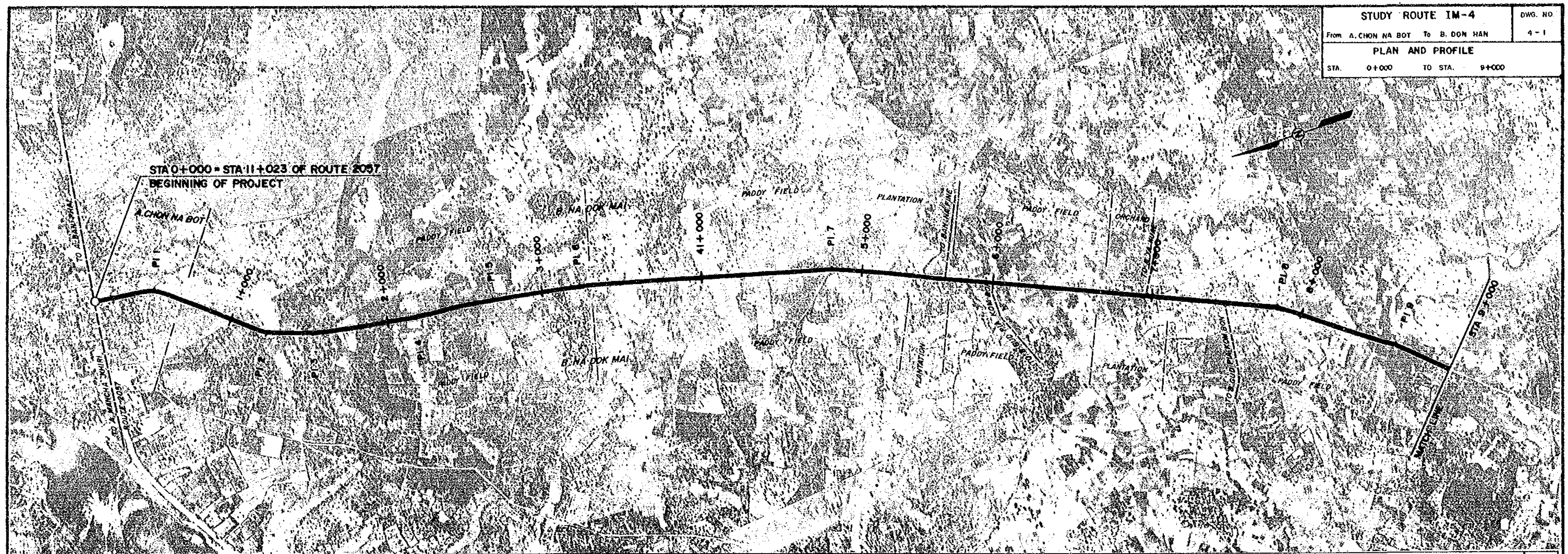
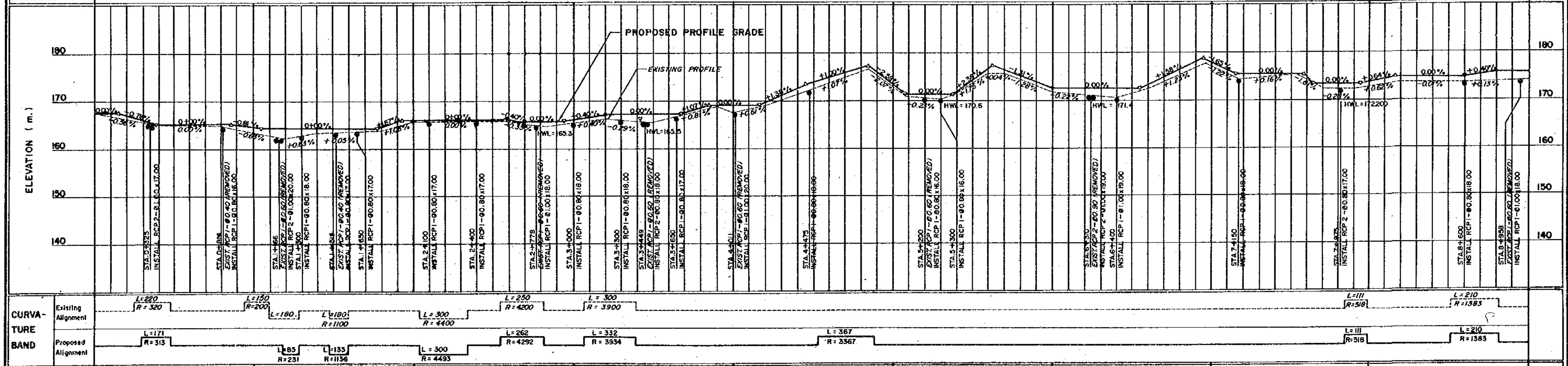
STUDY ROUTE IM-4	DWG. NO
From A. CHON NA BOT To B. DON HAN	4-1
PLAN AND PROFILE	
STA. 0+000 TO STA. 9+000	



TERRAIN		FLAT										
PAVEM'T	Type	DT	LATERITE									
	Condition	FAIR	GOOD							FAIR		
FLOODING	Length (m.)		500		200	200		100	400			300
	Height (m.)		1.10		0.50	0.10		.20	0.50			0.50
RIGHT OF WAY (m.)												
ROUTE NO. AGENCIES		DOH ROUTE NO. 2199										



STATION (Km.)	0+000	1+000	2+000	3+000	4+000	5+000	6+000	7+000	8+000	9+000

STUDY ROUTE IM-4

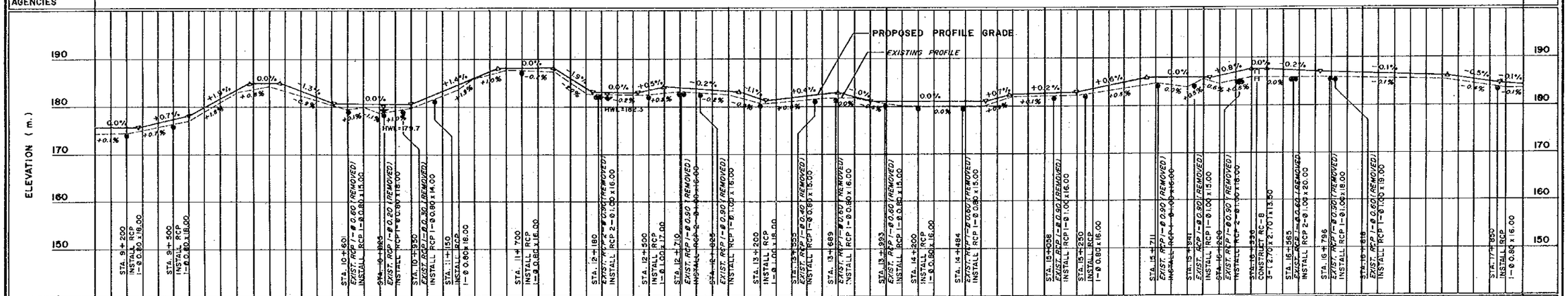
From A.CHON NA BOT To B. DON HAN

DWG NO 4-2

PLAN AND PROFILE

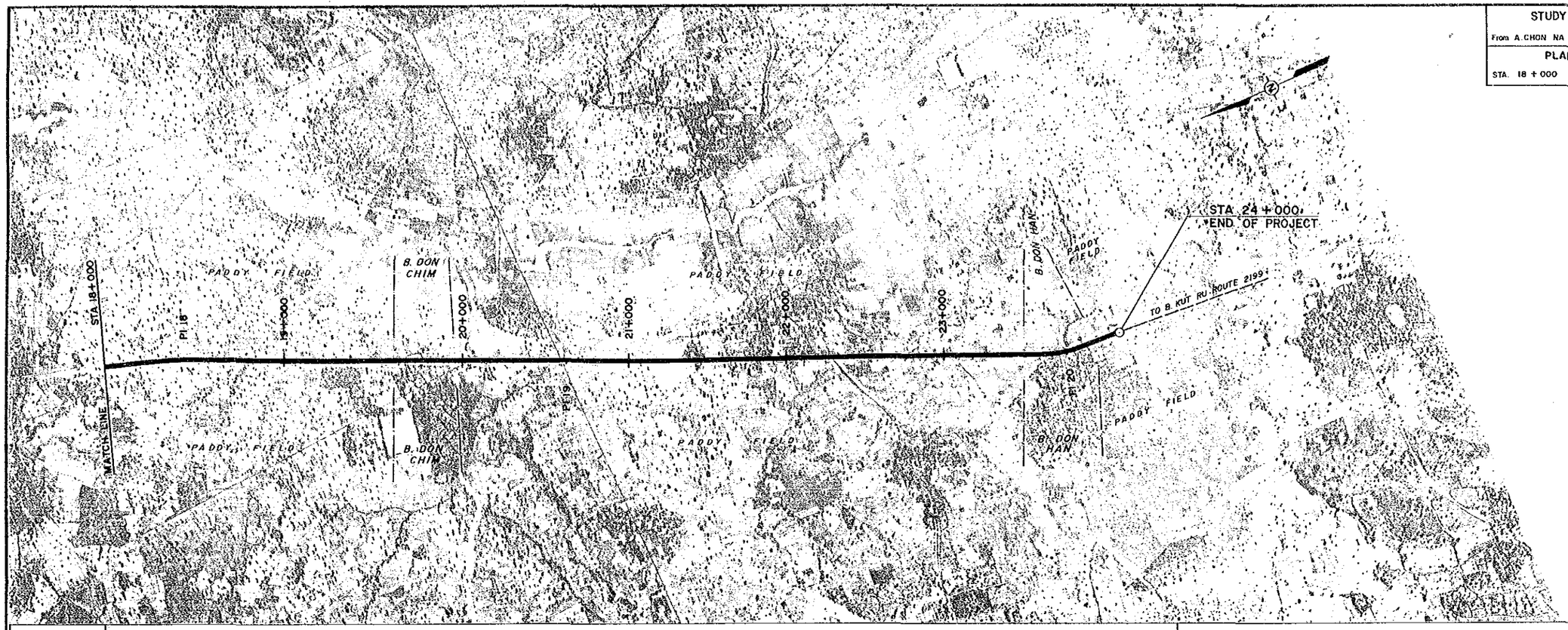
STA 9+000 TO STA 18+000

TERRAIN		FLAT
PAVEMENT	Type	LATERITE / DT / LATERITE / DT / LATERITE
	Condition	GOOD / FAIR
FLOODING	Length (m.)	300
	Height (m.)	0.50
RIGHT OF WAY (m.)		
ROUTE NO. AGENCIES		DOH ROUTE NO. 2199

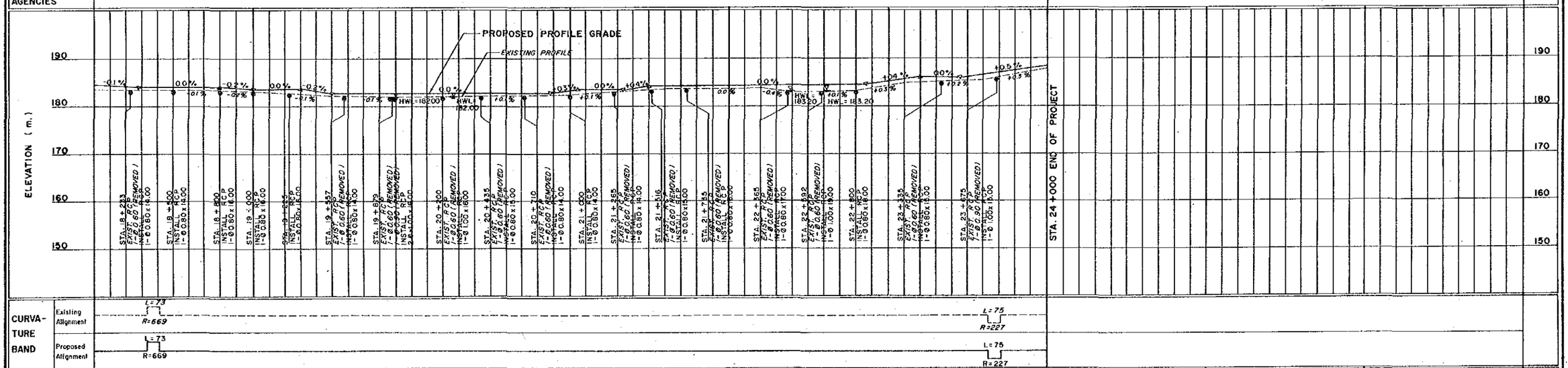


CURVATURE BAND	Existing Alignment	L=195 R=1062; L=208 R=724; L=137 R=786; L=100 R=400; L=300 R=1040; L=350 R=1200
	Proposed Alignment	L=195 R=1062; L=208 R=724; L=137 R=786; L=284 R=1071
STATION (Km.)		9+000 10+000 11+000 12+000 13+000 14+000 15+000 16+000 17+000 18+000

STUDY ROUTE IM-4	DWG. NO
From A.CHON NA BOT To B. DON HAN	4-3
PLAN AND PROFILE	
STA. 18+000 TO STA. 24+000	



TERRAIN		FLAT
PAVEMENT	Type	LATERITE
	Condition	POOR
FLOODING	Length (m.)	1,500 / 500
	Height (m.)	0.50 / 0.10
RIGHT OF WAY (m.)		
ROUTE NO. AGENCIES		DOH ROUTE NO. 2199



STATION (Km.) 18+000 19+000 20+000 21+000 22+000 23+000 24+000

STUDY ROUTE NO. IM-5

Changwat : Khon Kaen

A. Nam Phong (J.R. 2039)—B. Nong Tum

Length : 28.0 KM.

