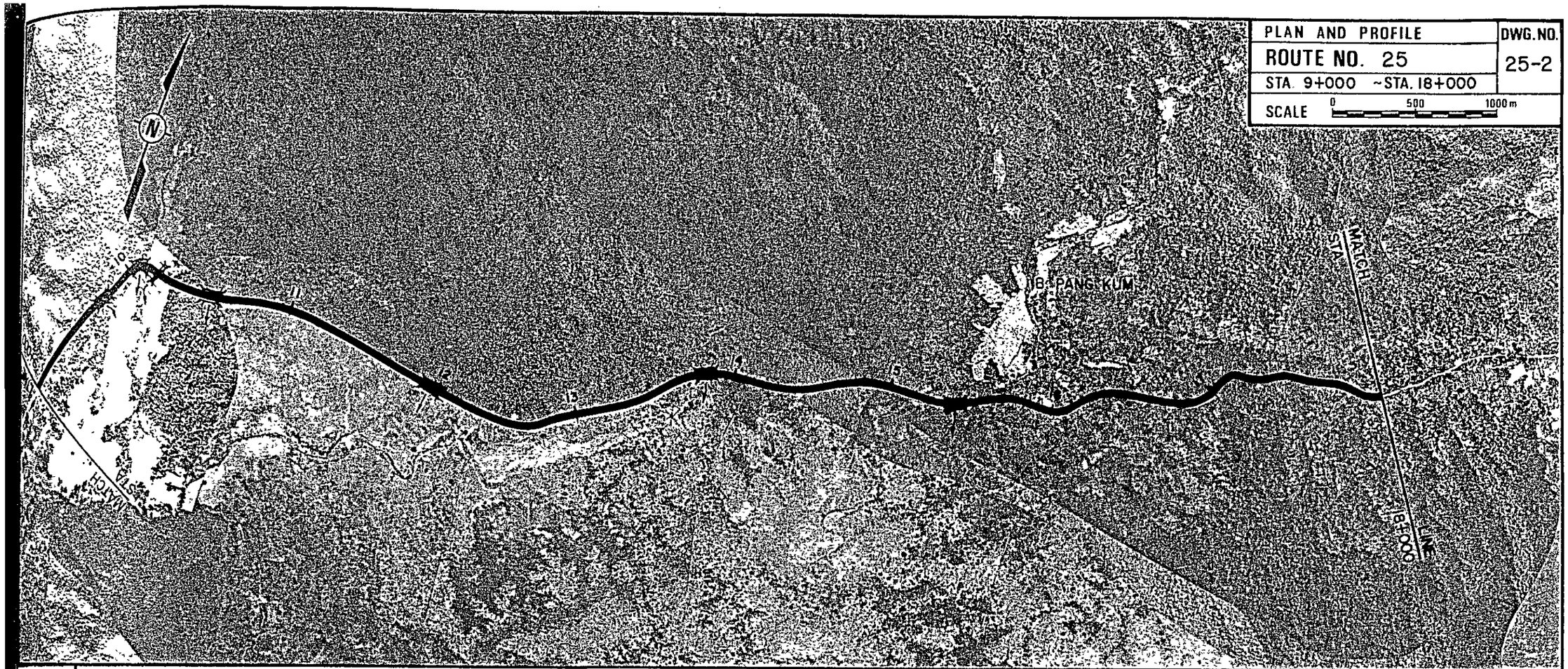
DISCOUNTED ECONOMIC COSTS :	164,102
DISCOUNTED ECONOMIC BENEFITS :	226,665
AGRICULTURAL DEVELOPMENT BENEFIT	47,515
VOC SAVING	179,388
RMC SAVING	-238
NET PRESENT VALUE :	62,563
BENEFIT COST RATIO :	1.38
INTERNAL RATE OF RETURN :	16.2 %

