8.2 AGRICULTURAL DEVELOPMENT

8.2.1 Present Condition

Eighty percent of cultivated land in the influence area is covered by paddy fields. Many old paddy fields are affected by salinity and the average yield of rice is comparatively low. Among the major crops planted in upland fields in the 1983 crop year, sugarcane made up 96%. Other crops are kenaf and cassava. A large sugarcane factory with a 5,300-ton/day capacity is located in Muang Kumphawapi adjacent to the area.

Land use and capability conditions in the area are shown in Table 8.2.1 and Figure 8.2.1. A typical cropping calendar in the area is shown in Figure 8.2.2.

8.2.2 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 8.2.2.

Based on the above projected production amount, farmgate prices and production costs estimated separately, net production value (NPV) was obtained as shown in Table 8.2.3. The difference in NPV between the two cases is deemed to be the development benefit of the study route.

FIGURE 8.2.1 LAND USE AND CAPABILITY OF INFLUENCE AREA STUDY ROUTE NO. IM-8

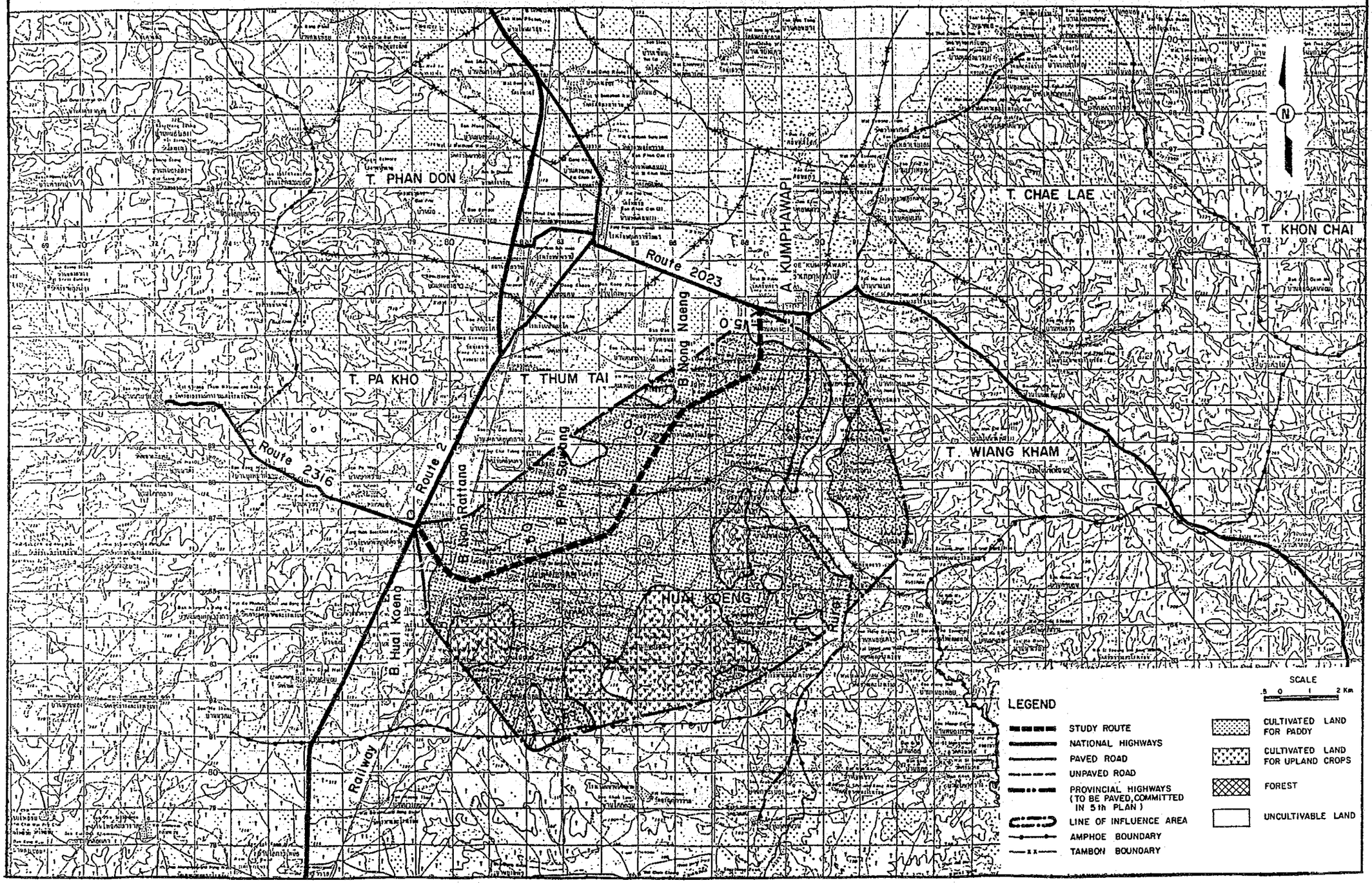
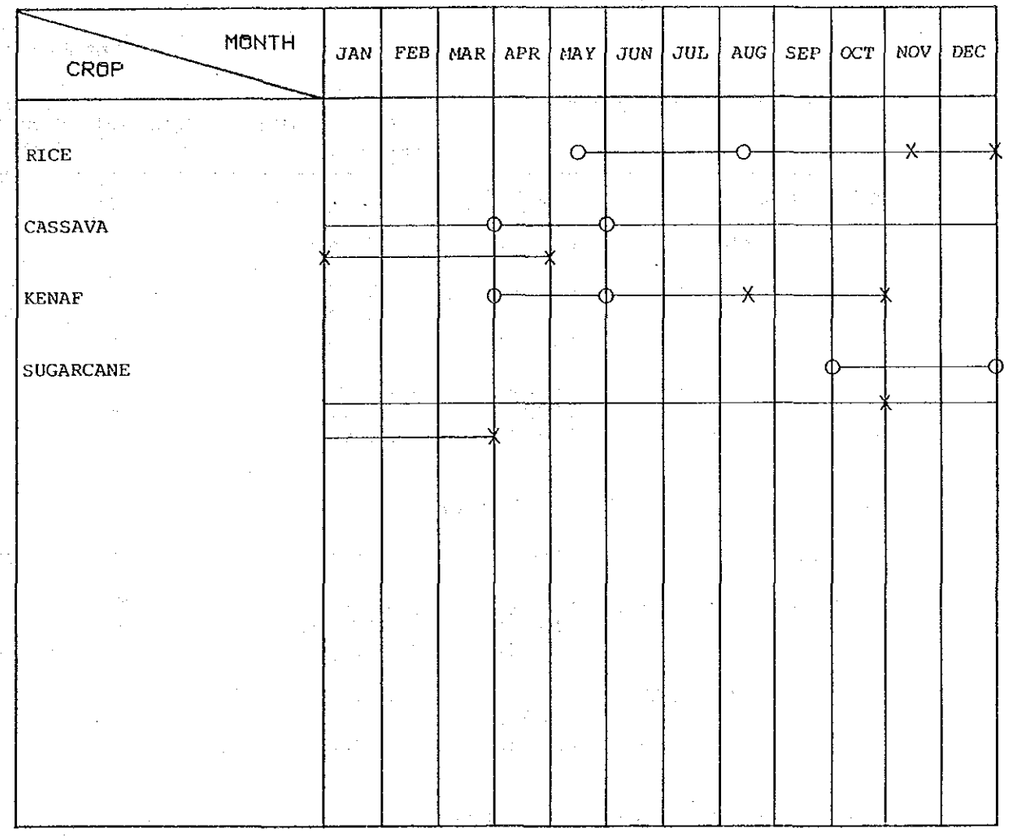


FIGURE 8.2.2 CROPPING CALENDAR

ROUTE IM-8 Related Amphoe: 0216 Kumphawapi



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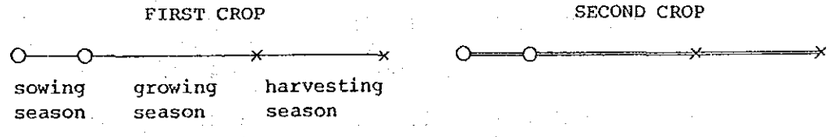


TABLE 8.2.1 CULTIVATED LAND

[UNIT : 1000 RAI (KM2)]

CHANGWAT NAME	AMPHOE NAME	CULTIVATED LAND		
		PADDY FIELD	UPLAND FIELD	TOTAL
UDON THANI	KUMPHAWAPI	32.01 (51.22)	8.24 (13.18)	40.25 (64.40)
TOTAL		32.01 (51.22)	8.24 (13.18)	40.25 (64.40)