TABLE OF CONTENTS

SUMMARY ____ 5-2

5.1 TRAFFIC ____ 5-3
5.1.1 Method Employed in Traffic Forecasting ____ 5-3
5.1.2 Assumed Road Link ____ 5-3
5.1.3 Traffic Forecast ____ 5-3

5.2 AGRICULTURAL DEVELOPMENT ____ 5-5
5.2.1 Present Condition ____ 5-5
5.2.2 Development Projection ____ 5-5

5.3 VOC SAVINGS ____ 5-12

5.4 ENGINEERING ____ 5-13
5.4.1 Soils and Materials ____ 5-13
5.4.2 Preliminary Design ____ 5-16
5.4.3 Quantities and Construction and Road Maintenance Costs ____ 5-18
5.4.4 Construction and Disbursement Schedules ____ 5-18

5.5 EVALUATION ____ 5-21
5.5.1 Economic Evaluation ____ 5-21
5.5.2 Social Impact ____ 5-21
5.5.3 Overall Evaluation ____ 5-22

5.6 DRAWINGS ____ 5-23/5-29

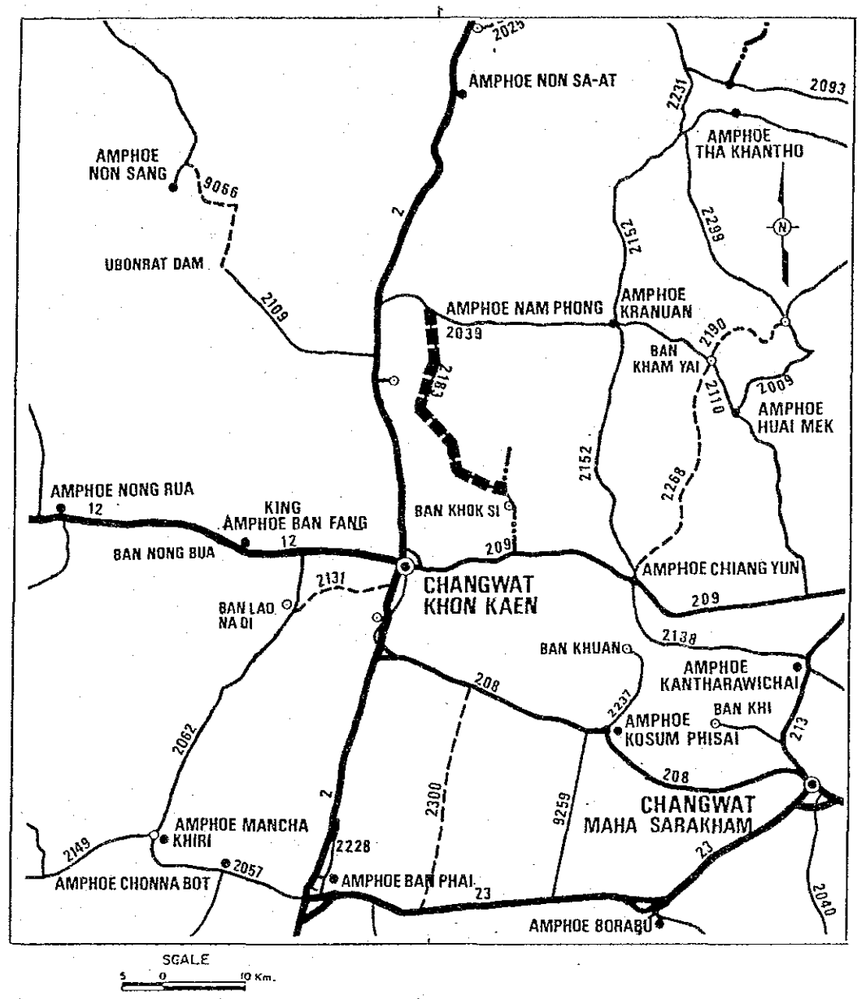
5-1

SUMMARY

STUDY ROUTE IM-5

General		
Changwat	:	Khon Kaen
Origin and Destination	:	A. Nam Phong—B. Nong Tum
Connected Road Network	:	2039
Amphoe on Route	:	-
Number of Related Villages	:	11
Influence Area		
Area	:	189 km^2
Cultivated Area Ratio to Total Land Area in %	:	89
Population in 1983	:	40,400
Main Crops	:	Paddy & Sugar cane
Number of Public Activities		
Public Health Service Centers	:	-
Hospitals Changwat Level	:	1
Amphoe Level	:	1
Schools Primary	:	10
Secondary	:	3
Traffic (ADT)	:	1984—186 1988—317 1994—461 2002—776
Nomenclature of Study Route		
Total Length	:	28.0 km
Improvement Section	:	28.0 km
DOH Road	:	23.0 km
ARD Road	:	5.0 km
Other Road	:	-
New Construction Section	:	-
Design Standard Employed	:	F4
Construction Cost in Baht		
Financial	:	61,886,000
Economic	:	51,725,000
Economic Indicators		
IRR	:	14.6% Ranking: 7
Social Impact		
Social B/C Ratio	:	0.263 Ranking: 5
Recommendations		
Opening Year	:	1988 Overall Ranking: 5

LOCATION OF STUDY ROUTE

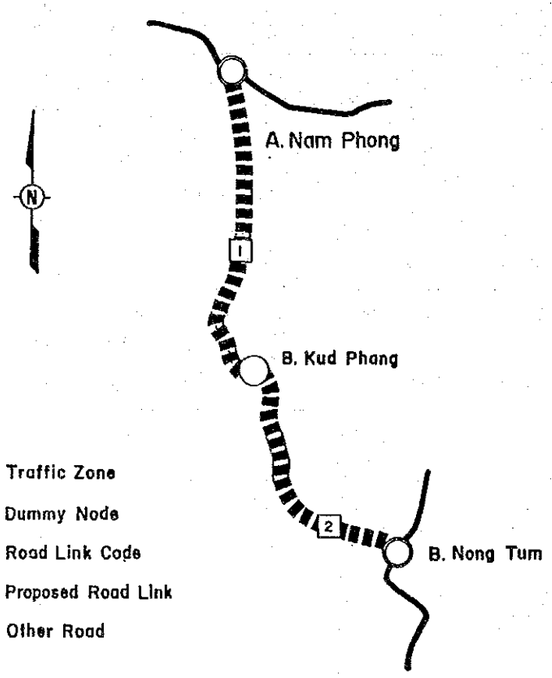


5.1 TRAFFIC

5.1.1 Method Employed in Traffic Forecasting

The growth rate method was employed in forecasting because no diverted traffic after improvement was expected on this study route.

5.1.2 Assumed Road Link



5.1.3 Traffic Forecast

1) Items necessary for forecasting traffic were:
   - Traffic volume in base year
   - Passenger and freight movements in base year
   - Growth rates of passenger and freight movements
   - Rate of induced and developed movements
   - Traffic composition

TRAFFIC VOLUME IN BASE YEAR

LINK	TYPE OF VEHICLE								ADT	M/C	TOTAL
	P/C	L/B	M/B	H/B	P/P&T	4/T	6/T	10/T			
1	5	0	35	6	46	11	10	1	114	245	359
2	20	8	151	0	137	15	16	3	350	418	768
AVE.	12	4	87	3	87	13	13	2	219	322	542

PASSENGER AND FREIGHT MOVEMENT IN BASE YEAR

PROPOSED ROAD LINK	PASSENGER MOVEMENT (TRIPS PER DAY)	FREIGHT MOVEMENT (TONNAGE PER DAY)		
		NON-AGRI.	AGRI.	TOTAL
1	1189	38.0	5.7	43.7
2	3974	70.3	10.5	80.8

GROWTH RATE OF PASSENGER MOVEMENT

(UNIT : % P.A.)

YEAR	PER CAPITA INCOME	POPULATION	PASSENGER MOVEMENT
1984 - 1988	3.1	1.3	5.7
1988 - 1994	3.1	1.1	5.6
1994 - 2002	3.1	1.0	5.4

GROWTH RATE OF FREIGHT MOVEMENT

(UNIT : % P.A.)

YEAR	NON-AGRI. FREIGHT	AGRI. FREIGHT	FREIGHT MOVEMENT
1984 - 1988	7.1	0.5	6.3
1988 - 1994	6.9	0.6	6.3
1994 - 2002	6.7	0.6	6.3

RATE OF INDUCED AND DEVELOPED MOVEMENT

(UNIT : %)

YEAR	INDUCED LINK 1	INDUCED LINK 2	DEVELOPED PASSENGER MOVEMENT	DEVELOPED NON-AGRI. FREIGHT MOVEMENT	DEVELOPED AGRI. FREIGHT MOVEMENT
1988	15.0	15.0	0.0	0.0	0.4
1994	15.0	15.0	0.0	0.0	2.8
2002	15.0	15.0	0.0	0.0	6.4

TRAFFIC COMPOSITION

(UNIT : %)

LINK NO.	YEAR	PASSENGER P/C	P/P	L/B	M/B	H/B	FREIGHT P/T	4/T	6/T	10/T
1	1984	7.2	56.5	0.0	30.9	5.3	24.1	37.9	34.5	3.4
	1988	14.3	52.4	0.7	26.9	5.7	21.7	31.9	37.9	8.5
	1994	24.9	46.2	1.7	21.0	6.2	18.0	23.0	43.1	16.0
	2002	39.0	38.0	3.0	13.0	7.0	13.0	11.0	50.0	26.0
2	1984	8.6	49.3	2.1	40.0	0.0	39.3	26.8	28.6	5.4
	1988	15.3	46.8	2.3	34.0	1.6	33.4	23.3	33.3	9.9
	1994	25.5	43.0	2.6	25.0	3.9	24.7	18.0	40.5	16.8
	2002	39.0	38.0	3.0	13.0	7.0	13.0	11.0	50.0	26.0

2) The following were output:
- Forecasted ADT
- Traffic volumes

AVERAGE FUTURE TRAFFIC ON PROPOSED ROUTE

YEAR	TYPE OF VEHICLE P/C	L/B	M/B	H/B	P/P&T	4/T	6/T	10/T	ADT	M/C	TOTAL
1988	49	6	105	9	172	13	17	5	376	337	713
1994	125	12	118	22	229	11	23	9	548	391	939
2002	334	26	111	60	334	8	34	18	924	466	1390

TRAFFIC VOLUME ON ROUTE IM- 5 LINK COUNT= 2

	YEAR	1988			1994			2002		
	LINK	1	2	AVR.	1	2	AVR.	1	2	AVR.
P/C	N+D	20	71	43	52	179	109	142	474	290
	I	3	11	6	8	27	16	21	71	44
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	23	82	49	60	206	125	163	545	334
L/B	N+D	1	11	5	3	18	10	11	36	22
	I	0	2	1	1	3	2	2	5	3
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	1	12	6	4	21	12	13	42	26
M/B	N+D	37	158	91	44	175	103	47	158	97
	I	6	24	14	7	26	15	7	24	15
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	43	182	105	50	202	118	54	182	111
H/B	N+D	8	7	8	13	27	19	25	85	52
	I	1	1	1	2	4	3	4	13	8
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	9	8	9	15	31	22	29	98	60
P/P&T	N+D	79	237	150	103	318	199	144	472	290
	I	12	36	22	15	48	30	22	71	44
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	91	273	172	118	365	229	165	543	334
4/T	N+D	10	13	11	8	11	9	5	9	7
	I	1	2	2	1	2	1	1	1	1
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	11	15	13	9	13	11	5	10	8
6/T	N+D	11	19	15	15	26	20	22	40	30
	I	2	3	2	2	4	3	3	6	4
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	13	22	17	17	30	23	25	46	34
10/T	N+D	3	6	4	5	11	8	11	21	15
	I	0	1	1	1	2	1	2	3	2
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	3	7	5	6	12	9	13	24	18
ADT	N+D	169	523	327	243	765	476	407	1295	803
	I	25	78	49	36	115	71	61	194	120
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	194	601	376	280	880	548	468	1489	924
M/C	N+D	243	408	317	297	463	371	371	539	446
	I	20	20	20	20	20	20	20	20	20
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	264	428	337	317	483	391	391	559	466
TOTAL	N+D	412	930	643	540	1228	847	778	1834	1249
	I	46	99	69	57	135	92	81	215	141
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	458	1029	713	596	1363	939	859	2049	1390

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

5.2 AGRICULTURAL DEVELOPMENT

5.2.1 Present Condition

Almost all the cultivated land in the influence area is covered by paddy fields, since the area extends along the Chi River basin. In Amphoe Nam Phong, there is a large sugar factory with a 9,600-ton/day capacity and the ability to process nearly 1.4 million tons per year. For this reason, sugarcane is the major upland field crop.