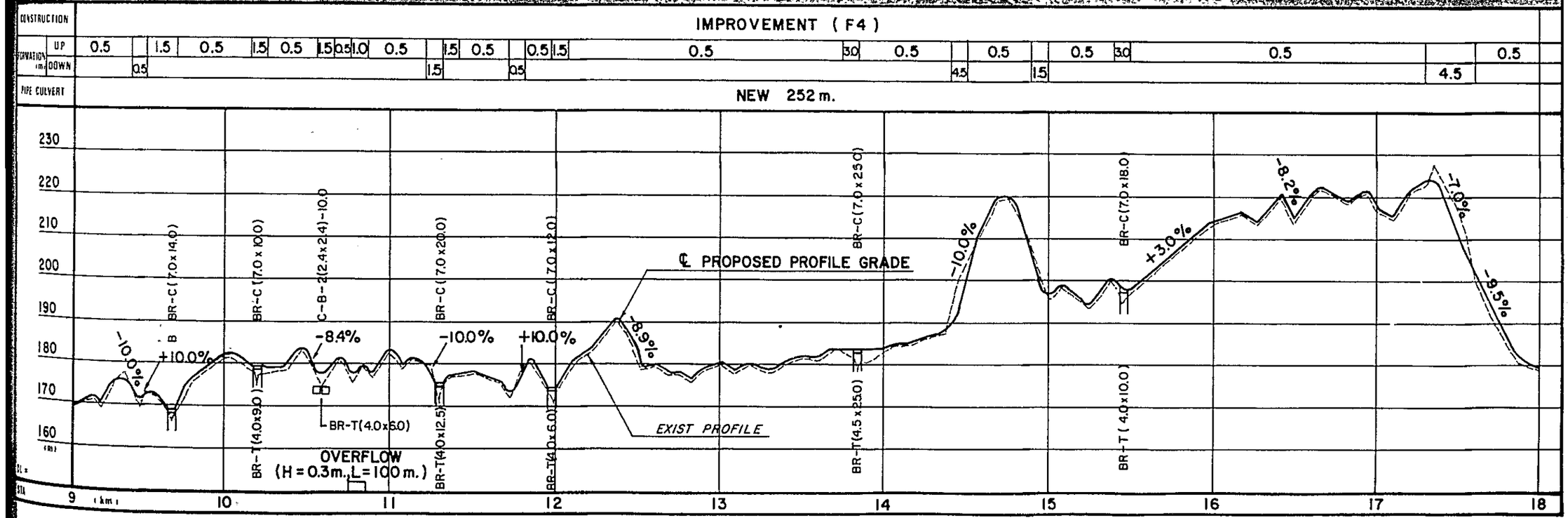
PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-1
STA. 0+000 ~STA. 9+000	
SCALE 0 500 1000 m	