TABLE 8.2.2 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)	25.64	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.15
WITHOUT PROJECT	(1988)	25.64	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.15
	(1994)	25.64	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.15
	(2002)	25.64	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.15
WITH PROJECT	(1988)	25.72	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.23
	(1994)	26.19	-	-	-	-	0.02	0.26	7.23	-	-	7.51	33.70
	(2002)	26.83	-	-	-	-	0.02	0.26	7.23	-	-	7.51	34.34
CROP YIELD	(KG/RAI)												
BASE YEAR	(1983)	246.8	-	-	-	-	2062.5	202.5	7296.0	-	-		
WITHOUT PROJECT	(1988)	248.2	-	-	-	-	2072.8	202.5	7332.6	-	-		
	(1994)	249.8	-	-	-	-	2085.3	202.5	7376.7	-	-		
	(2002)	252.0	-	-	-	-	2102.0	202.5	7435.9	-	-		
WITH PROJECT	(1988)	249.1	-	-	-	-	2074.9	202.5	7339.9	-	-		
	(1994)	256.6	-	-	-	-	2099.9	202.5	7428.4	-	-		
	(2002)	267.0	-	-	-	-	2133.8	202.5	7548.1	-	-		
CROP PRODUCTION AMOUNT	(TON)												
BASE YEAR	(1983)	6,328	-	-	-	-	41	53	52,750	-	-	52,844	59,172
WITHOUT PROJECT	(1988)	6,363	-	-	-	-	41	53	53,014	-	-	53,108	59,471
	(1994)	6,405	-	-	-	-	42	53	53,333	-	-	53,428	59,832
	(2002)	6,461	-	-	-	-	42	53	53,761	-	-	53,856	60,317
WITH PROJECT	(1988)	6,407	-	-	-	-	41	53	53,067	-	-	53,161	59,568
	(1994)	6,721	-	-	-	-	42	53	53,707	-	-	53,802	60,523
	(2002)	7,164	-	-	-	-	43	53	54,573	-	-	54,668	61,832

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE

TABLE 8.2.3 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)		4,069	-	-	-	-	876	4,120	467	-	-		
WITH PROJECT	(1988 - 2002)		4,076	-	-	-	-	880	4,135	471	-	-		
CROP PRODUCTION COST	(BAHT/RAI)													
BASE YEAR		(1983)	704	-	-	-	-	776	803	1,958	-	-		
WITHOUT PROJECT		(1988)	707	-	-	-	-	778	803	1,962	-	-		
		(1994)	710	-	-	-	-	780	803	1,973	-	-		
		(2002)	715	-	-	-	-	783	803	1,983	-	-		
WITH PROJECT		(1988)	708	-	-	-	-	778	803	1,962	-	-		
		(1994)	723	-	-	-	-	783	803	1,979	-	-		
		(2002)	742	-	-	-	-	789	803	1,997	-	-		
NET PRODUCTION VALUE	(1000 BAHT)													
WITHOUT PROJECT		(1988)	7,763	-	-	-	-	20	8	10,549	-	-	10,577	18,340
		(1994)	7,857	-	-	-	-	21	8	10,618	-	-	10,647	18,504
		(2002)	7,958	-	-	-	-	21	8	10,746	-	-	10,775	18,733
WITH PROJECT		(1988)	7,906	-	-	-	-	21	9	10,810	-	-	10,840	18,746
		(1994)	8,460	-	-	-	-	21	9	10,988	-	-	11,018	19,478
		(2002)	9,291	-	-	-	-	22	9	11,266	-	-	11,297	20,588
NET VALUE ADDED	(1000 BAHT)													
1988			143	-	-	-	-	1	1	261	-	-	263	406
1994			603	-	-	-	-	0	1	370	-	-	371	974
2002			1,333	-	-	-	-	1	1	520	-	-	522	1,855

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE

8.3 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 8.3.1. Data for additional VOCs are shown in Table 8.3.2.

VOC savings, obtained as the balance of total link VOCs between the two cases, "with and without project", were calculated as shown in Table 8.3.3.

TABLE 8.3.1 ROAD LENGTH BY ROAD CLASS

(UNIT : KM)

LINK NO.	WITHOUT PROJECT CASE						WITH PROJECT CASE
	PAVED	LATERITE			EARTH	TOTAL	PAVED
		GOOD	FAIR	POOR			
1	-	-	-	14.2	-	14.2	14.2

TABLE 8.3.2 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	385	131	106	-	200	157	344	235	182	7005	1000	500	100	100	6	2100	4	1	-	-
	WITH	230	131	106	-	200	157	453	136	182	5750	1400	500	100	-	6	2100	1	-	-	-

TABLE 8.3.3 VEHICLE OPERATING COST SAVING

(UNIT : 1000 BAHT)

LINK NO.	1988			1994			2002		
	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING
1	7,534	5,632	1,902	10,224	7,540	2,683	15,548	11,279	4,269
TOTAL	7,534	5,632	1,902	10,224	7,540	2,683	15,548	11,279	4,269

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

8.4 ENGINEERING

8.4.1 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 8.4.1 and Table 8.4.1 respectively.

Rock aggregate sources were assumed as shown below:

No.	Source	Description of Sample	Est. Quantity m^3
8/CS-1	KM. 40+800 Rt close to Wang Saphung-Udon Thani	Limestone	Plentiful
8/CS-2	KM. 48+900 Rt Wang Saphung-Udon Thani (Scale Pattana Quarry)	Limestone	Plentiful