Land use and capability conditions in the area are shown in Table 5.2.1 and Figure 5.2.1. A typical cropping calendar in the area is shown in Figure 5.2.2.

5.2.2 Development Projection

Future agricultural development in the area of influence was projected for both cases of "with and without project". The projected planted area, unit yields by crop, and the consequent production amount are shown in Table 5.2.2.

Based on the above projected production amount, farmgate prices and production costs estimated separately, net production value (NPV) was obtained as shown in Table 5.2.3. The difference in NPV between the two cases is deemed to be the development benefit of the study route.

FIGURE 5.2.1 LAND USE AND CAPABILITY OF INFLUENCE AREA

STUDY ROUTE NO. IM-5

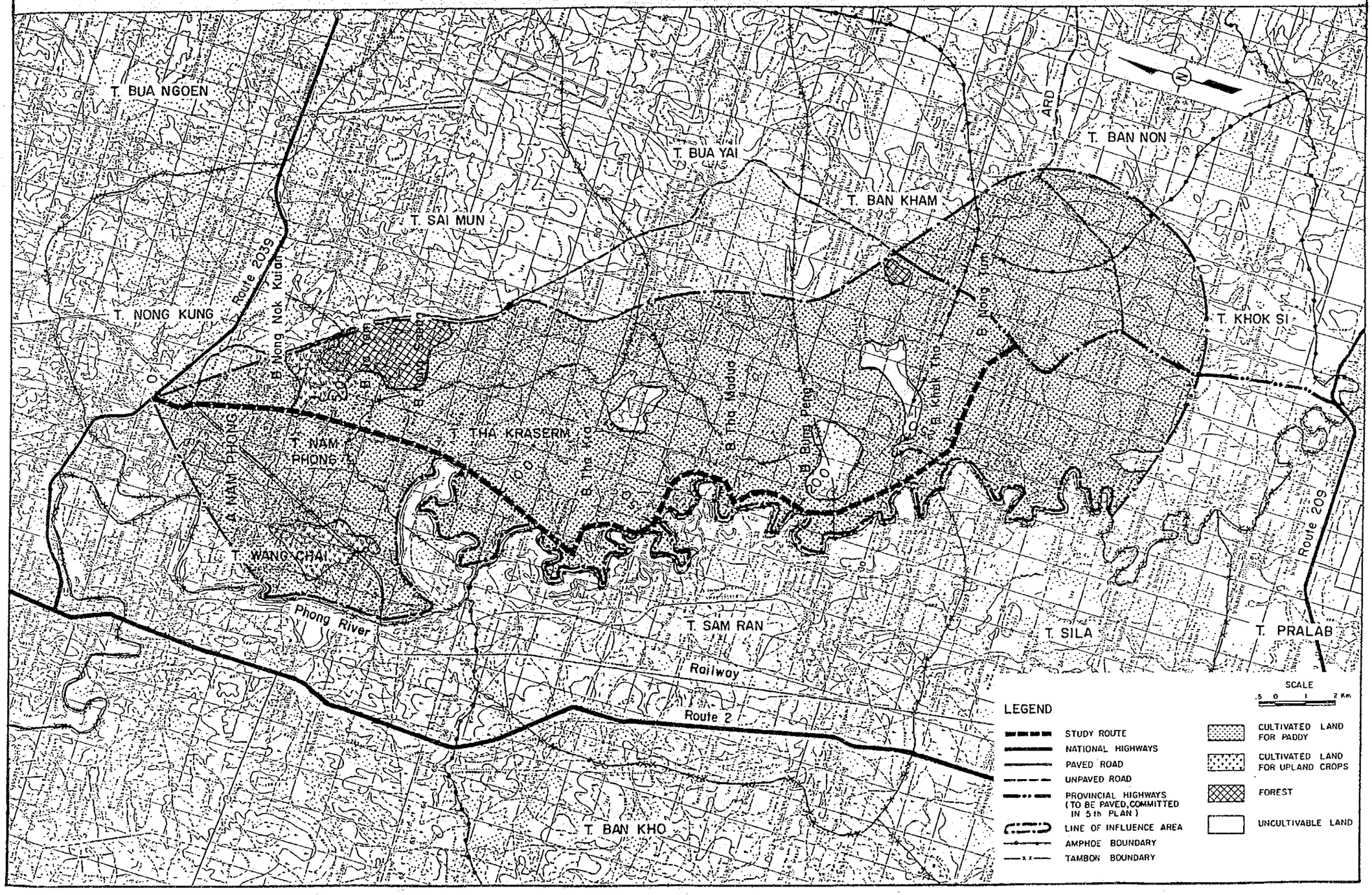
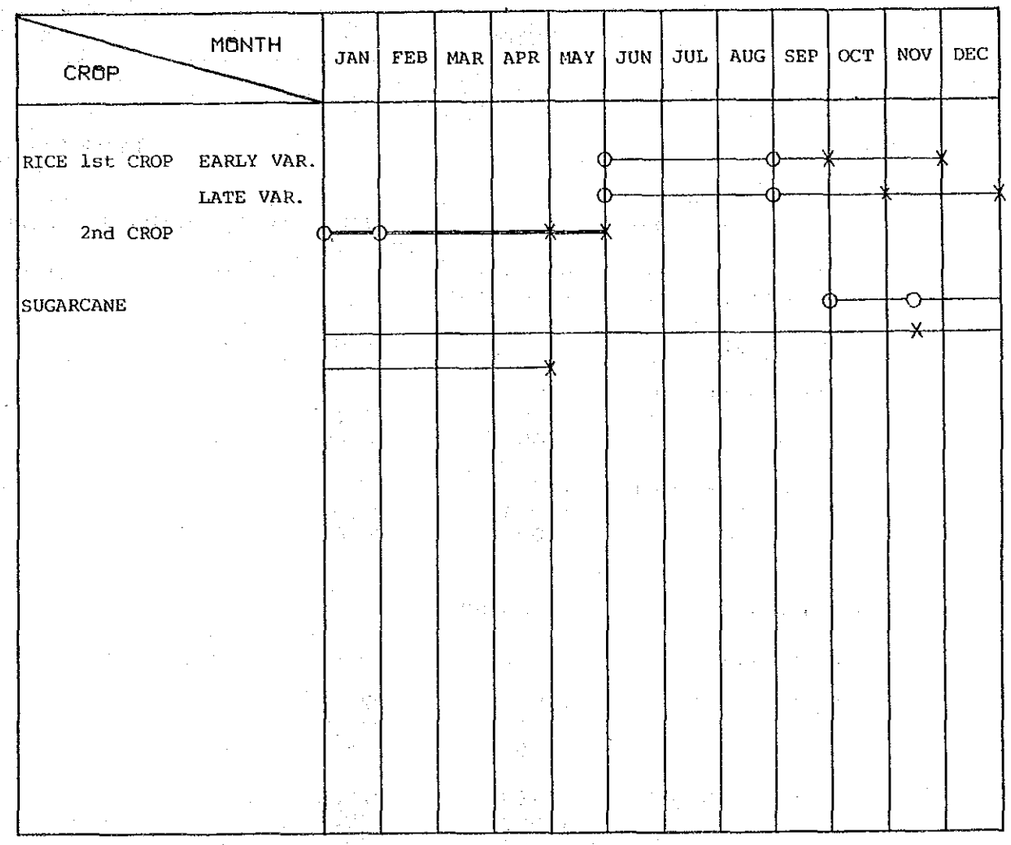


FIGURE 5.2.2 CROPPING CALENDAR

ROUTE IM-5

Related Amphoes: 0601 M. Khon Kaen
0609 Nam Phong
0610 Kranuan



Note:

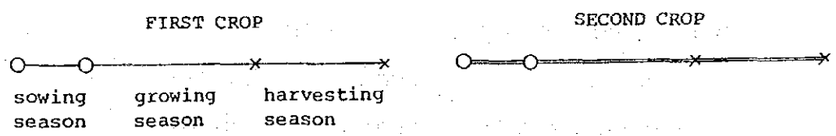


TABLE 5.2.1 CULTIVATED LAND

[UNIT : 1000 RAI (KM2)]

CHANGWAT NAME	AMPHOE NAME	CULTIVATED LAND		
		PADDY FIELD	UPLAND FIELD	TOTAL
KHON HAEN	M. KHON KAEN	30.50 (48.80)	0.00 (0.00)	30.50 (48.80)
	NAM PHONG	66.00 (105.60)	2.37 (3.79)	68.37 (109.39)
	KRANUAN	5.63 (9.01)	0.00 (0.00)	5.63 (9.01)
TOTAL		102.13 (163.41)	2.37 (3.79)	104.50 (167.20)

TABLE 5.2.2 CROP PRODUCTION

ITEM		RICE (PADDY)	MAIZE	SORGHUM	BEANS	GROUND NUTS	CASSAVA	KENAF	SUGAR CANE	COTTON	CASTOR BEANS	UPLAND TOTAL	TOTAL
PLANTED AREA	(1000 RAI)												
BASE YEAR	(1983)	74.04	-	-	-	-	-	-	1.85	-	-	1.85	75.89
WITHOUT PROJECT	(1988)	77.20	-	-	-	-	-	-	1.85	-	-	1.85	79.05
	(1994)	81.18	-	-	-	-	-	-	1.85	-	-	1.85	83.03
	(2002)	86.80	-	-	-	-	-	-	1.85	-	-	1.85	88.65
WITH PROJECT	(1988)	77.39	-	-	-	-	-	-	1.85	-	-	1.85	79.24
	(1994)	82.56	-	-	-	-	-	-	1.85	-	-	1.85	84.41
	(2002)	90.00	-	-	-	-	-	-	1.85	-	-	1.85	91.85
CROP YIELD	(KG/RAI)												
BASE YEAR	(1983)	269.0	-	-	-	-	-	-	8000.0	-	-		
WITHOUT PROJECT	(1988)	270.3	-	-	-	-	-	-	8000.0	-	-		
	(1994)	271.9	-	-	-	-	-	-	8000.0	-	-		
	(2002)	274.0	-	-	-	-	-	-	8000.0	-	-		
WITH PROJECT	(1988)	271.3	-	-	-	-	-	-	8008.0	-	-		
	(1994)	278.7	-	-	-	-	-	-	8056.2	-	-		
	(2002)	289.0	-	-	-	-	-	-	8120.8	-	-		
CROP PRODUCTION AMOUNT	(TON)												
BASE YEAR	(1983)	19,917	-	-	-	-	-	-	14,800	-	-	14,800	34,717
WITHOUT PROJECT	(1988)	20,869	-	-	-	-	-	-	14,800	-	-	14,800	35,669
	(1994)	22,071	-	-	-	-	-	-	14,800	-	-	14,800	36,871
	(2002)	23,783	-	-	-	-	-	-	14,800	-	-	14,800	38,583
WITH PROJECT	(1988)	20,994	-	-	-	-	-	-	14,815	-	-	14,815	35,808
	(1994)	23,013	-	-	-	-	-	-	14,904	-	-	14,904	37,917
	(2002)	26,010	-	-	-	-	-	-	15,024	-	-	15,024	41,034