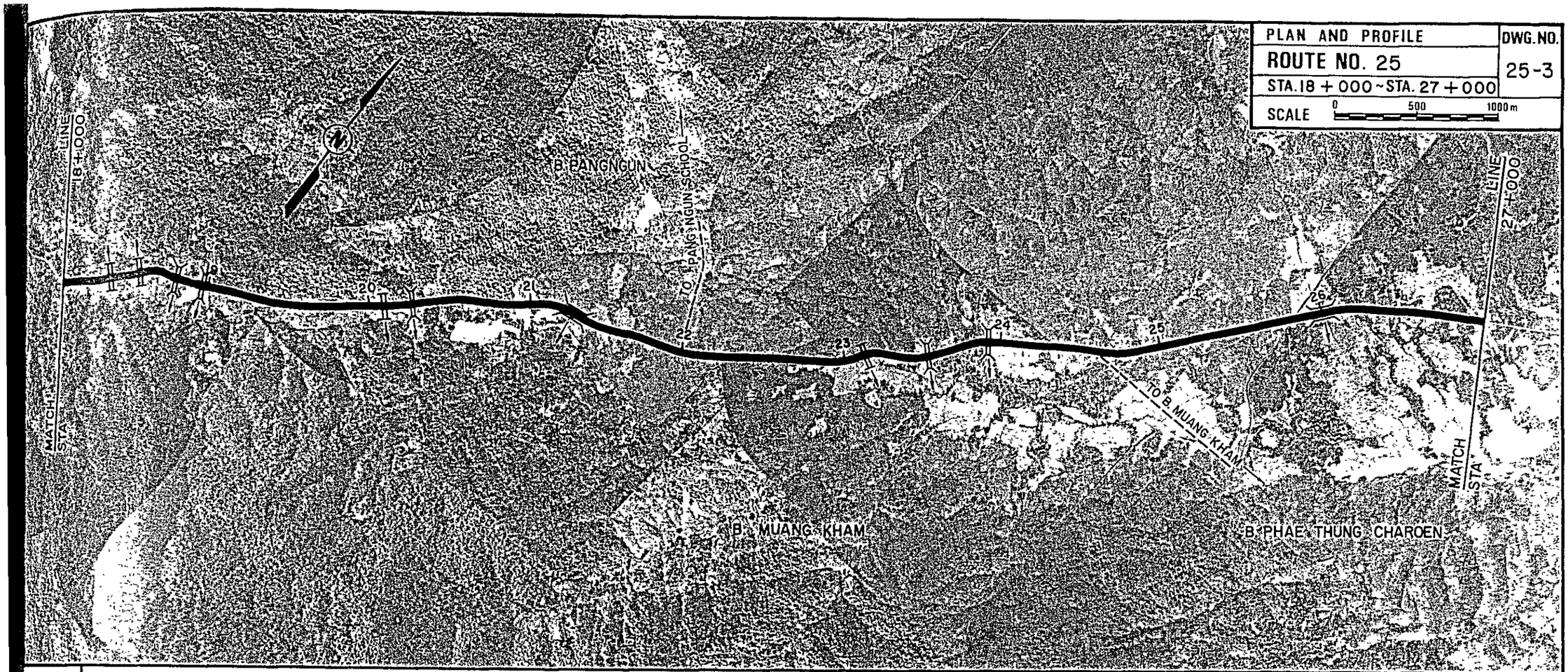


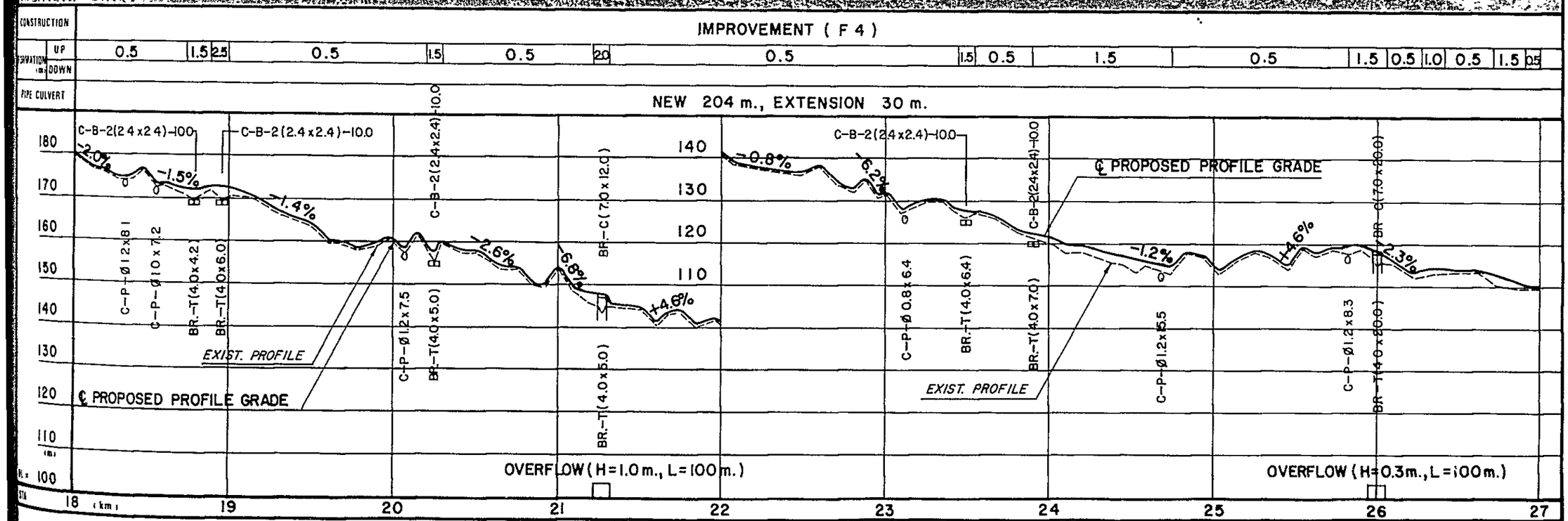
PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-2
STA. 9+000 ~STA. 18+000	
SCALE 0 500 1000 m	