FIGURE 8.4.1 SOIL AND MATERIAL SOURCES

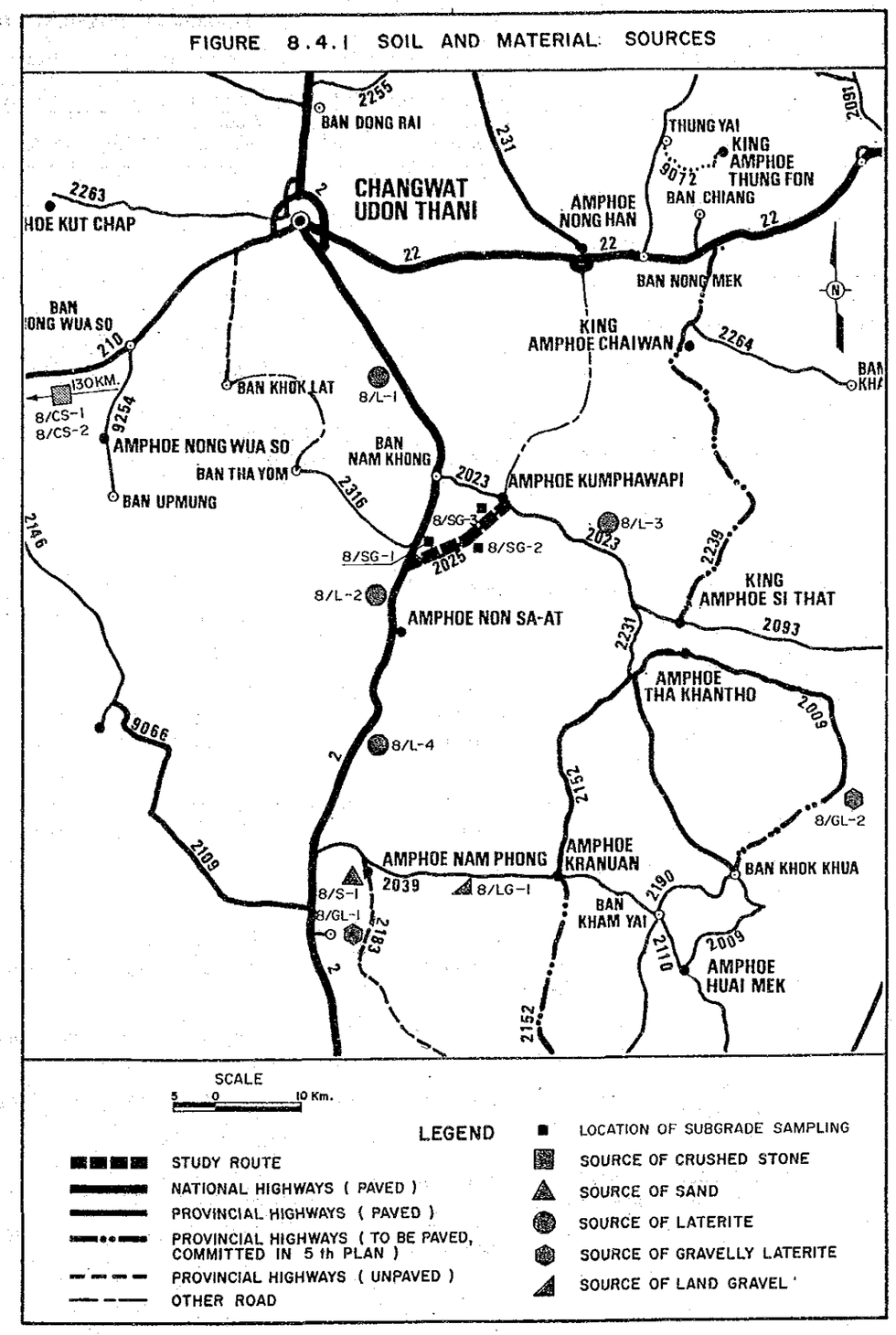


TABLE 8.4.1 PHYSICAL CHARACTERISTICS OF MATERIALS

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																				
8/SG-1	KM. 4+500 Lt 13 M.			A-4					100.0	99.6	97.6	66.0	N-P		11.0	1.830	30.5	-		
8/SG-2	KM. 10+000 Rt 15 M.			A-4						100.0	86.8	52.4	N-P		9.0	1.976	15.4	0.5		
8/SG-3	KM. 13+950 Lt 12 M.			A-4						100.0	56.8	53.6	N-P		9.5	1.856	14.0	0.4		
SAND																				
8/S-1	KM. 4+800 Lt 1.5 KM. Nam Pong - Route No. 209	Nam Lai sand	>200,000				100	91	80	67	46	21	N.P.							
LAND GRAVEL																				
8/LG-1	KM. 26+050 Rt 4,000 M. Nam Pong - Kranuan	Land gravel	100,000	A-1-a		100	98.8	86.0	59.7	38.1	23.3	10.0	N.P.		5.8	2.209	97.8			
				A-1-a		100	98.4	88.1	64.6	41.7	24.5	9.6	N.P.							
GRAVELLY LATERITE																				
8/GL-1	KM. 5+300 Rt 20 M. Nong Sang - B. Khok Si	Gravelly laterite	200,000	A-2-4	100		93.7	84.9	66.8	45.2	24.6	17.8	10.3	34.2	9.7	6.7	2.151	20.0		
				A-2-4	100		92.8	84.8	65.1	44.9	29.6	18.2	10.2	33.6	10.1					
8/GL-2	KM. 46+800 Rt close to Huay Mag - Tha Kan Tor	Gravelly laterite	20,000	A-2-6		100	97.4	88.4	72.0	39.2	20.6	12.2	37.4	13.9	7.8	2.142	67.3			
				A-2-6		100	97.2	88.8	71.9	40.7	21.9	13.1	37.7	13.8						
LATERITE																				
8/L-1	KM. 544+000 Lt 200 M. Khon Kaen - Udon Thani	Laterite	16,000	A-1-a	100	98	90	59	34	22	17	11	24.2	4.3	8.0	2.360	53.5	0.20	57.6	65.5
8/L-2	KM. 517+200 Lt 350 M. Khon Kaen - Udon Thani	Laterite	20,000	A-2-4	100	95	84	48	26	20	15	13	23.3	9.9	5.4	2.319	26.0		40.8	70.0
8/L-3	KM. 13+950 Lt 300 M. Kumphawapi - Sri Tart	Laterite	84,000	A-2-4	100	90	81	46	28	23	22	12	24.0	9.1	7.4	2.233	39.5	0.24	46.6	67.6
8/L-4	KM. 498+000 Rt 1 KM. Khon Kaen - Udon Thani	Laterite	37,500	A-2-6	100	96	86	50	24	19	17	13	37.1	16.3					37.6	65.5
	L1:S2 = 7.3 by weight	Laterite and sand		A-2-4	100	96	88	61	46	33	18	11	22.0	9.7	6.7	2.271	70.0	-		

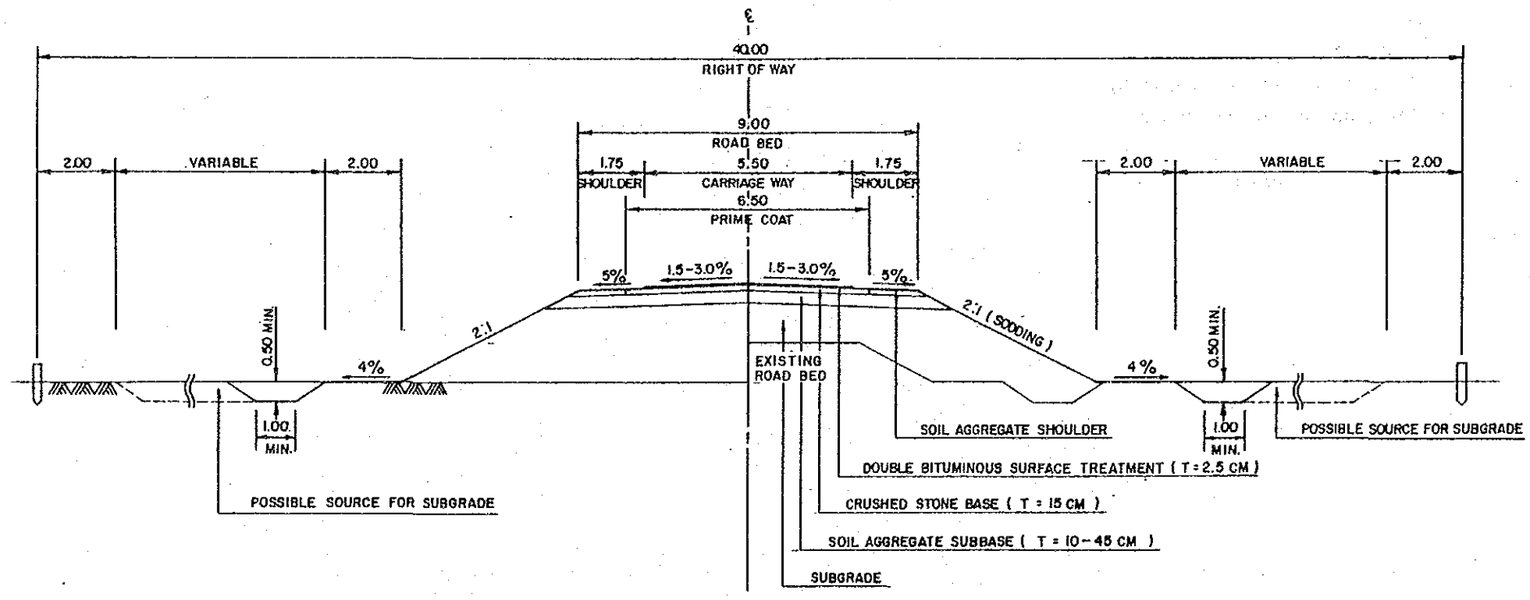
8.4.2 Preliminary Design

8.4.2.1 Design Criteria

Design Standard	:	F4
Geometric Design Criteria	:	DOH (Provincial Highway)
Typical Cross Section	:	as shown in Figure 8.4.2
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 8-1/8-2.

FIGURE 8.4.2 TYPICAL CROSS SECTION



PROVINCIAL HIGHWAY (CLASS F4)

8.4.2.3 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			
Traffic/road link	1	2	3	4	1	2	3	4
Heavy bus	3	—	—	—	11	—	—	—
Medium truck	30	—	—	—	46	—	—	—
Heavy truck	21	—	—	—	28	—	—	—

- Cumulative number of ESA in one direction by road link

Road link	1	2	3	4
7 years (10^6)	0.080	-	-	-

2) Design CBR values

Road link	1	2	3	4
Design CBR (%)	13.7	-	-	-

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
	10 cm	-	-	-

4) Overlay required in 7 years

DBST resurfacing

8.4.2.4 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
6 + 687	Timber Bridge	4.0 x 6.0	RC Bridge	9.0 x 10.0

8.4.3 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 8.4.2. Financial costs with breakdown into local and foreign currency portions, economic costs and residual values were estimated as follows and in 8.4.4:

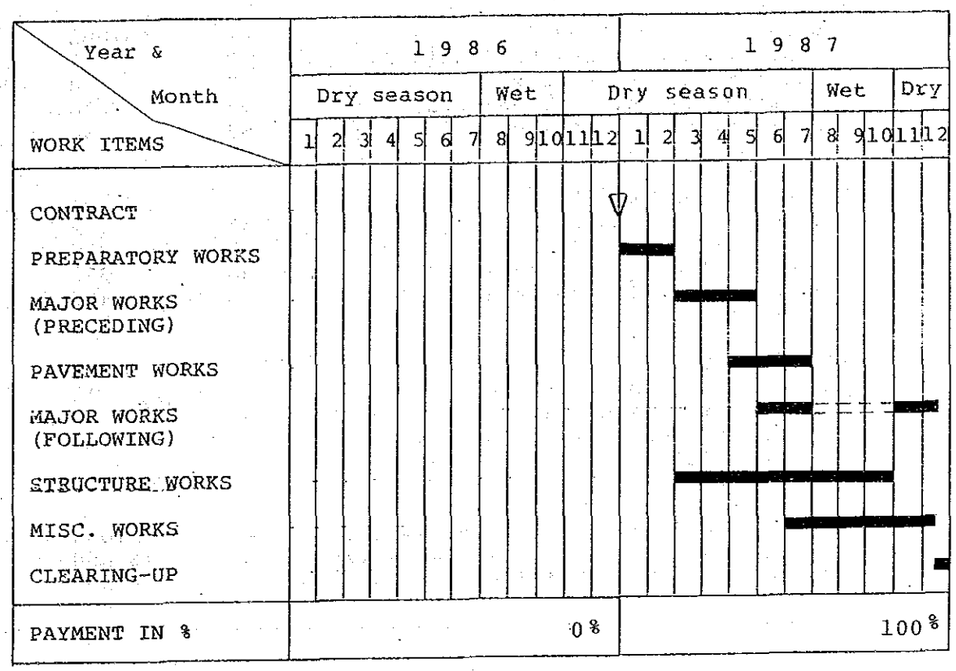
IM—8	L = 14.2 km		(baht)
	Financial cost	:	22,274,000
	Economic cost	:	18,621,000
	Residual value	:	7,265,000

The required road maintenance cost savings are shown in Table 8.4.3.