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE

TABLE 5.2.3 NET PRODUCTION VALUE

ITEM			RICE (PADDY)	MAIZE	SORGHUM	BEANS	GROUND NUTS	CASSAVA	KENAF	SUGAR CANE	COTTON	CASTOR BEANS	UPLAND TOTAL	TOTAL
FARMGATE PRICE	(BAHT/TON)													
WITHOUT PROJECT	(1983 - 2002)		3,705	-	-	-	-	-	-	489	-	-		
WITH PROJECT	(1988 - 2002)		3,719	-	-	-	-	-	-	499	-	-		
CROP PRODUCTION COST	(BAHT/RAI)													
BASE YEAR		(1983)	700	-	-	-	-	-	-	1,954	-	-		
WITHOUT PROJECT		(1988)	703	-	-	-	-	-	-	1,954	-	-		
		(1994)	706	-	-	-	-	-	-	1,954	-	-		
		(2002)	711	-	-	-	-	-	-	1,954	-	-		
WITH PROJECT		(1988)	704	-	-	-	-	-	-	1,955	-	-		
		(1994)	719	-	-	-	-	-	-	1,964	-	-		
		(2002)	738	-	-	-	-	-	-	1,974	-	-		
NET PRODUCTION VALUE	(1000 BAHT)													
WITHOUT PROJECT		(1988)	23,044	-	-	-	-	-	-	3,626	-	-	3,626	26,670
		(1994)	24,462	-	-	-	-	-	-	3,626	-	-	3,626	28,088
		(2002)	26,402	-	-	-	-	-	-	3,626	-	-	3,626	30,028
WITH PROJECT		(1988)	23,592	-	-	-	-	-	-	3,776	-	-	3,776	27,368
		(1994)	26,222	-	-	-	-	-	-	3,804	-	-	3,804	30,026
		(2002)	30,311	-	-	-	-	-	-	3,845	-	-	3,845	34,156
NET VALUE ADDED	(1000 BAHT)													
1988			548	-	-	-	-	-	-	150	-	-	150	698
1994			1,760	-	-	-	-	-	-	178	-	-	178	1,938
2002			3,909	-	-	-	-	-	-	219	-	-	219	4,128

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE SMALL

5.3 VOC SAVINGS

In accordance with the concept and data given in Section 3.4 of the Text Report, VOCs on the road link concerned were calculated in the two cases of "with and without project".

Road length by road class is shown in Table 5.3.1. Data for additional VOCs are shown in Table 5.3.2.

VOC savings, obtained as the balance of total link VOCs between the two cases, were calculated as shown in Table 5.3.3.

TABLE 5.3.1 ROAD LENGTH BY ROAD CLASS

(UNIT : KM)

LINK NO.	WITHOUT PROJECT CASE						WITH PROJECT CASE
	PAVED	LATERITE			EARTH	TOTAL	PAVED
		GOOD	FAIR	POOR			
1	-	-	-	15.5	-	15.5	15.5
2	-	-	-	12.5	-	12.5	12.5

TABLE 5.3.2 DATA FOR ADDITIONAL VOC COST

(UNIT OF LENGTH : M)

LINK NO.	CASE	CURVE									GRADE					VILLAGE		NO. OF INTER-SECTION	NO. OF TIMBER BRIDGE	NO. OF NARROW BRIDGE	NO. OF CORNER
		100	150	200	250	300	375	500	750	1500	1	2	3	4	5	NO.	LENGTH				
1	WITHOUT	357	288	132	214	170	124	-	491	419	3100	1200	100	200	-	10	5270	4	-	5	10
	WITH	213	288	247	214	170	186	-	491	419	2400	1550	-	150	-	10	5270	1	-	-	2
2	WITHOUT	239	49	83	137	-	408	226	909	388	1900	200	-	-	-	2	1100	-	2	1	-
	WITH	239	49	83	137	-	408	226	909	388	1800	200	-	-	-	2	1100	-	-	-	-

TABLE 5.3.3 VEHICLE OPERATING COST SAVING

(UNIT : 1000 BAHT)

LINK NO.	1988			1994			2002		
	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING
1	8,055	5,612	2,443	11,421	7,859	3,562	18,239	12,502	5,737
2	11,744	7,951	3,793	16,741	11,236	5,506	27,249	18,205	9,044
TOTAL	19,800	13,563	6,237	28,163	19,095	9,068	45,488	30,707	14,781

N O T E
(1) WITHOUT : WITHOUT PROJECT CASE (2) WITH : WITH PROJECT CASE
(3) SAVING : VEHICLE OPERATING COST SAVING
(4) LINK NO. = 1 - 9 : PROPOSED LINK (5) LINK NO. = 11 - 19 : SURROUNDING LINK

5.4 ENGINEERING

5.4.1 Soil and Materials

Existing subgrade soil and material sources in the vicinity of the Study Route investigated by DOH and their physical characteristics are shown in Figure 5.4.1 and Table 5.4.1, respectively.

Rock aggregate sources were assumed as shown below:

No.	Source	Description of Sample	Estim. Quantity m^3
5/CS-1	KM. 90+800 Lt 1,500 M. Chum Pae Rung Rueng Quarry	Lime Stone	Plenty
5/CS-2	KM. 105+600 Lt 6,000 M. Sila Sri Buri Quarry	Lime Stone	Plenty
5/CS-3	KM. 109+300 Lt 6,000 M. Sila Esarn Quarry	Lime Stone	Plenty

The borehole location, boring log and summary of boring test results are shown in Figures 5.4.2 and 5.4.3 and Table 5.4.2, respectively.

FIGURE 5.4.1 SOIL AND MATERIAL SOURCES

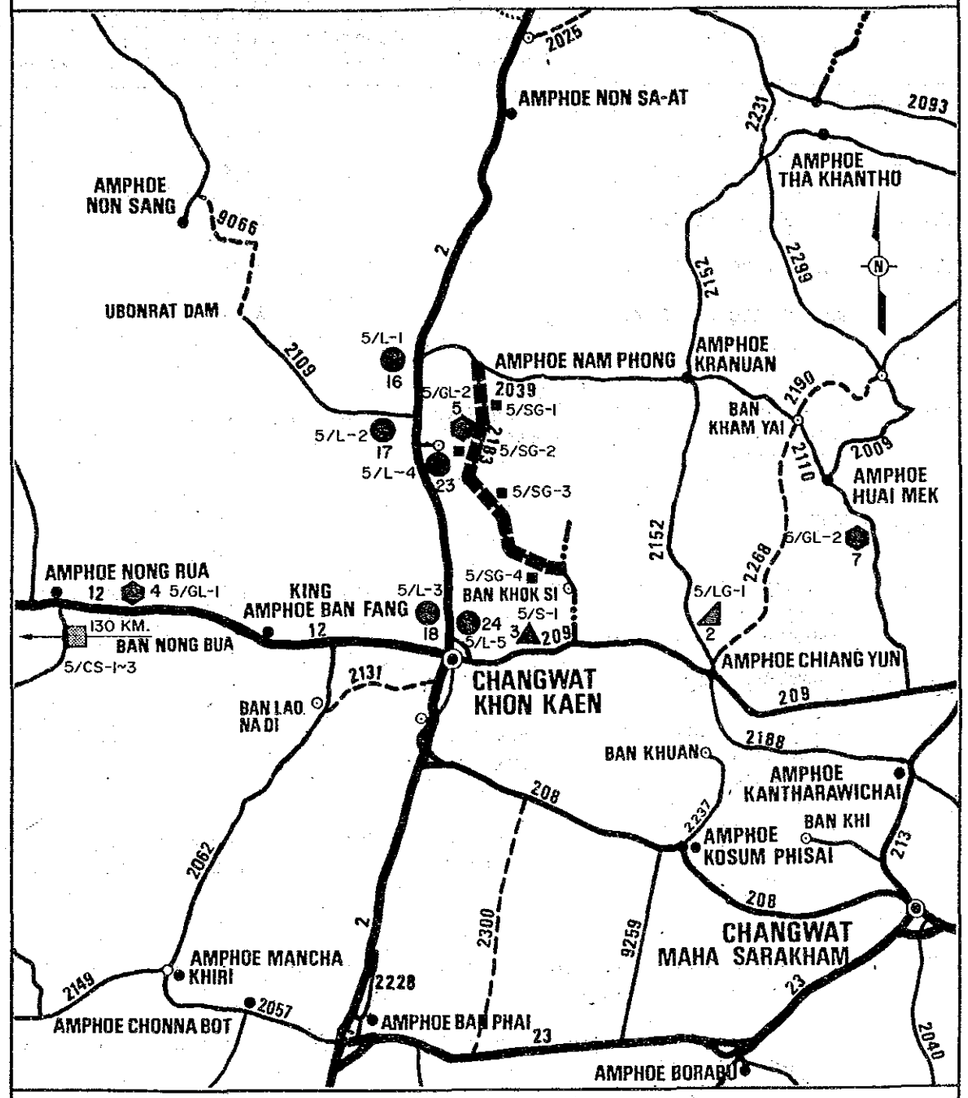


TABLE 5.4.1 PHYSICAL CHARACTERISTICS OF MATERIALS

No.	Source	Description of Sample	Est. Quantity m^3	AASHTO Classification	Sieve Analysis % Passing 50.0	25.0	19.0	9.5	#4	#10	#40	#200	Plasticity LL	PT	Comp. DH-T Stand. Opt. 95%	gm/cc	Lab. C.B.R. CBR 95%	Swell %	Durability Abr.	Dur.
SUBGRADE																				
5/SG-1.	KM. 5+000 Lt 15 M.			A-4					100.0	99.0	95.2	37.4	N-P		10.6	1.750	29.0	-		
5/SG-2.	KM. 10+000 Rt 12 M.			A-7-6				100.0	98.2	96.4	95.4	94.8	40.00	19.17	20.8	1.603	2.5	2.8		
5/SG-3.	KM. 16+000 Lt 14 M.			A-7-6						100.0	92.0	90.0	37.90	15.72	17.3	1.691	4.8	1.5		
5/SG-4.	KM. 22+000 Rt 12 M.			A-7-6					100.0	97.4	94.2	92.4	40.60	13.68	21.8	1.599	2.2	2.7		
SAND																				
5/S-1.	KM. 10+000 Lt 700 M. Khon Kaen - Yang Talad	Pong River Sand	Plentiful	A-3					100	99	95	6	N.P.							
LAND GRAVEL																				
5/LG-1	KM. 29+000 Lt, Rt close to Kranuan - Chiang Yuen	Land gravel	70,000	A-2-7	100	92.3		71.6	55.4	41.6	24.9	14.9	45.7	18.6	8.0	2.170	5.4			
				A-2-7	100	93.6		71.7	55.8	41.1	24.2	14.3	45.3	17.8						
GRAVELLY LATERITE																				
5/GL-1	KM. 42+000 Rt 45 M. Khon Kaen - Chum Phae	Gravelly laterite	20,000		100	98.1		81.3		36.7	22.0	12.0	31.3	8.2	6.9	2.092	54.5			
5/GL-2	KM. 16+000 Lt close to Yang Talad - Kra Nuan	Gravelly laterite	100,000	A-2-4	100	94.4		90.3	72.5	52.9	38.6	20.1	32.1	10.3	8.0	2.101	24.8			
				A-2-4	100	98.2		88.2	72.0	49.1	35.7	19.3	31.9	10.9						
LATERITE																				
5/L-1	KM. 483+000 Lt close to Khon Kaen - Udon Thani	Laterite	60,000	A-2-4	100	98	97	94	57	31	16	9	31.1	9.6	5.5	2.145	31.0		52.4	78.6
5/L-2	KM. 1+000 Rt close to Ubon Rat Dam	Laterite	22,500	A-1-a	100	94	88	60	41	20	12	8	N.P.		5.6	2.184	50.0		59.8	70.0
5/L-3	KM. 450+150 Lt 4.5 KM. Khon Daen - Udon Thani L3:S2 = 4:1 by weight	Laterite	100,000	A-2-6	100	96	91	67	49	34	23	14	32.1	13.6					33.8	75.0
		Laterite with sand		A-2-4	100	98	93	71	59	48	38	13	15.7	6.6	5.6	2.258	51.0	0.40		
5/L-4	KM. 468+000 Rt 1.50 KM. Khon Kaen - Udon Thani	Laterite	32,000	A-2-4	100	98	87	48	25	18	17	12	29.3	8.5					30.0	68.9
5/L-5	KM. 450+200 Rt 1.7 KM. Khon Kaen - Udon Thani L2:S2 = 4:1 by weight	Laterite	30,000	A-2-6		100	92	73	55	43	28	17	35.1	15.5					28.2	68.9
		Laterite with sand		A-2-4		100	93	77	61	4.7	32	17	26.0	11.0	7.2	2.150	39.0	0.61		