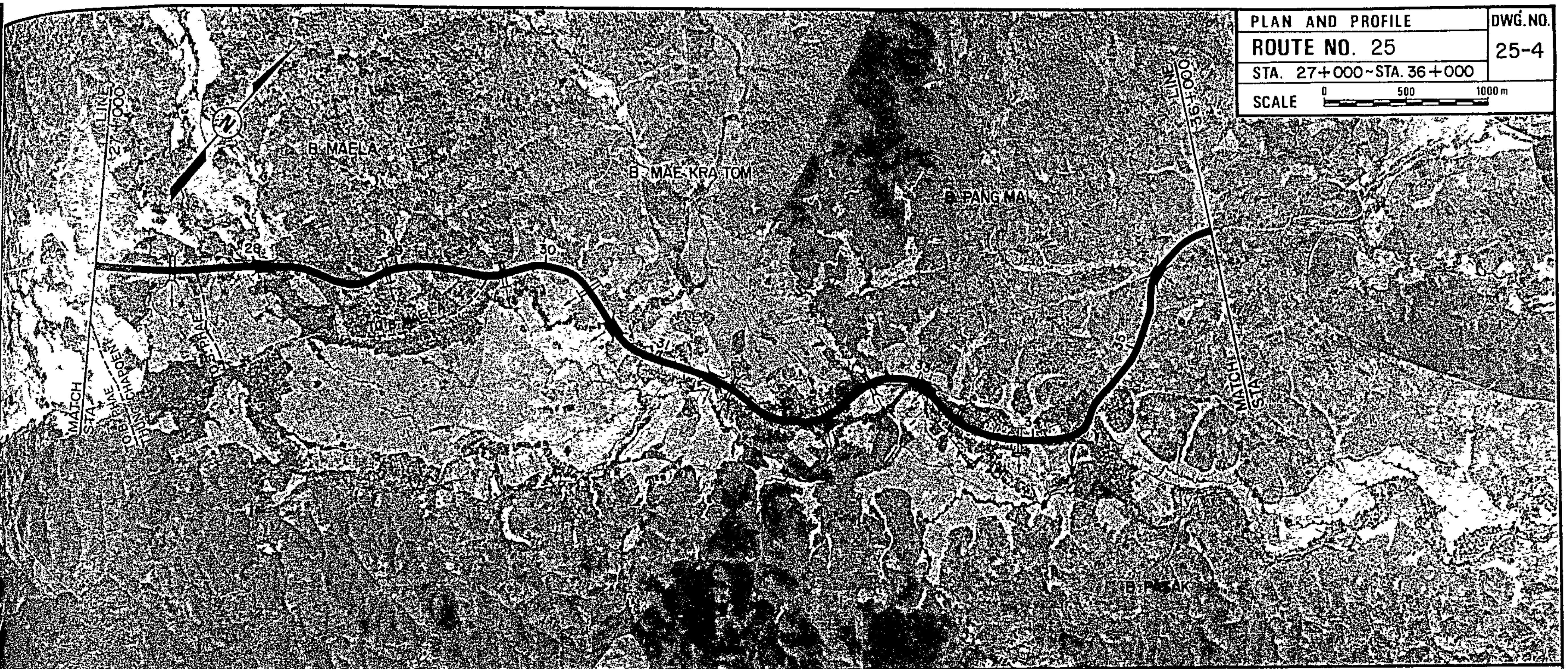


PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-3
STA. 18 + 000 ~ STA. 27 + 000	
SCALE 0 500 1000 m	