8.4.4 Construction and Disbursement Schedules

IM—8 **Length = 14.2 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 - 8)

(Unit : Million Baht)

	1986			1987			Total		
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total
Construction Cost	0.0	0.0	0.0	11.0	11.2	22.2	11.0	11.2	22.2
Price Contingency	0.0	0.0	0.0	3.6	2.3	5.9	3.6	2.3	5.9
Total	0.0	0.0	0.0	14.6	13.5	28.1	14.6	13.5	28.1
	(0.00)	(0.00)	(0.00)	(0.54)	(0.50)	(1.04)	(0.54)	(0.50)	(1.04)

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

TABLE 8.4.2 CONSTRUCTION QUANTITIES AND COSTS
(ROUTE IM—8 Length = 14.2 km)

D8ST

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	33	330						
Roadway Excavation, Unclassified	m3	19	0	0						
Embankment, Common Soil	m3	38	84,200	3,200						
Embankment, Selected Material	m3	70	0	0						
Replacement of Soft Spot	m3	88	1,700	150						
Sub Total				3,679	1,876	1,803		3,054		2,748
SUBBASE & BASE COURSES							83		50	
Subbase, Soil Aggregate	m3	112	13,300	1,490						
Aggregate Base*	m3	429	13,800	5,920						
Cement Stabilized Base	m3	390	0	0						
Shoulder, Soil Aggregate	m3	120	5,300	636						
Sub Total				8,046	4,345	3,701		6,678		3,339
SURFACE COURSES							85		50**	
Asphaltic Prime/Tack Coat	m2	12	92,300	1,108						
Double Bituminous Surface Treatment*	m2	40	78,100	3,124						
Asphaltic Concrete Surfacing**	t	750	0	0						
Sub Total				4,232	1,862	2,370		3,597		0
STRUCTURES							83		50	
RC Pipe Culvert (D 1.0m Equivalent)	m	2,000	391	782						
RC Box Culvert (2.4mx2.4m Equivalent)	m	18,800	0	0						
RC Bridge(W=9.0m L=10m Equivalent)	m	46,500	10	465						
Sub Total				1,247	624	624		1,035		518
Total (a)				17,204	8,707	8,497		14,364		6,605
INCIDENTALS							83		0	
Miscellaneous Work ((a)x7%)	ls			1,204	602	602		1,000		0
CONTRACT AMOUNT (b)				18,408	9,309	9,099		15,363		6,605
PHYSICAL CONTINGENCIES ((b)x10%) (c)	ls			1,841	931	910		1,536		660
ENGINEERING AND SUPERVISION							85		0	
(((b)+(c))x10%) (d)	ls			2,025	810	1,215		1,721		0
LAND ACQUISITION							100		100	
Highly Developed Land	ha	50,000	0	0						
Less Developed Land	ha	15,000	0	0						
Sub Total (e)	ls			0	0	0		0		0
PROJECT COST ((b)+(c)+(d)+(e))				22,274	11,049	11,224		18,621		7,265
AVERAGE COST PER KM				1,569						

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

TABLE 8.4.3 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	253.4	14.2	0.42	1.46	15,357	218	277.3	14.2	0.00	1.17	13,129	186	32
1	1994	341.1	14.2	0.63	1.60	16,859	239	364.0	14.2	0.00	1.17	13,129	186	53
	2002	509.1	14.2	0.95	1.83	19,231	273	527.7	14.2	0.00	1.17	13,129	186	87
	1988	253.4	14.2			15,357	218	277.3	14.2			13,129	186	32
TOTAL	1994	341.1	14.2			16,859	239	364.0	14.2			13,129	186	53
	2002	509.1	14.2			19,231	273	527.7	14.2			13,129	186	87

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

(2) UNIT MAINTENANCE COST $U = M * (KA \text{ or } KB) * FA * (1 + FR) * FE$

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 = 1.16 + 0.70 * A1
WITH PROJECT CASE KB = 1.17 + 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

8.5 EVALUATION

8.5.1 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 - 8

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	TOTAL COST	TOTAL BENEFIT
1986	0	0	0	0	0	0	0
1987	18,621	0	0	0	0	20,856	0
1988	0	406	1,902	32	2,340	0	2,089
1989	0	501	2,032	35	2,568	0	2,047
1990	0	595	2,163	39	2,797	0	1,991
1991	0	690	2,293	42	3,025	0	1,922
1992	0	785	2,423	46	3,254	0	1,846
1993	0	879	2,553	49	3,482	0	1,764
1994	0	974	2,683	53	3,710	0	1,678
1995	5,148	1,084	2,882	57	4,023	2,329	1,625
1996	0	1,194	3,080	61	4,336	0	1,563
1997	0	1,304	3,278	66	4,648	0	1,497
1998	0	1,415	3,476	70	4,961	0	1,426
1999	0	1,525	3,675	74	5,273	0	1,353
2000	0	1,635	3,873	78	5,586	0	1,280
2001	0	1,745	4,071	82	5,898	0	1,207
2002	-7,265	1,855	4,269	87	6,211	-1,327	1,135
TOTAL	16,504	16,587	44,653	871	62,111	21,857	24,424
DISCOUNTED	21,857	6,112	17,970	342	24,424		

NET PRESENT VALUE	:	2,567
BENEFIT/COST RATIO	:	1.12
INTERNAL RATE OF RETURN	:	13.5 %
FIRST YEAR RATE OF RETURN	:	10.0 %
OPTIMUM OPENING YEAR	:	1988

SENSITIVITY TESTS

ITEM	CASE		
	BASE	1	2
NET PRESENT VALUE	2,567	-711	-1,097
BENEFIT/COST RATIO	1.12	0.97	0.95
INTERNAL RATE OF RETURN	13.5 %	11.6 %	11.3 %
FIRST YEAR RATE OF RETURN	10.0 %	8.7 %	8.5 %
COSTS	BASE	+15%	BASE
BENEFITS	BASE	BASE	-15%

8.5.2 Social Impact

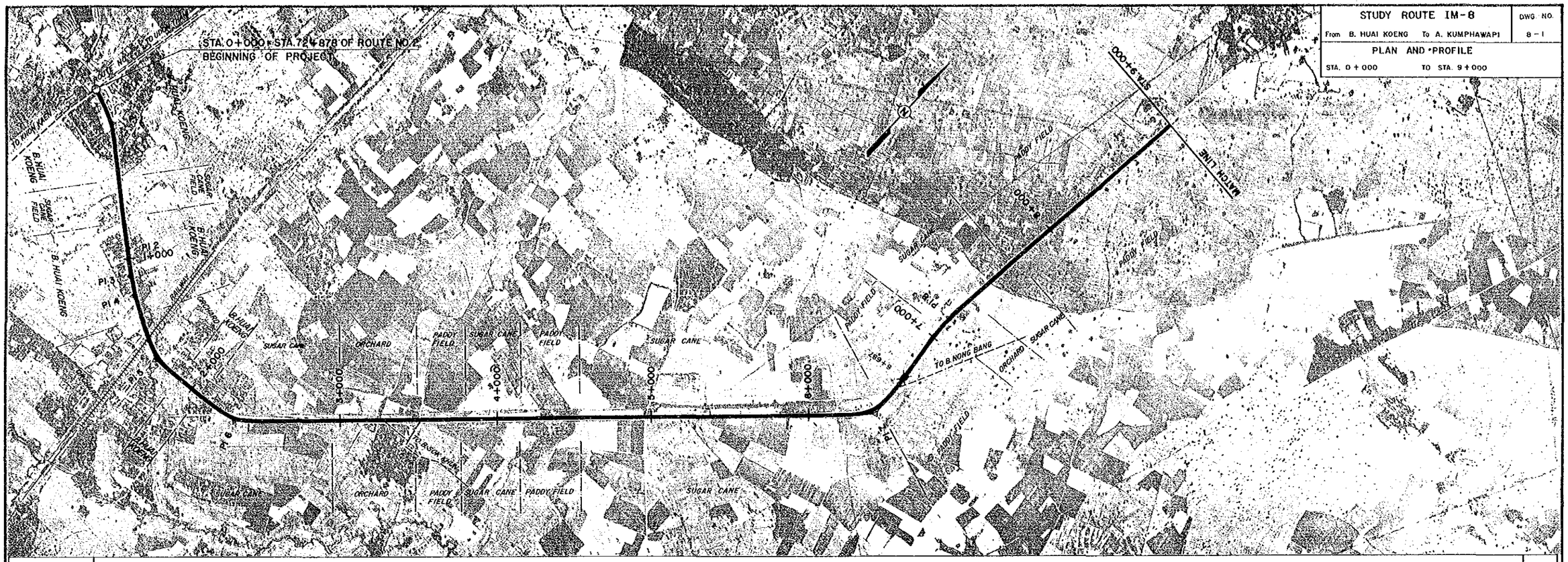
The social impact brought about by the improvement of the study route is shown in the following social benefit indicators:

Construction Cost (million baht)	:	18.6
1) General Accessibility Benefit (million baht)	:	2.08
2) Education Benefit (million baht)	:	2.72
3) Medical Care Benefit (million baht)	:	0.048
4) Total Social Benefits (million baht) (1+2+3)	:	4.85
5) Social Benefit/Cost Ratio ($\times 10^{-2}$)	:	26.05
6) Ranking by Social Benefits	:	1
7) Weighted Production Value Gain/Cost ($\times 10^{-2}$)	:	13.9
8) Ranking by 7	:	3
9) Combined Ratio ($\times 10^{-2}$)	:	39.95
Overall Ranking	:	2