FIGURE 5.4.2 BOREHOLE LOCATION

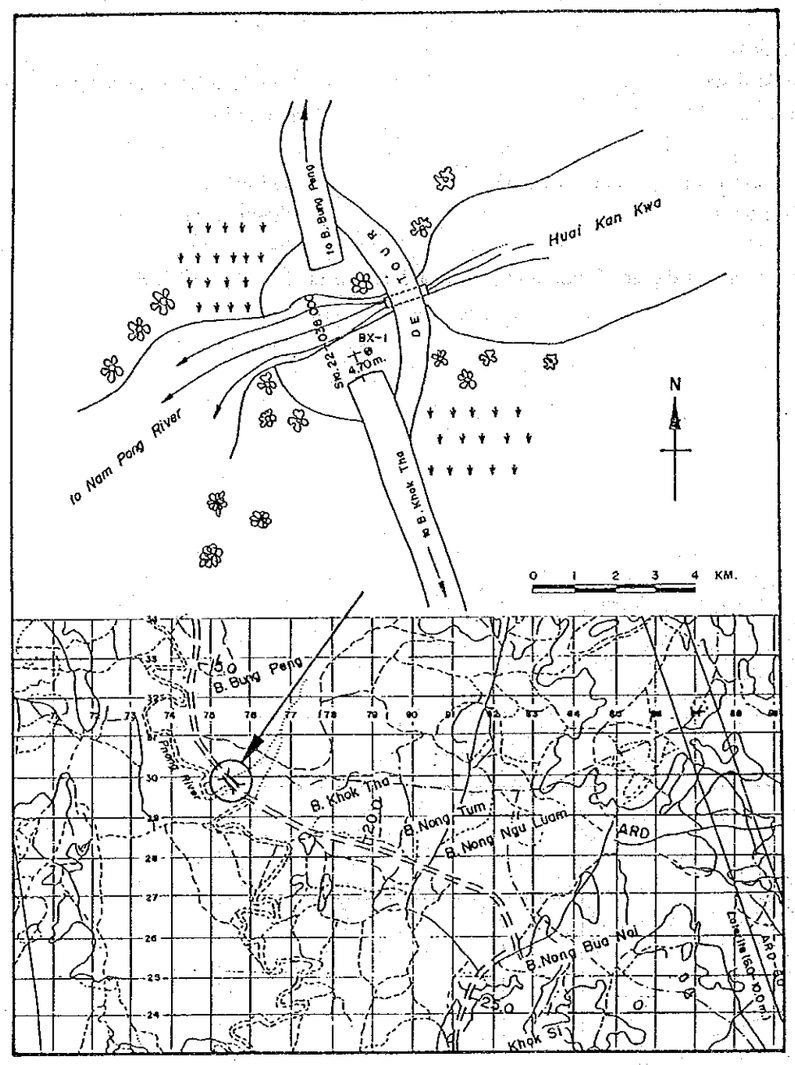


FIGURE 5.4.3 BORING LOG

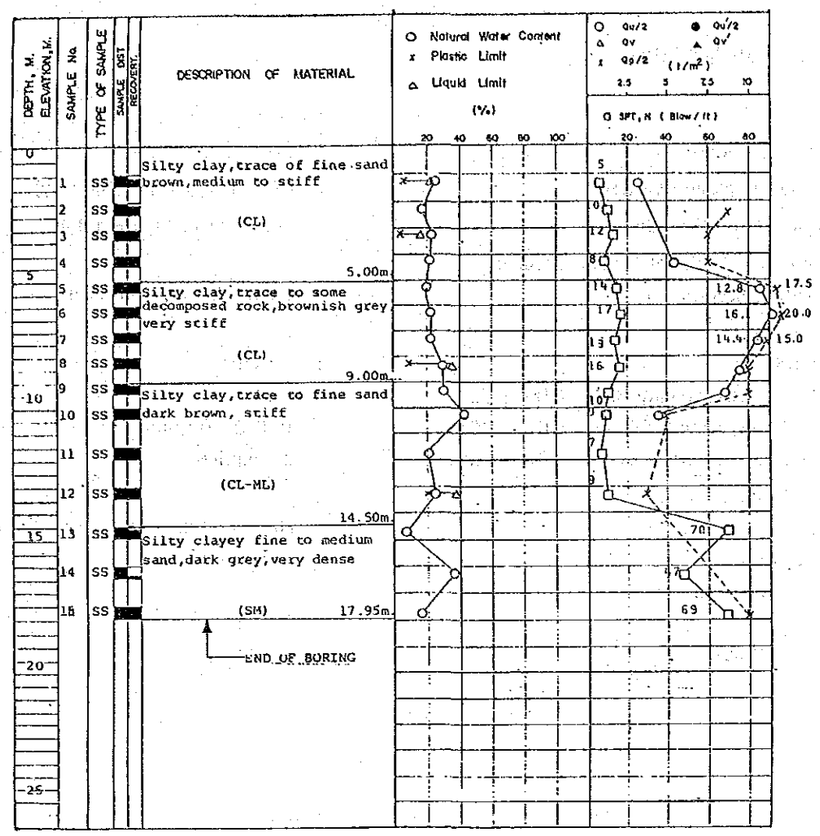


TABLE 5.4.2 SUMMARY OF TEST RESULTS

SAMPLE No.	DEPTH M. FROM	DEPTH M. TO	WATER CONTENT %	ATTERBERG LIMIT % LL.	PL.	PI.	WET UNIT WEIGHT t/m³	SIEVE ANALYSIS % FINER No. 3/8"	No. 4	No. 10	No. 40	No. 200	CLASSIFICATION	UNDRAINED SHEAR STRENGTH t/m.² UNCONFINED SHEAR Qu/2	Qu'/2	FIELD VANE SHEAR Qv	Qv'	POCKET PENETRATION ½Qp	STANDARD PENETRATION (N)		
SS-1	1.00	1.45	23.9	20.8	5.9	14.9	2.06			100	99	97	CL	3.2				-	5		
SS-2	2.00	2.45	17.9				-						CL	-				8.7	10		
SS-3	3.00	3.45	21.8	14.9	4.4	10.5				100	99	92	CL	-				7.5	12		
SS-4	4.00	4.45	21.4				1.99						CL	5.5				7.5	8		
SS-5	5.00	5.45	19.3				2.02						CL	12.8				17.5	14		
SS-6	6.00	6.45	22.3				1.99						CL	16.1				20.0	17		
SS-7	7.00	7.45	21.8				2.02						CL	14.4				15.0	13		
SS-8	8.00	8.45	28.7	34.8	9.8	25.0	1.96				100	99	CL	9.5				10.0	16		
SS-9	9.00	9.45	29.8				1.90						CL	8.7				10.0	10		
SS-10	10.00	10.45	41.6				1.79						CL	4.6				5.0	9		
SS-11	11.50	11.95	20.5		NP.		-			100	99	70	ML	-				-	7		
SS-12	13.00	13.45	24.4	38.0	19.9	18.1	-	100	98	96	92	71	CL	-				3.7	9		
SS-13	14.50	14.95	7.7				-						SM	-				-	70		
SS-14	16.00	16.45	37.5		NP.		-	100	80	63	48	33	SM	-				-	47		
SS-15	17.50	17.95	17.4				-						SM	-				10.0	69		

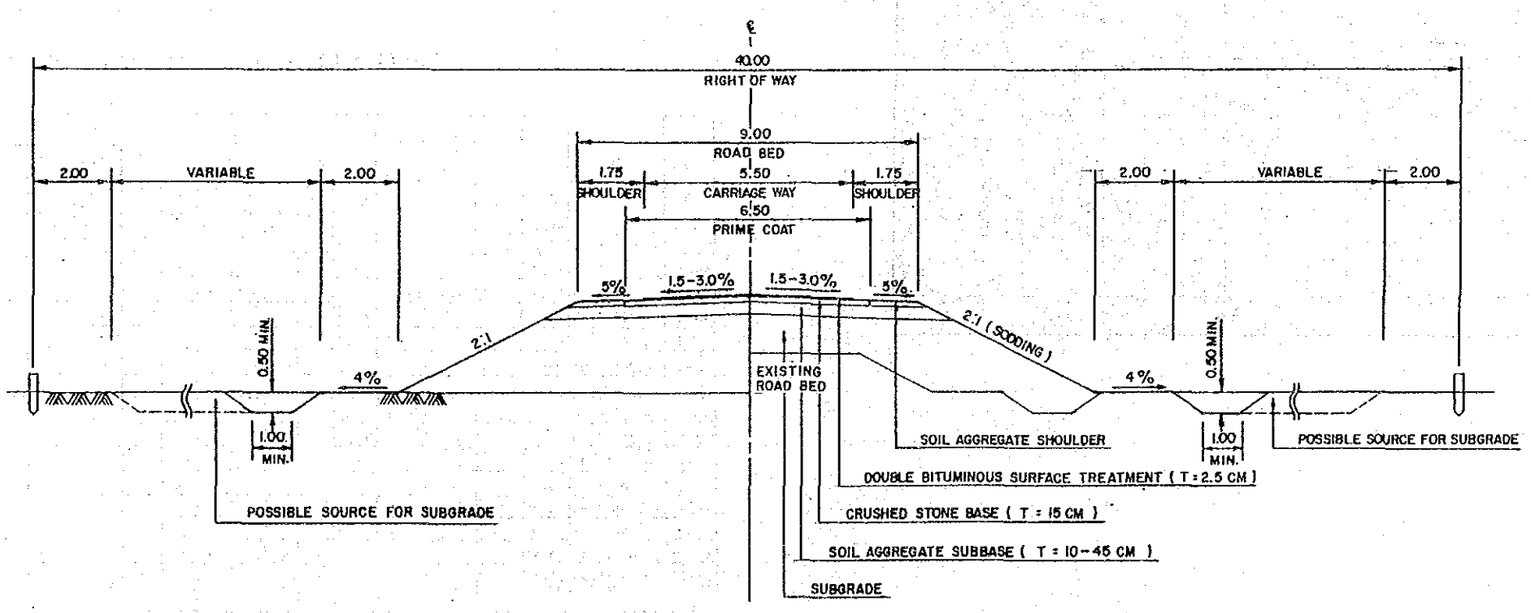
5.4.2 Preliminary Design

5.4.2.1 Design Criteria

Design Standard		: F4
Geometric Design Criteria		: DOH (Provincial Highway)
Typical Cross Section		: as shown in Figure 5.4.4.
Minimum Height of Embankment in Flooding Section		: 0.7 m above flood level
Pavement Structure		
DBST		: 2.5 cm
Crushed Aggregate Base	CBR≥ 80%	: 15.0 cm
Soil Aggregate Subbase	CBR≥ 25%	: 10.0 cm (minimum requirement)
Selected Materials	CBR≥ 6%	: as required
Pipe Culvert		
Standardized type		: 80, 100, 120 & 150 cm in diameter
Location		: as required
Standard intervals		
Paddy area		: 200 m
Others		: 500 m
Box Culvert		
Standard size		: 1.5×1.5, 2.4×2.4 & 3.0×3.0 m
Location		: as required
Bridge		
Reinforced concrete standard type		: Width 9.0 m
Substructure		: Pile-bent type

The existing and designed plan and profile are shown in Drawings 5-1/5-4.