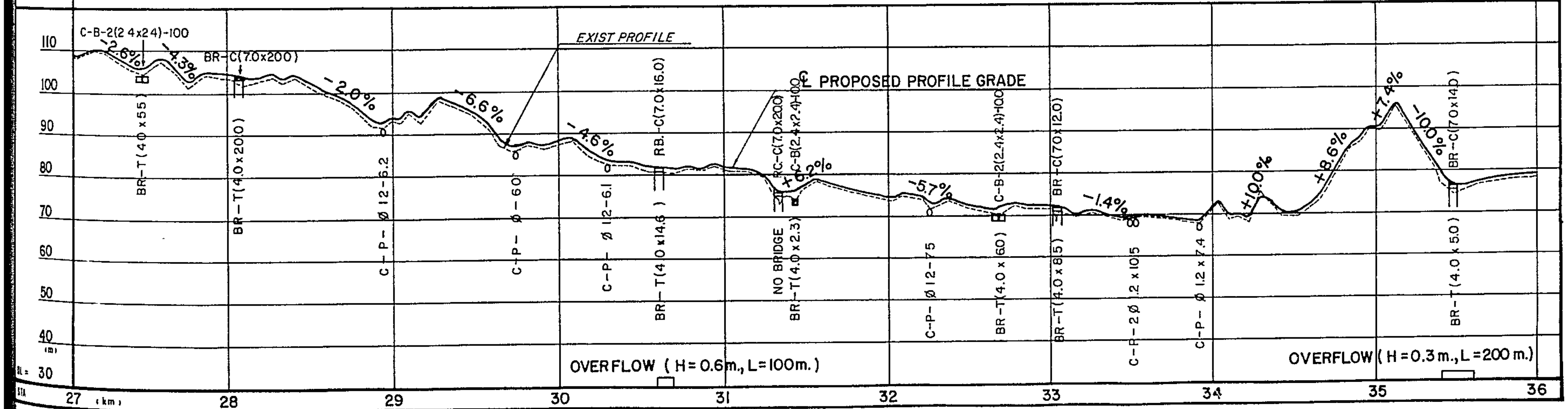




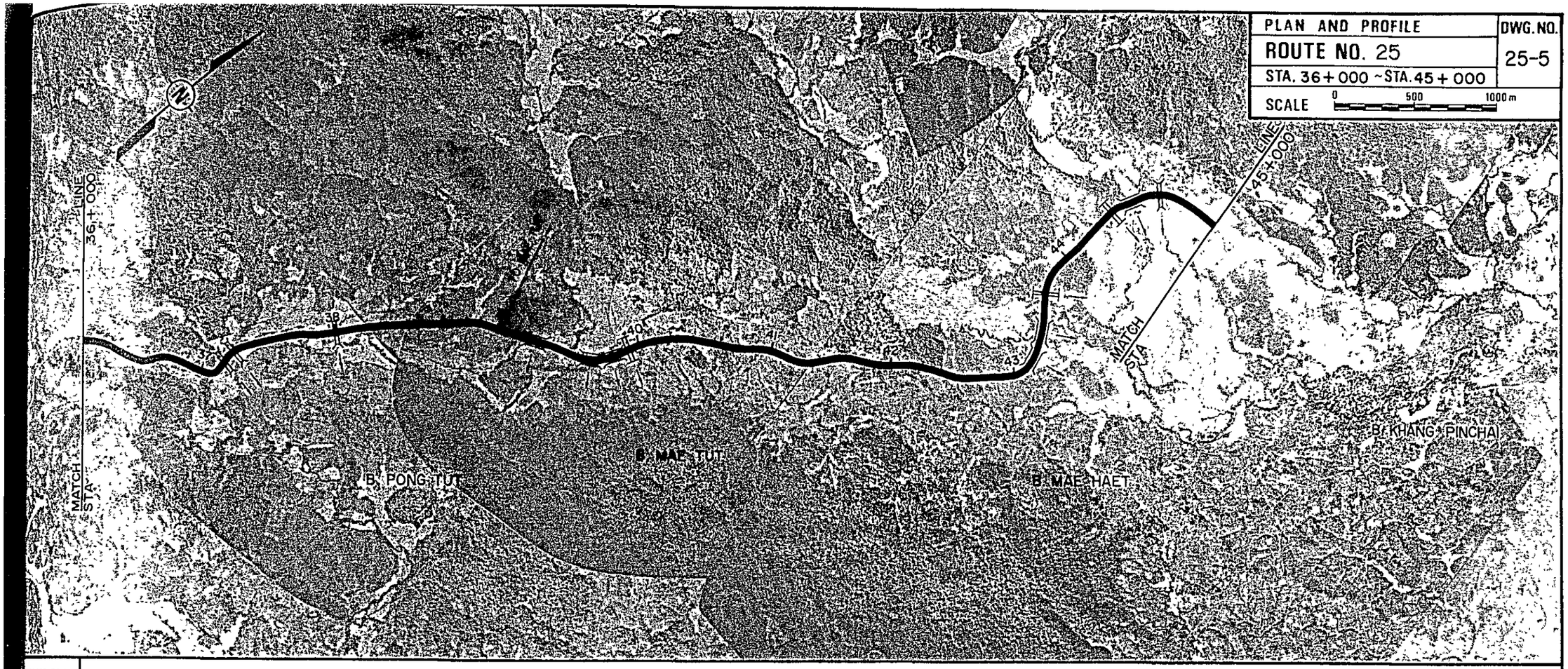
PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-4
STA. 27+000~STA. 36+000	
SCALE 0 500 1000 m	