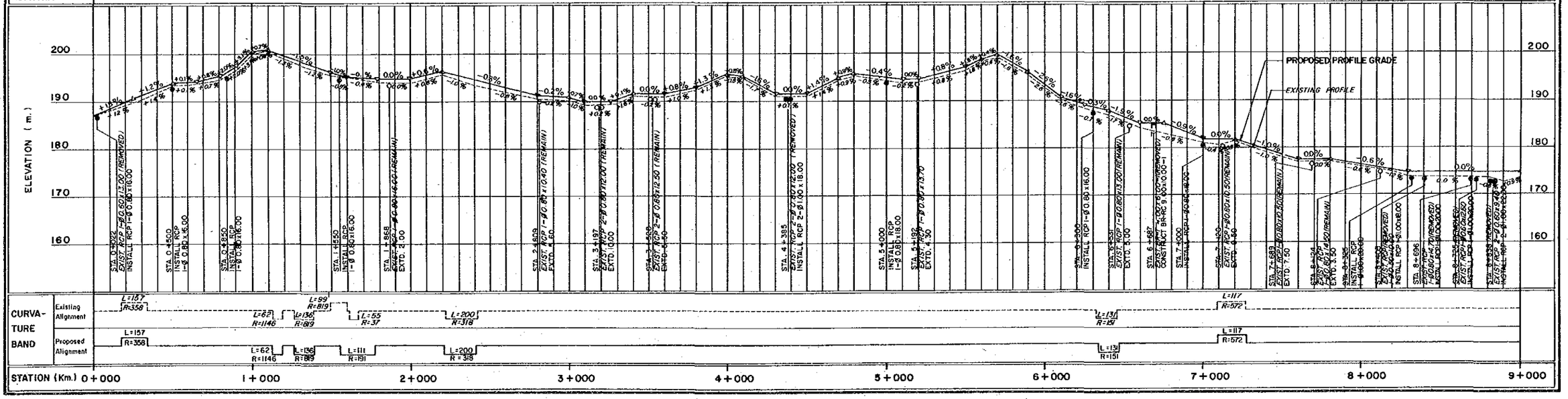
8.5.3 Overall Evaluation

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 improved with the opening year 1988.

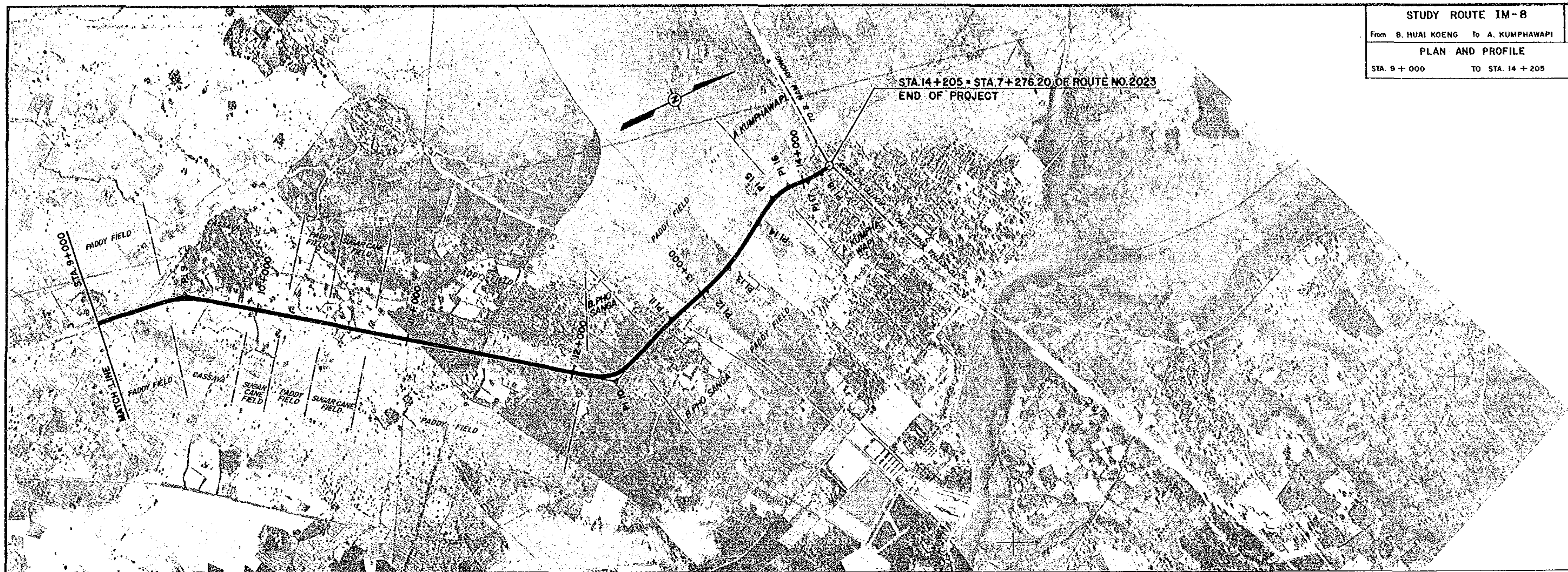
STUDY ROUTE IM-8	DWG. NO.
From B. HUAI KOENG To A. KUMPHAWAPI	8 - 1
PLAN AND PROFILE	
STA. 0 + 000 TO STA. 9 + 000	



TERRAIN	FLAT							
PAVEM'T Type	DT	LATERITE						
PAVEM'T Condition	POOR							
FLOODING Length (m.) / Height (m.)								
RIGHT OF WAY (m.)	20	8	30	40			14	40
ROUTE NO. AGENCIES	DOH ROUTE NO. 2025							

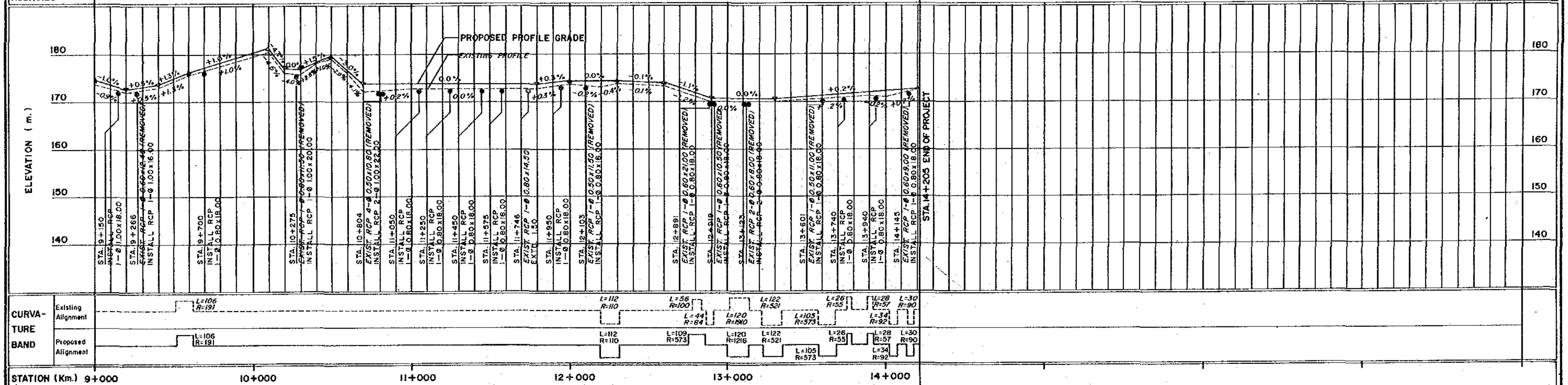


STUDY ROUTE IM-8	DWG. NO
From B. HUAI KOENG To A. KUMPHAWAPI	8-2
PLAN AND PROFILE	
STA. 9+000 TO STA. 14+205	



TERRAIN		FLAT		
PAVEM'T	Type	LATERITE	DT	LATERITE
	Condition	POOR		
FLOODING	Length (m.) Height (m.)			
ROUTE NO. AGENCIES		DOH ROUTE NO. 2025		

RIGHT OF WAY (m.)	40	28	20	40	18	40	30	40	12



STATION (Km.) 9+000 10+000 11+000 12+000 13+000 14+000

STUDY ROUTE NO. IM-9

Changwat : Udon Thani

A. Nong Han (J.R. 22) – A. Kumphawapi (J.R. 2023)

Length : 34.3 KM.

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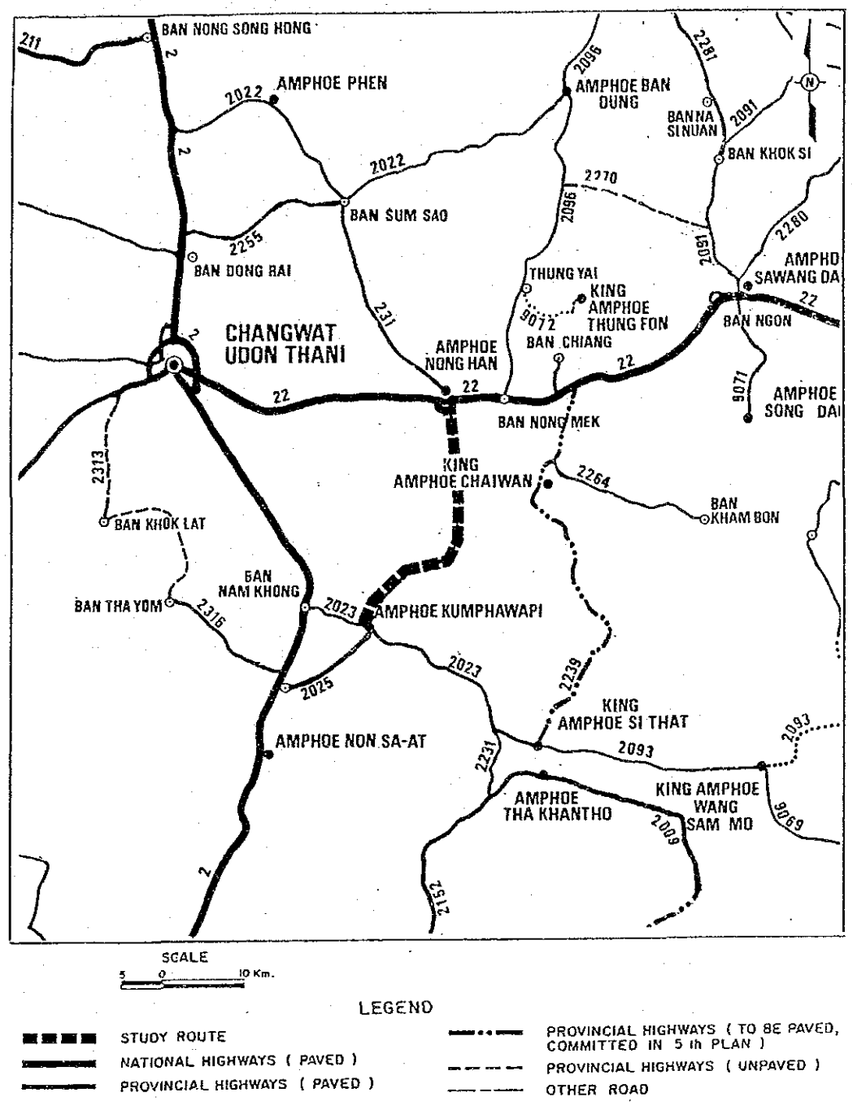
SUMMARY