FIGURE 5.4.4 TYPICAL CROSS SECTION



PROVINCIAL HIGHWAY (CLASS F4)

5.4.2.2 Special Conditions in Designing

Minor Modifications in Alignment

The existing road crosses many small irrigation canals at right angles. Minor modifications in alignment were made by removing the bridges crossing canals.

5.4.2.3 Pavement Design

1) Cumulative number of ESA in one direction

- ESA conversion factors

Heavy bus	:	0.50
Medium truck	:	0.76
Heavy truck	:	1.24

- Forecasted ADT by vehicle type

Year	1988				1994			
Trafic/road link	1	2	3	4	1	2	3	4
Heavy bus	2	—	—	—	5	—	—	—
Medium truck	6	—	—	—	12	—	—	—
Heavy truck	10	—	—	—	11	—	—	—

- Cumulative number of ESA in one direction by road link

Road link	1	2	3	4
7 years (10^6)	0.029	0.050	-	-

2) Design CBR values

Road link	1	2	3	4
Design CBR (%)	3.9	2.2	-	-

3) Required thickness of pavement

Surfacing	:	DBST (2.5 cm)
Aggregate base	:	15 cm (CBR not less than 25%)
Subbase	:	Minimum requirement 10 cm

Road link	1	2	3	4
	25 cm	40 cm	-	-

4) Overlay required in 7 years
DBST resurfacing

5.4.2.4 Drainage and Structures

The locations of existing and designed RC box culverts and RC bridges and their dimensions are shown below:

STATION	EXISTING STRUCTURES		PROPOSED STRUCTURES	
	TYPE	SIZE	TYPE	SIZE
4 + 843	RC Bridge	8.0 x 30.0	-	-
5 + 352	" "	4.0 x 14.0	RC Bridge	4.5 x 14.0
5 + 870	Box Culvert	1-2.5 x 2.5 x 12.0	Extd. 6.0 m	
8 + 191	RC Bridge	4.0 x 8.0	RC Bridge	4.5 x 8.0
9 + 404	" "	4.0 x 8.0	" "	4.5 x 8.0
11 + 120	" "	4.0 x 7.0	" "	9.0 x 15.0
13 +907	" "	4.0 x 6.0	" "	9.0 x 15.0
16 + 445	Box Culvert	3-3.0 x 3.0 x 18.5	-	-
22 + 173	Timber Bridge	4.0 x 15.0	RC Bridge	9.0 x 15.0
23 + 059	" "	4.5 x 30.0	" "	9.0 x 30.0
26 + 771	RC Bridge	4.0 x 8.0	" "	4.5 x 8.0
39 + 653	Timber Bridge	4.0 x 15.4	RC Bridge	9.0 x 20.0
39 + 787	Pipe Culvert	2-Ø1.0 x 13.0	Box Culvert	1-2.4 x 2.4 x 13.0

5.4.3 Quantities and Construction and Road Maintenance Costs

The required construction costs were estimated based on the results of the preliminary design as shown in Table 5.4.2. Financial costs with breakdown into local and foreign currency portions, economic costs and residual values were estimated as follows and in 5.4.4:

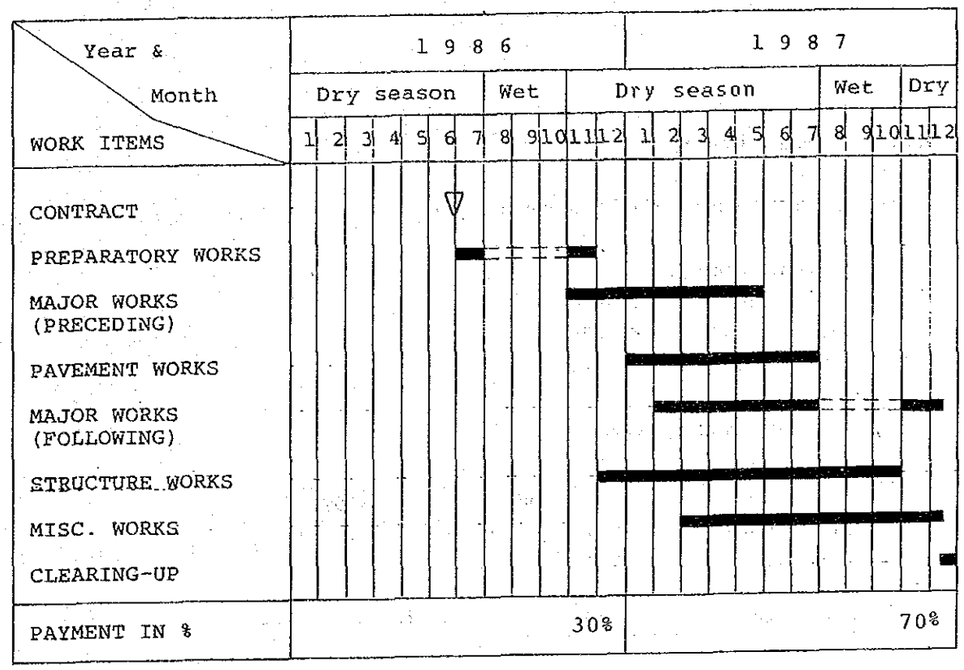
			(baht)
IM—5	L = 28.0 km		
	Financial cost	:	61,886,000
	Economic cost	:	51,725,000
	Residual value	:	21,531,000

The required road maintenance cost savings are shown in Table 5.4.4.

5.4.4 Construction and Disbursement Schedules

IM—5 **Length = 28.0 km**

Construction Schedule
Assumption: Completion date December 31, 1987



Yearly Disbursement Schedule
Assumption: Annual rise in prices

Year / Currency	Base year 1984	(1985)	1986	1987
Local	100	110.0	121.0	133.1
Foreign	100	106.5	113.4	120.8

LOCAL AND FOREIGN COMPONENTS OF CONSTRUCTION COST

(Route IM - 5)

(Unit : Million Baht)

	1986			1987			Total		
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total
Construction Cost	9.3	9.2	18.5	21.8	21.6	43.4	31.1	30.8	61.9
Price Contingency	2.0	1.2	3.2	7.2	4.5	11.7	9.2	5.7	14.9
Total	11.3	10.4	21.7	29.0	26.1	55.1	40.3	36.5	76.8
	(0.42)	(0.39)	(0.80)	(1.07)	(0.97)	(2.04)	(1.49)	(1.35)	(2.84)

Remarks : L/C : Local Currency Portion
F/C : Foreign Currency Portion
( ) : US$ Equivalent (US$ 1 = 27 Baht)

TABLE 5.4.3 CONSTRUCTION QUANTITIES AND COSTS
(ROUTE IM---5 Length = 28.0 km)

DBST

Item	Unit	Financial Unit Rate B	Quantity	Financial Cost 1000 B			Economic Cost		Residual Value	
				Total	Local	Foreign	%	1000 B	%	1000 B
EARTHWORK							83		90	
Clearing & Grubbing	ha	10,000	65	650						
Roadway Excavation, Unclassified	m3	19	6,500	124						
Embankment, Common Soil	m3	38	203,200	7,722						
Embankment, Selected Material	m3	70	0	0						
Replacement of Soft Spot	m3	88	2,800	246						
Sub Total				8,742	4,458	4,283		7,255		6,530
SUBBASE & BASE COURSES							83		50	
Subbase, Soil Aggregate	m3	112	83,400	9,341						
Aggregate Base*	m3	372	27,300	10,156						
Cement Stabilized Base	m3	390	0	0						
Shoulder, Soil Aggregate	m3	120	10,500	1,260						
Sub Total				20,756	11,208	9,548		17,228		8,614
SURFACE COURSES							85		50**	
Asphaltic Prime/Tack Coat	m2	12	182,100	2,185						
Double Bituminous Surface Treatment*	m2	39	154,100	6,010						
Asphaltic Concrete Surfacing**	t	750	0	0						
Sub Total				8,195	3,606	4,589		6,966		0
STRUCTURES							83		50	
RC Pipe Culvert (D 1.0m Equivalent)	m	2,000	2,452	4,904						
RC Box Culvert (2.4mx2.4m Equivalent)	m	18,800	8	150						
RC Bridge(W=9.0m L=10m Equivalent)	m	46,500	102	4,743						
Sub Total				9,797	4,899	4,899		8,132		4,066
Total (a)				47,490	24,171	23,319		39,581		19,210
INCIDENTALS							83		0	
Miscellaneous Work ((a)x7%)	ls			3,324	1,662	1,662		2,759		0
CONTRACT AMOUNT (b)				50,815	25,833	24,981		42,340		19,210
PHYSICAL CONTINGENCIES ((b)x10%) (c)	ls			5,081	2,583	2,498		4,234		1,921
ENGINEERING AND SUPERVISION							85		0	
(((b)+(c))x10%) (d)	ls			5,590	2,236	3,354		4,751		0
LAND ACQUISITION							100		100	
Highly Developed Land	ha	50,000	8	400						
Less Developed Land	ha	15,000	0	0						
Sub Total (e)	ls			400	400	0		400		400
PROJECT COST ((b)+(c)+(d)+(e))				61,886	31,053	30,833		51,725		21,531
AVERAGE COST PER KM				2,210						

Note : * The unit prices are modified by aggregate haulage distance
** Rate is applied only for Asphaltic Concrete Surfacing

TABLE 5.4.4 ROAD MAINTENANCE COST SAVING

LINK NO.	YEAR	WITHOUT PROJECT CASE: AVERAGE DAILY TRAFFIC <ADT> (VEHICLE)	LENGTH OF LINK <L> (KM)	FACTOR FOR ADT <A1>	ROAD CHARA. FACTOR <KA>	UNIT MAINTE. COST <U> (BAHT/KM)	TOTAL MAINTE. COST <T> (1000 BAHT)	WITH PROJECT CASE: AVERAGE DAILY TRAFFIC <ADT> (VEHICLE)	LENGTH OF LINK <L> (KM)	FACTOR FOR ADT <X3>	ROAD CHARA. FACTOR <KB>	UNIT MAINTE. COST <U> (BAHT/KM)	TOTAL MAINTE. COST <T> (1000 BAHT)	ROAD MAINTE. COST SAVING (1000 BAHT)
	1988	163.4	15.5	0.22	1.46	15,399	239	181.2	15.5	0.00	1.22	13,690	212	26
1	1994	252.2	15.5	0.42	1.61	16,917	262	261.3	15.5	0.00	1.22	13,690	212	50
	2002	457.7	15.5	0.90	1.94	20,435	317	437.2	15.5	0.00	1.22	13,690	212	105
	1988	501.9	12.5	0.95	1.98	20,811	260	561.8	12.5	0.00	1.22	13,690	171	89
2	1994	773.3	12.5	0.95	1.98	20,811	260	822.4	12.5	0.00	1.22	13,690	171	89
	2002	1395.7	12.5	0.95	1.98	20,811	260	1392.0	12.5	0.08	1.22	13,736	172	88
	1988	314.5	28.0			17,815	499	351.1	28.0			13,690	383	115
TOTAL	1994	484.8	28.0			18,656	522	511.8	28.0			13,690	383	139
	2002	876.5	28.0			20,603	577	863.5	28.0			13,711	384	193

NOTE (1) TOTAL MAINTENANCE COST T = U * L

(2) UNIT MAINTENANCE COST U = M * (KA or KB) * FA * (1 + FR) * FE

M ; SPECIFIED MAINTENANCE COST
WITHOUT PROJECT CASE M = 7,700 BAHT/KM
WITH PROJECT CASE M = 8,200 BAHT/KM

FA = 1.40 ADMINISTRATION FACTOR FOR DIRECT LABOUR OPERATION BY DOH
FR = 0.15 EMERGENCY REHABILITATION COST FACTOR
FE = 0.85 ECONOMIC MAINTENANCE COST FACTOR TO FINANCIAL MAINTENANCE COST

(3) ROAD CHARACTERISTIC FACTOR
WITHOUT PROJECT CASE KA = 1.31 + 0.70 * A1
WITH PROJECT CASE KB = 1.22 + 0.05 * X3

(4) FACTOR FOR ADT
WITHOUT PROJECT CASE A1 = -0.1630 + 0.002320 * ADT
WITH PROJECT CASE X3 = -0.2034 + 0.000409 * (ADT / LANE) ; LANE = 2

5.5 EVALUATION

5.5.1 Economic Evaluation

The yearly distribution of the economic costs and benefits and the calculated economic indicators for evaluation are given in the table below.