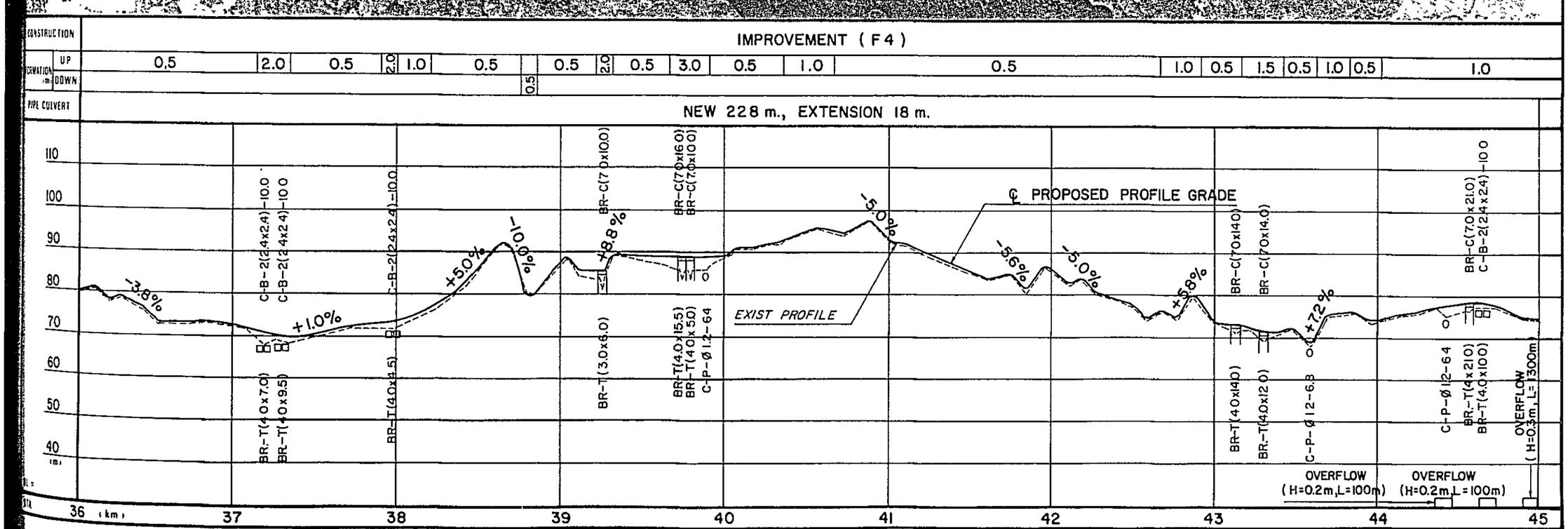


CONSTRUCTION	IMPROVEMENT (F4)
FORMATION (m) UP	0.5 / 1.5 / 1.0 / 1.5 / 1.0 / 1.5 / 0.5 / 1.5 / 0.5 / 1.0 / 1.5 / 1.0 / 1.5 / 0.5 / 0.5 / 2.5 / 1.0
FORMATION (m) DOWN	0.5 / 1.0
PIPE CULVERT	NEW 252 m., EXTENSION 32 m.