STUDY ROUTE IM-9

General		
Changwat	:	Udon Thani
Origin and Destination	:	A. Nong Han—A. Kumphawapi
Connected Road Network	:	22—2023
Amphoe on Route	:	-
Number of Related Villages	:	11
Influence Area		
Area	:	233 km^2
Cultivated Area Ratio to Total Land Area in %	:	74
Population in 1983	:	29,300
Main Crops	:	Paddy & Sugarcane
Number of Public Activities		
Public Health Service Centers	:	-
Hospitals Changwat Level	:	-
Amphoe Level	:	1
Schools Primary	:	11
Secondary	:	1
Traffic (ADT)	:	1984—184 1988—280 1994—368 2002—536
Nomenclature of Study Route		
Total Length	:	34.3 km
Improvement Section	:	34.3 km
DOH Road	:	-
ARD Road	:	34.3 km
Other Road	:	-
New Construction Section	:	-
Design Standard Employed	:	F4
Construction Cost in Baht		
Financial	:	80,463,000
Economic	:	67,569,000
Economic Indicators		
IRR	:	13.5% Ranking: 11
Social Impact		
Social B/C Ratio	:	0.154 Ranking: 13
Recommendations		
Opening Year	:	1988 Overall Ranking: 11

LOCATION OF STUDY ROUTE

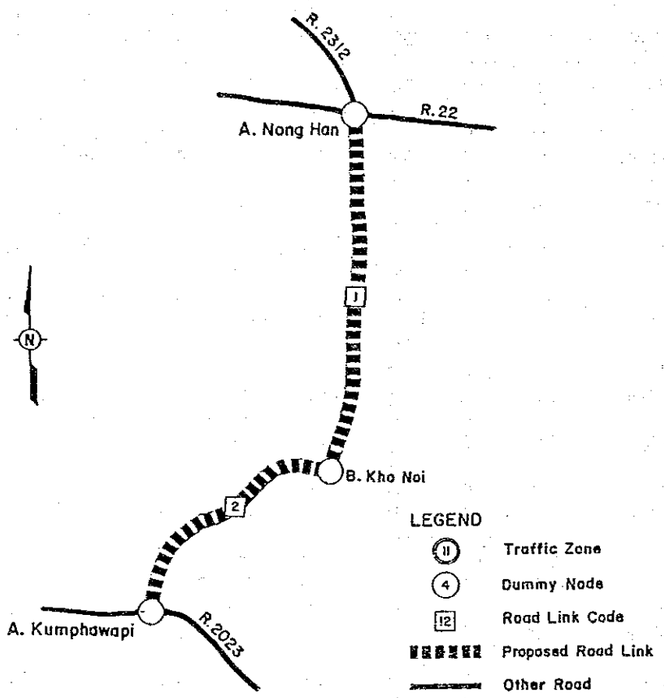


9.1 TRAFFIC

9.1.1 Method Employed in Traffic Forecasting

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

9.1.2 Assumed Road Link



9.1.3 Traffic Forecast

1) Items necessary for forecasting traffic were:
   - Traffic volume in base year
   - Passenger and freight movement in base year
   - Growth rates of passenger and freight movement
   - Rate of induced and developed movement
   - 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	27	33	2	67	18	24	4	180	256	436
2	1	87	13	0	51	19	14	5	190	258	448
AVE.	3	51	25	1	61	18	20	4	184	257	441

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	1296	59.8	45.2	105.0
2	1272	50.8	38.4	89.2

GROWTH RATE OF PASSENGER MOVEMENT

(UNIT : % P.A.)

YEAR	PER CAPITA INCOME	POPULATION	PASSENGER MOVEMENT
1984 - 1988	3.1	1.2	5.7
1988 - 1994	3.1	1.1	5.5
1994 - 2002	3.1	0.9	5.4

GROWTH RATE OF FREIGHT MOVEMENT

(UNIT : % P.A.)

YEAR	NON-AGRI. FREIGHT	AGRI. FREIGHT	FREIGHT MOVEMENT
1984 - 1988	7.0	0.5	4.4
1988 - 1994	6.8	0.5	4.7
1994 - 2002	6.7	0.5	5.1

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	0.5
1994	15.0	15.0	0.0	0.0	4.0
2002	15.0	15.0	0.0	0.0	7.2

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	5.0	56.5	16.7	20.4	1.2	19.3	31.6	42.1	7.0
	1988	12.6	52.4	13.7	18.8	2.5	17.9	27.0	43.9	11.2
	1994	23.9	46.2	9.1	16.3	4.4	15.8	20.1	46.5	17.6
	2002	39.0	38.0	3.0	13.0	7.0	13.0	11.0	50.0	26.0
2	1984	1.0	41.6	50.0	7.5	0.0	17.4	41.3	30.4	10.9
	1988	9.4	40.8	39.5	8.7	1.6	16.4	34.6	34.8	14.2
	1994	22.1	39.6	23.9	10.5	3.9	15.0	24.5	41.3	19.3
	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	25	53	32	5	114	19	26	8	280	317	598
1994	69	45	42	13	141	15	31	13	368	357	725
2002	175	13	58	31	182	10	43	23	536	411	947

TRAFFIC VOLUME ON ROUTE IM- 9 LINK COUNT= 2

	YEAR	1988 1	1988 2	1988 AVR.	1994 1	1994 2	1994 AVR.	2002 1	2002 2	2002 AVR.
	LINK									
P/C	N+D	23	19	21	61	58	60	153	151	152
	I	3	3	3	9	9	9	23	23	23
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	27	21	25	70	67	69	176	173	175
L/B	N+D	25	78	46	23	63	39	12	12	12
	I	4	12	7	3	9	6	2	2	2
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	29	90	53	27	72	45	14	13	13
M/B	N+D	35	17	28	42	28	36	51	50	51
	I	5	3	4	6	4	5	8	8	8
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	40	20	32	48	32	42	59	58	58
H/B	N+D	5	3	4	11	10	11	28	27	27
	I	1	0	1	2	2	2	4	4	4
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	5	4	5	13	12	13	32	31	31
P/P&T	N+D	107	88	100	129	113	122	160	155	158
	I	16	13	15	19	17	18	24	23	24
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	123	102	114	148	130	141	184	179	182
4/T	N+D	16	17	16	13	13	13	9	7	8
	I	2	2	2	2	2	2	1	1	1
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	18	19	19	15	15	15	10	9	10
6/T	N+D	26	17	22	30	22	27	40	34	37
	I	4	3	3	5	3	4	6	5	6
	DV	0	0	0	0	0	0	1	1	1
	TOTAL	30	19	26	35	26	31	46	39	43
10/T	N+D	7	7	7	11	10	11	21	17	19
	I	1	1	1	2	2	2	3	3	3
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	8	8	8	13	12	13	24	20	23
ADT	N+D	243	245	244	321	318	320	472	453	465
	I	36	37	37	48	48	48	71	68	70
	DV	0	0	0	1	1	1	1	1	1
	TOTAL	279	282	280	370	366	368	545	522	536
M/C	N+D	296	298	297	337	335	336	393	387	391
	I	20	20	20	20	20	20	20	20	20
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	317	318	317	357	356	357	414	407	411
TOTAL	N+D	539	543	541	657	653	656	865	840	855
	I	57	57	57	68	68	68	91	88	90
	DV	0	0	0	1	1	1	2	1	2
	TOTAL	596	600	598	727	722	725	958	930	947

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

9.2 AGRICULTURAL DEVELOPMENT

9.2.1 Present Condition

Seventy-nine percent of cultivated land in the influence area is covered by paddy fields. Many old paddy fields are affected by salinity and the average yield of rice is relatively low. Among the major crops planted in upland fields in the 1983 crop year, sugarcane occupies around 45% and other crops are cassava, kenaf and beans. Two large sugarcane factories are located in Amphoe Muang Kumphawapi and near Nong Han. They process a total of around 1.2 million tons of sugarcane from November to May every year.

Land use and capability conditions in the area are shown in Table 9.2.1 and Figure 9.2.1. A typical cropping calendar in the area is shown in Figure 9.2.2.

9.2.2 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 9.2.2.