The results indicate that the improvement of this study route is feasible by employing the F4 standard with DBST surfacing.

COST AND BENEFIT STATEMENT OF ROUTE IM - 5

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	TOTAL COST	TOTAL BENEFIT
1986	15,518	0	0	0	0	19,466	0
1987	36,207	0	0	0	0	40,552	0
1988	0	698	6,237	115	7,050	0	6,295
1989	0	905	6,708	119	7,733	0	6,164
1990	0	1,111	7,180	123	8,415	0	5,990
1991	0	1,318	7,652	127	9,097	0	5,782
1992	0	1,525	8,124	131	9,780	0	5,549
1993	0	1,731	8,596	135	10,462	0	5,301
1994	0	1,938	9,068	139	11,145	0	5,041
1995	10,079	2,212	9,782	146	12,139	4,559	4,903
1996	0	2,486	10,496	153	13,134	0	4,736
1997	0	2,759	11,210	159	14,129	0	4,549
1998	0	3,033	11,924	166	15,123	0	4,348
1999	0	3,307	12,638	173	16,118	0	4,137
2000	0	3,581	13,352	179	17,112	0	3,922
2001	0	3,854	14,067	186	18,107	0	3,705
2002	-21,531	4,128	14,781	193	19,102	-3,934	3,490
TOTAL	40,273	34,585	151,815	2,246	188,646	60,643	73,911
DISCOUNTED	60,643	12,354	60,612	944	73,911		

NET PRESENT VALUE : 13,268

BENEFIT/COST RATIO : 1.22

INTERNAL RATE OF RETURN : 14.6 %

FIRST YEAR RATE OF RETURN : 10.5 %

OPTIMUM OPENING YEAR : 1988

SENSITIVITY TESTS

ITEM	CASE		
	BASE	1	2
NET PRESENT VALUE	13,268	4,171	2,181
BENEFIT/COST RATIO	1.22	1.06	1.04
INTERNAL RATE OF RETURN	14.6 %	12.7 %	12.4 %
FIRST YEAR RATE OF RETURN	10.5 %	9.1 %	8.9 %
COSTS	BASE	+15%	BASE
BENEFITS	BASE	BASE	-15%

5.5.2 Social Impact

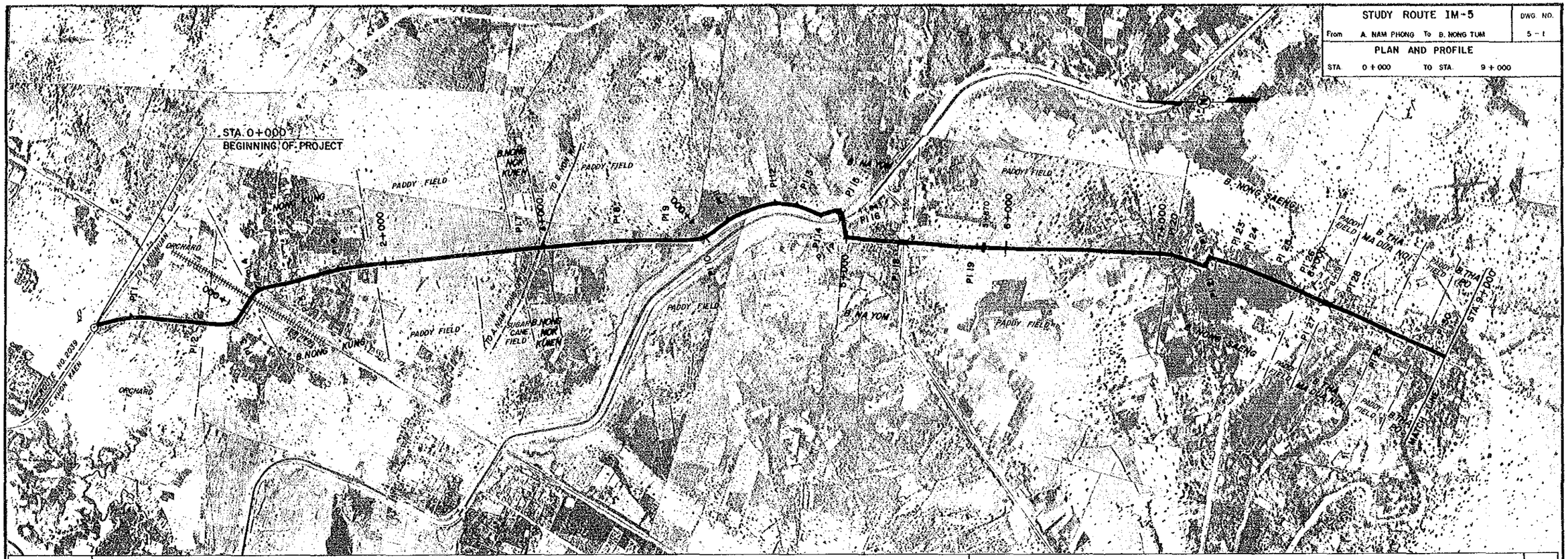
The social impact brought about by the improvement of the study route is shown by the following social benefit indicators:

Construction Cost (million baht)	: 51.7
1) General Accessibility Benefit (million baht)	: 3.60
2) Education Benefit (million baht)	: 4.29
3) Medical Care Benefit (million baht)	: 0.079
4) Total Social Benefits (million baht) (1+2+3)	: 7.97
5) Social Benefit/Cost Ratio ($\times 10^{-2}$)	: 15.42
6) Ranking by Social Benefit	: 5
7) Weighted Production Value Gain/Cost ($\times 10^{-2}$)	: 10.92
8) Ranking by 7	: 6
9) Combined Ratio ($\times 10^{-2}$)	: 26.34
Overall Ranking	: 5

5.5.3 Overall Evaluation

It is concluded and recommended that, considering the overall ranking and possible schedule of the improvement and/or new construction of the study routes, this study route should be constructed with the opening year 1988.

STUDY ROUTE IM-5	DWG. NO.
From A. NAM PHONG To B. NONG TUM	5 - 1
PLAN AND PROFILE	
STA. 0 + 000 TO STA. 9 + 000	



TERRAIN		ROLLING	FLAT	
PAVEMENT	Type	DT / LATERITE	DT	
	Condition	POOR		
FLOODING	Length (m.) / Height (m.)			
RIGHT OF WAY (m.)				
ROUTE NO. AGENCIES		RURAL ROAD	DOH ROUTE NO. 2183	

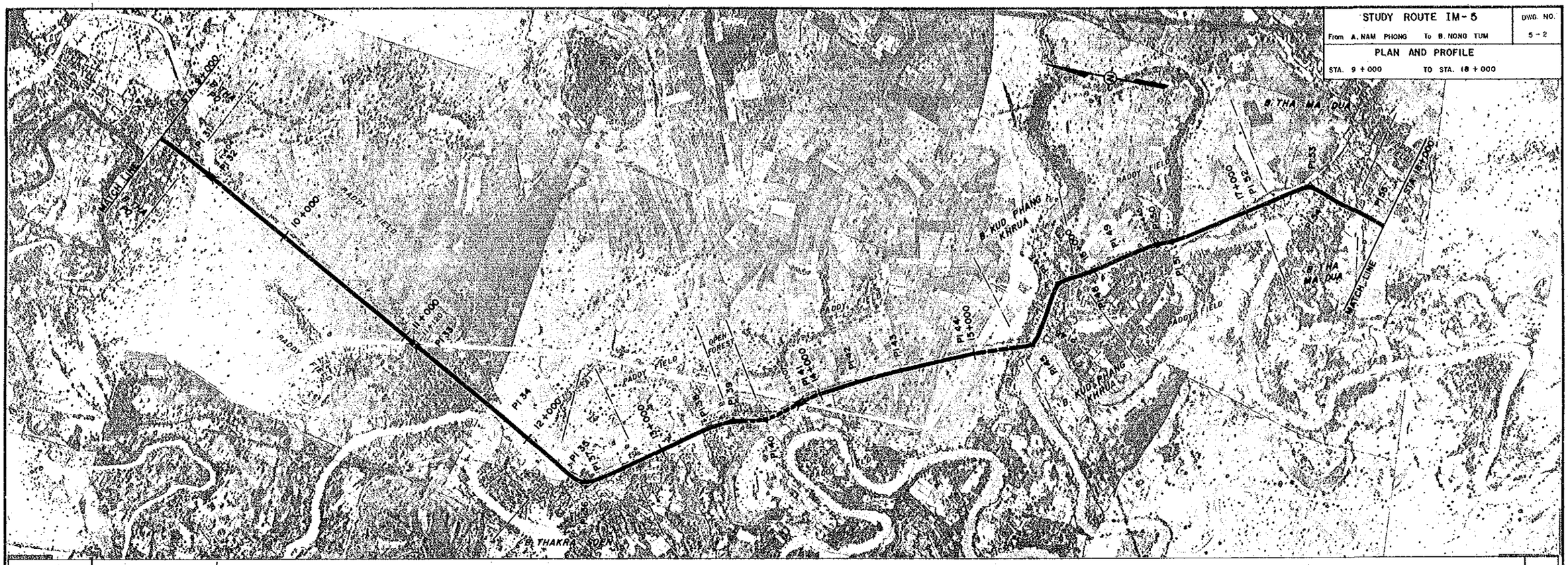
ELEVATION (m.): 170, 160, 150, 140, 130

CURVATURE BAND — Existing Alignment / Proposed Alignment

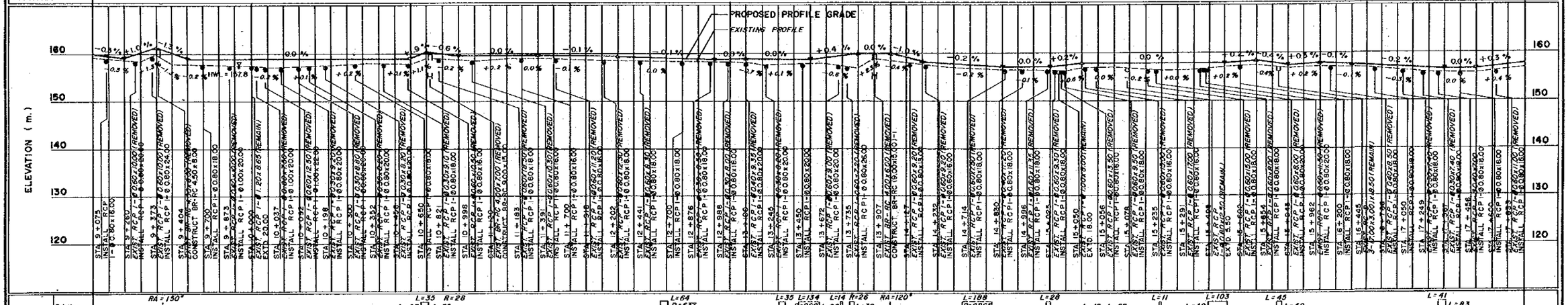
Existing Alignment	Proposed Alignment
L = 68, R = 198	L = 68, R = 198
L = 75, R = 62	L = 75, R = 62
L = 45, R = 49	L = 45, R = 49
L = 231, R = 1146	L = 231, R = 1146
L = 111, R = 151	L = 111, R = 151
L = 157, R = 150	L = 157, R = 150
L = 64, R = 194	L = 64, R = 194
L = 80, R = 256	L = 80, R = 256
L = 107, R = 286	L = 107, R = 286
L = 30, R = 20	L = 30, R = 20
R = 337	R = 337
L = 40, R = 28	L = 40, R = 28
L = 47, R = 32	
L = 161, R = 637	L = 161, R = 637
L = 19, L = 62, R = 13, R = 819	L = 19, L = 62, R = 13, R = 819
L = 63, R = 716	L = 63, R = 716
L = 80, R = 955	L = 80, R = 955
L = 61, R = 955	L = 61, R = 955