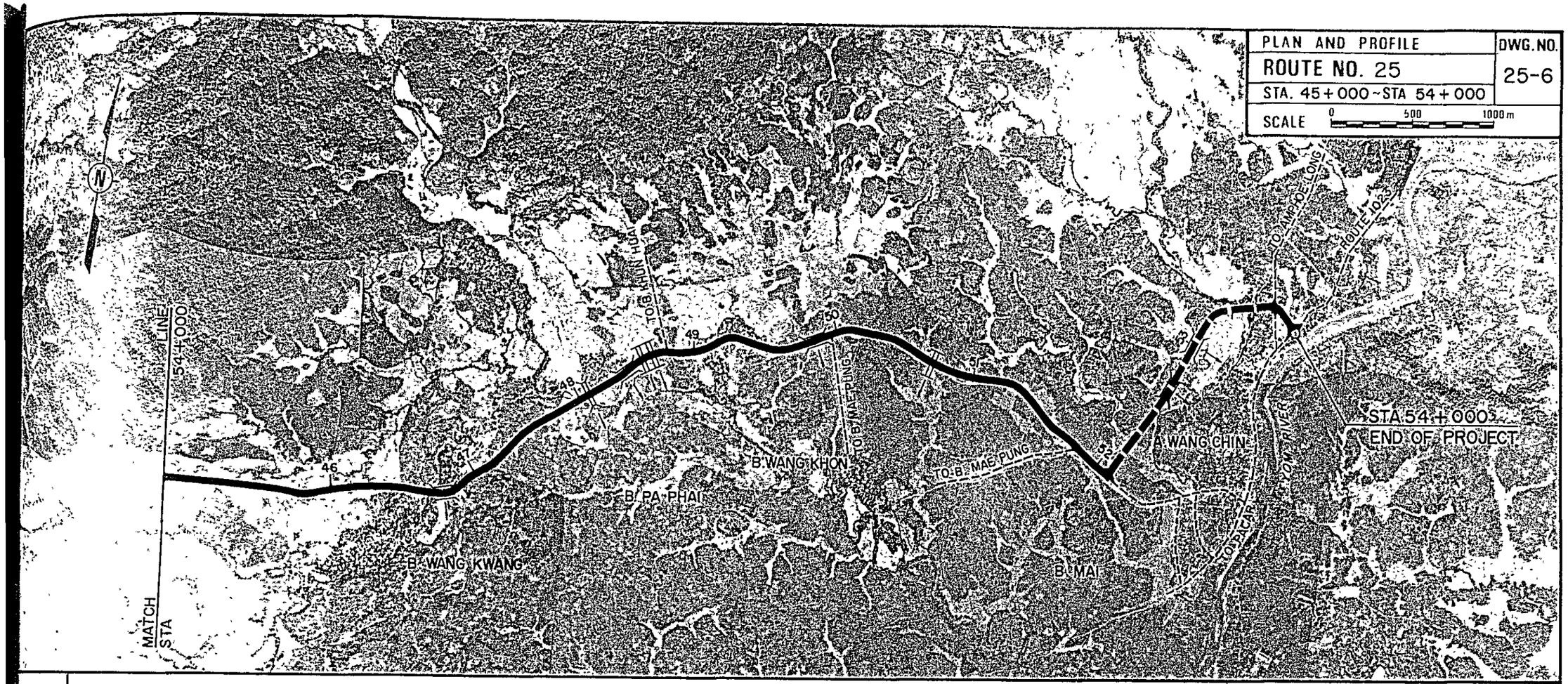


PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-5
STA. 36+000 ~STA. 45+000	
SCALE 0 500 1000 m	





PLAN AND PROFILE	DWG. NO.
ROUTE NO. 25	25-6
STA. 45+000 ~ STA 54+000	
SCALE 0 500 1000 m	



CONSTRUCTION		IMPROVEMENT (F4)												NEW CONSTRUCTION (F4)											
ELEVATION	UP	1.0	0.5	1.5	0.5	1.0	1.5	1.0	0.5	2.0	2.5	0.5		1.5	1.5		1.5		1.5			1.5	0.5	1.5
	DOWN													2.5		2.0	50	3.5						
PIPE CULVERT		NEW 252 m., EXTENSION 17 m.