Based on the above projected production amount, farmgate prices and production costs estimated separately, net production value (NPV) was obtained as shown in Table 9.2.3. The difference in NPV between the two cases is deemed to be the development benefit of the study route.

FIGURE 9.2.1 LAND USE AND CAPABILITY OF INFLUENCE AREA STUDY ROUTE NO. IM-9

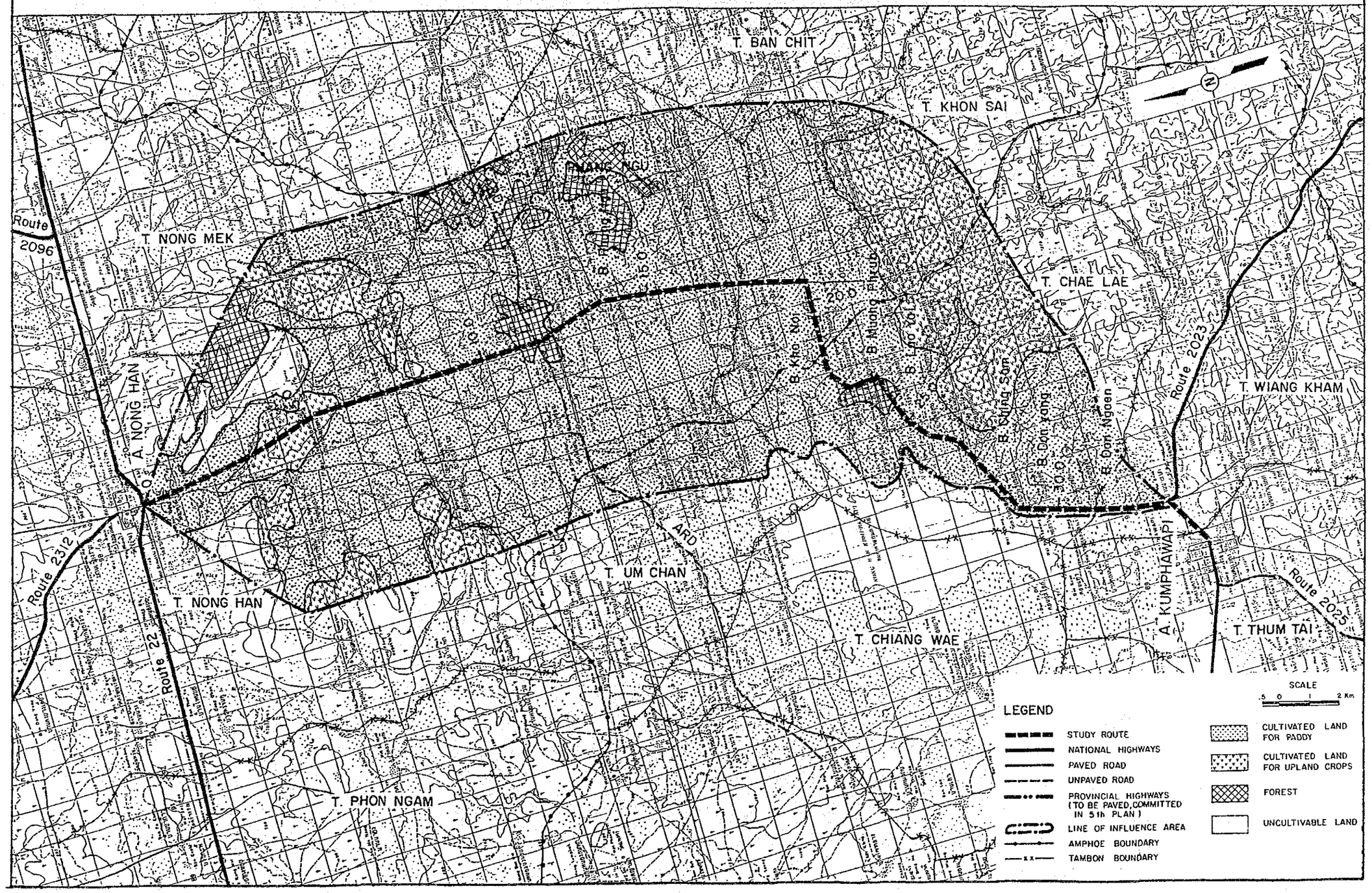
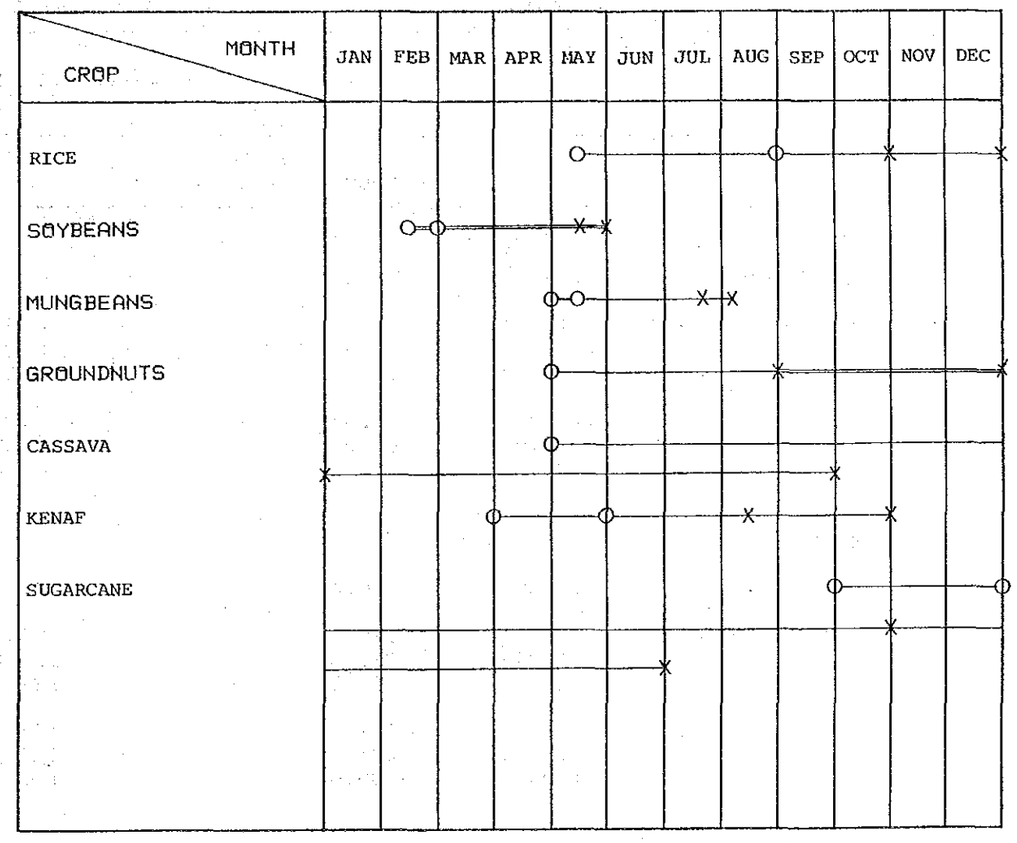


FIGURE 9.2.2 CROPPING CALENDAR

ROUTE IM-9

Related Amphoes: 0216 Kumphawapi
0217 Nong Han



Note:

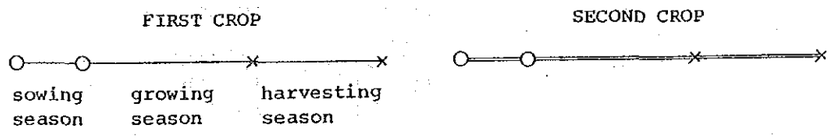


TABLE 9.2.1 *CULTIVATED LAND*

[UNIT : 1000 RAI (KM2)]

CHANGWAT NAME	AMPHOE NAME	CULTIVATED LAND		
		PADDY FIELD	UPLAND FIELD	TOTAL
UDON THANI	KUMPHAWAPI	13.69 (21.90)	7.25 (11.60)	20.94 (33.50)
	NONG HAN	71.62 (114.59)	15.39 (24.62)	87.01 (139.22)
TOTAL		85.31 (136.50)	22.64 (36.22)	107.95 (172.72)

TABLE 9.2.2 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)	58.35	-	-	0.18	0.09	5.07	3.59	7.33	-	-	16.26	74.61
WITHOUT PROJECT	(1988)	60.80	-	-	0.21	0.09	5.11	3.64	7.45	-	-	16.50	77.29
	(1994)	63.86	-	-	0.25	0.09	5.15	3.71	7.59	-	-	16.79	80.66
	(2002)	68.20	-	-	0.31	0.10	5.22	3.80	7.78	-	-	17.20	85.40
WITH PROJECT	(1988)	61.04	-	-	0.21	0.09	5.12	3.66	7.47	-	-	16.55	77.59
	(1994)	67.90	-	-	0.29	0.10	5.22	3.80	7.78	-	-	17.18	85.08
	(2002)	72.51	-	-	0.43	0.10	5.36	4.00	8.22	-	-	18.10	90.61
CROP YIELD	(KG/RAI)												
BASE YEAR	(1983)	270.8	-	-	120.8	230.0	2031.2	213.2	6731.0	-	-		
WITHOUT PROJECT	(1988)	270.8	-	-	122.6	230.0	2031.2	213.2	6764.7	-	-		
	(1994)	270.8	-	-	124.8	230.0	2031.2	213.2	6805.4	-	-		
	(2002)	270.8	-	-	127.9	230.0	2031.2	213.2	6860.0	-	-		
WITH PROJECT	(1988)	271.4	-	-	123.0	230.0	2031.2	213.2	6771.5	-	-		
	(1994)	275.1	-	-	127.5	230.0	2031.2	213.2	6853.1	-	-		
	(2002)	280.0	-	-	133.7	230.0	2031.2	213.2	6963.6	-	-		
CROP PRODUCTION AMOUNT	(TON)												
BASE YEAR	(1983)	15,801	-	-	22	21	10,298	765	49,338	-	-	60,444	76,245
WITHOUT PROJECT	(1988)	16,463	-	-	25	21	10,376	777	50,374	-	-	61,573	78,036
	(1994)	17,295	-	-	31	21	10,469	791	51,646	-	-	62,958	80,253
	(2002)	18,469	-	-	39	22	10,596	810	53,392	-	-	64,859	83,327
WITH PROJECT	(1988)	16,568	-	-	26	21	10,394	779	50,607	-	-	61,828	78,395
	(1994)	18,676	-	-	37	22	10,600	810	53,342	-	-	64,810	83,486
	(2002)	20,304	-	-	57	23	10,881	852	57,218	-	-	69,032	89,336