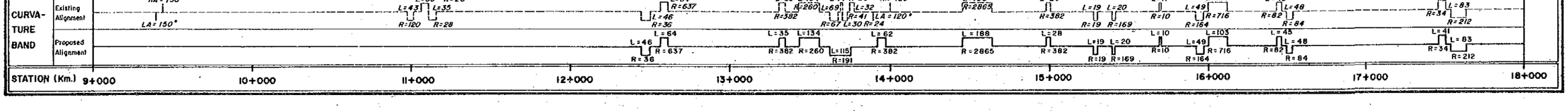
STATION (Km.): 0+000, 1+000, 2+000, 3+000, 4+000, 5+000, 6+000, 7+000, 8+000, 9+000

STUDY ROUTE IM-5	DWG NO.
From A. NAM PHONG To B. NONG TUM	5-2
PLAN AND PROFILE	
STA. 9 + 000 TO STA. 18 + 000	



TERRAIN		FLAT
PAVEMENT	Type	LATERITE / DT / LATERITE
	Condition	POOR
FLOODING	Length (m.) / Height (m.)	1,100 / 0.30
RIGHT OF WAY (m.)		
ROUTE NO. AGENCIES		DOH ROUTE NO 2183



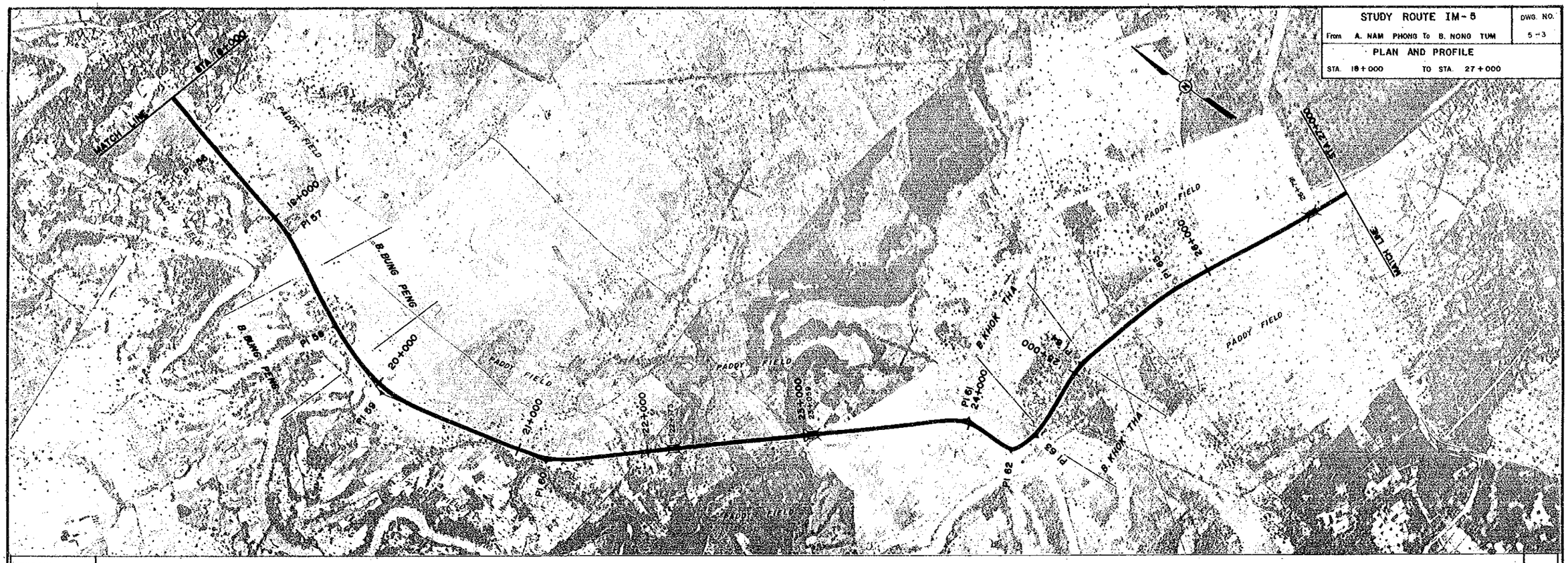


STUDY ROUTE IM-5 | DWG. NO. 5-3

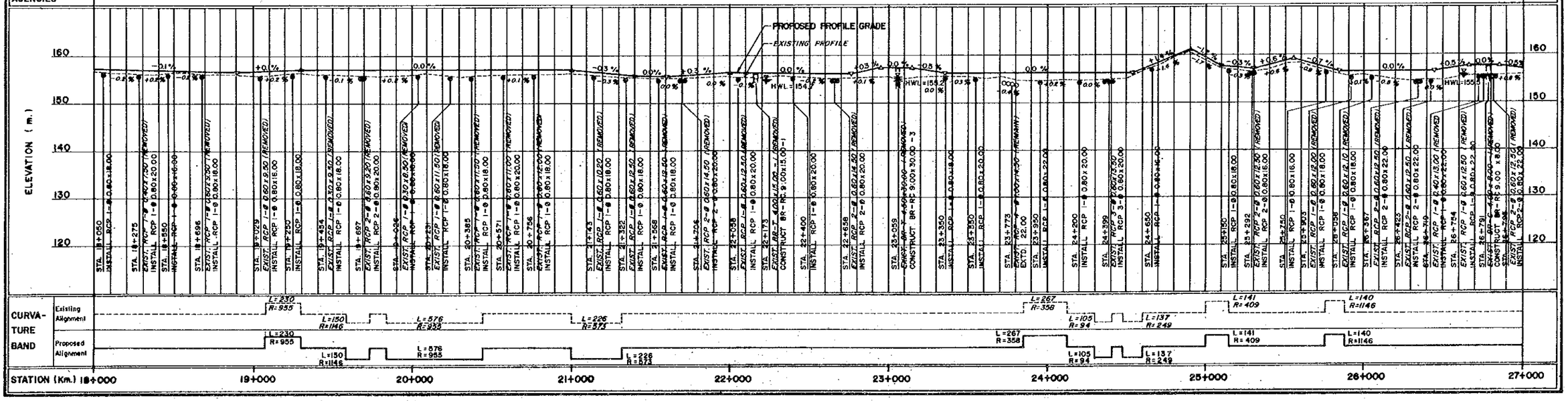
From A. NAM PHONG To B. NONG TUM

PLAN AND PROFILE

STA. 18+000 TO STA. 27+000

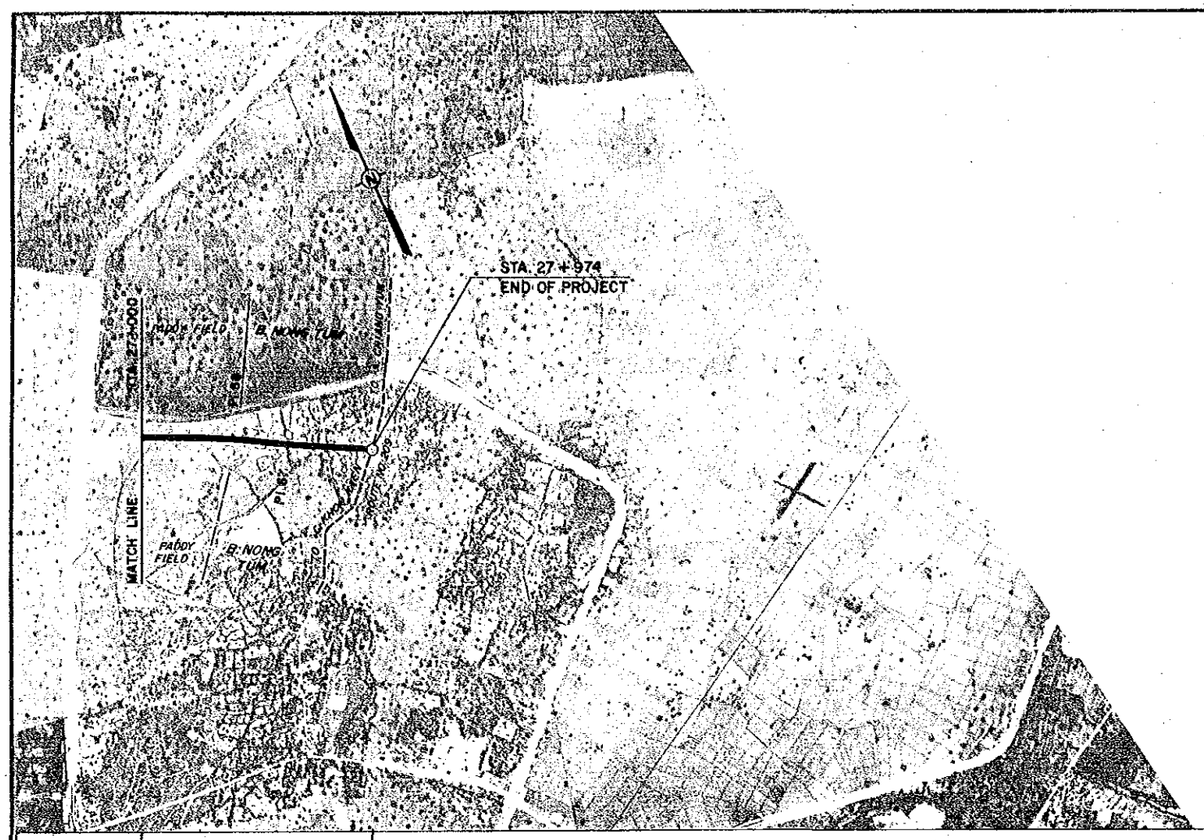


TERRAIN		FLAT
PAVEMENT	Type	LATERITE / DT / LATERITE
	Condition	POOR
FLOODING	Length (m.) / Height (m.)	
RIGHT OF WAY (m.)		
ROUTE NO. AGENCIES		DOH ROUTE NO. 2183

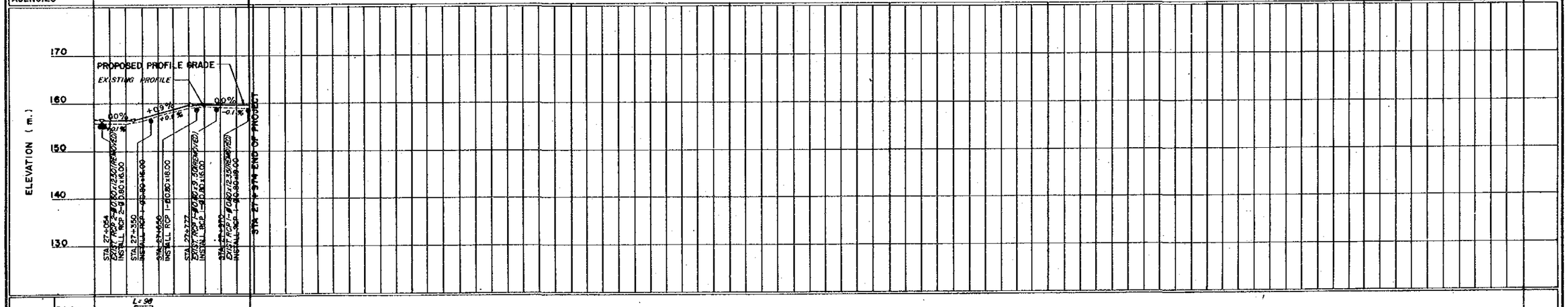


CURVATURE BAND	Existing Alignment	L=230 R=955; L=150 R=146; L=576 R=932; L=226 R=573; L=267 R=358; L=105 R=94; L=137 R=249; L=141 R=409; L=140 R=1146
	Proposed Alignment	L=230 R=955; L=150 R=1146; L=576 R=955; L=226 R=573; L=267 R=358; L=105 R=94; L=137 R=249; L=141 R=409; L=140 R=1146
STATION (Km.)		18+000 19+000 20+000 21+000 22+000 23+000 24+000 25+000 26+000 27+000

STUDY ROUTE IM-5	DWG NO.
From A. NAM PHONG To B. NONG TUM	5 – 4
PLAN AND PROFILE	
STA. 27+000 TO STA. 27 + 974	



TERRAIN		FLAT
PAVEMENT	Type	LATERITE DT
	Condition	POOR
FLOODING	Length (m.) / Height (m.)	
RIGHT OF WAY (m.)		
ROUTE NO. AGENCIES		



CURVATURE BAND	Existing Alignment	L=98 R=1146
	Proposed Alignment	L=98 R=1146
STATION (Km.) 27+000		