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE

TABLE 9.2.3 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)		4,069	-	-	5,150	7,148	876	4,120	467	-	-		
WITH PROJECT	(1988 - 2002)		4,087	-	-	5,168	7,166	887	4,155	478	-	-		
CROP PRODUCTION COST	(BAHT/RAI)													
BASE YEAR	(1983)		704	-	-	438	951	776	803	1,958	-	-		
WITHOUT PROJECT	(1988)		704	-	-	438	951	776	803	1,962	-	-		
	(1994)		704	-	-	438	951	776	803	1,972	-	-		
	(2002)		704	-	-	443	951	776	803	1,981	-	-		
WITH PROJECT	(1988)		705	-	-	438	951	776	803	1,962	-	-		
	(1994)		712	-	-	443	951	776	803	1,978	-	-		
	(2002)		722	-	-	448	951	776	803	1,994	-	-		
NET PRODUCTION VALUE	(1000 BAHT)													
WITHOUT PROJECT	(1988)		24,189	-	-	40	63	5,120	274	8,893	-	-	14,390	38,579
	(1994)		25,411	-	-	50	65	5,166	280	9,131	-	-	14,692	40,103
	(2002)		27,136	-	-	67	66	5,229	287	9,493	-	-	15,142	42,278
WITH PROJECT	(1988)		24,676	-	-	42	64	5,249	303	9,527	-	-	15,185	39,861
	(1994)		27,985	-	-	62	66	5,352	315	10,101	-	-	15,896	43,881
	(2002)		30,627	-	-	104	70	5,494	331	10,966	-	-	16,965	47,592
NET VALUE ADDED	(1000 BAHT)													
1988			487	-	-	2	1	129	29	634	-	-	795	1,282
1994			2,574	-	-	12	1	186	35	970	-	-	1,204	3,778
2002			3,491	-	-	37	4	265	44	1,473	-	-	1,823	5,314

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE

9.3 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 9.3.1. Data for additional VOCs are shown in Table 9.3.2.

VOC savings, obtained as the balance of total link VOCs between the two cases, were calculated as shown in Table 9.3.3.

TABLE 9.3.1 ROAD LENGTH BY ROAD CLASS

(UNIT : KM)

LINK NO.	WITHOUT PROJECT CASE						WITH PROJECT CASE
	PAVED	LATERITE			EARTH	TOTAL	PAVED
		GOOD	FAIR	POOR			
1	-	5.0	10.1	5.5	-	20.6	20.6
2	-	-	3.7	10.0	-	13.7	13.7

TABLE 9.3.2 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	69	31	-	-	98	115	123	96	1019	5650	1750	800	-	-	5	2200	5	11	-	-
	WITH	112	31	-	-	98	115	123	96	1019	5300	1600	650	350	-	5	2200	-	-	-	-
2	WITHOUT	163	188	71	550	429	305	229	639	849	4781	750	100	-	-	5	2300	4	2	-	-
	WITH	164	188	224	551	429	305	229	639	719	2500	950	-	-	-	5	2300	-	-	-	3

TABLE 9.3.3 VEHICLE OPERATING COST SAVING

(UNIT : 1000 BAHT)

LINK NO.	1988			1994			2002		
	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING	WITHOUT	WITH	SAVING
1	12,891	6,874	6,016	17,286	9,030	8,257	25,817	13,240	12,577
2	7,214	6,170	1,044	9,699	8,235	1,464	14,495	12,262	2,234
TOTAL	20,105	13,044	7,061	26,985	17,265	9,721	40,312	25,501	14,811

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

9.4 ENGINEERING

9.4.1 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 9.4.1 and Table 9.4.1, respectively.

Rock aggregate sources were assumed as shown below:

No.	Source	Description of Sample	Est. Quantity m^3
9/CS-1	KM. 40+800 Rt close to Wang Saphung-Udon Thani	Limestone	Plentiful
9/CS-2	KM. 48+900 Rt Wang Saphung-Udon Thani (Scale Pattana Quarry)	Limestone	Plentiful

FIGURE 9.4.1 SOIL AND MATERIAL SOURCES

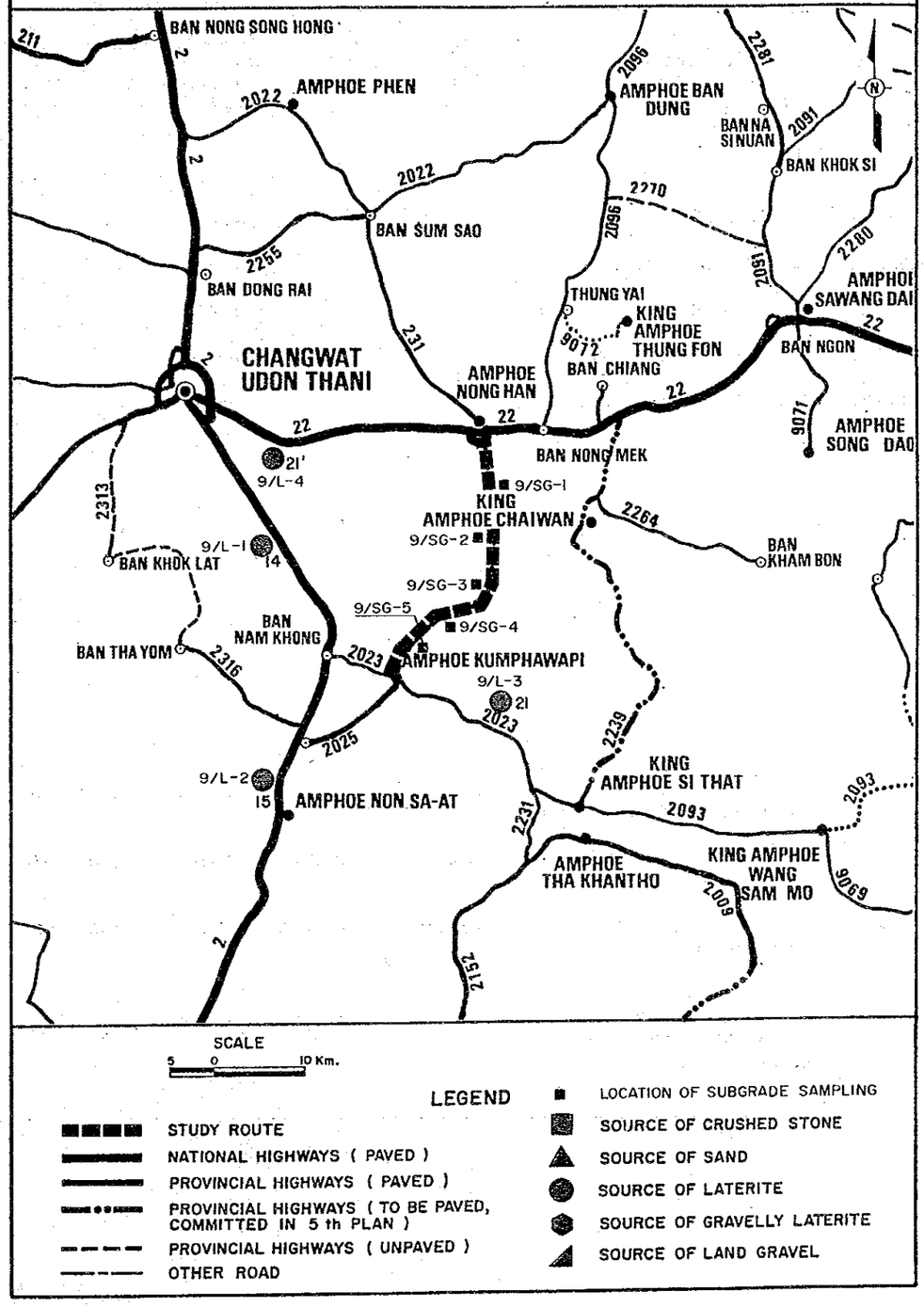


TABLE 9.4.1 PHYSICAL CHARACTERISTICS OF MATERIALS

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																				
9/SG-1.	KM. 6+400 Lt 13 M.			A-2-4						100	96.2	28.2	N-P		11.2	1.818	20.0	-		
9/SG-2.	KM. 12+000 Rt 15 M.			A-4						100	95.6	43.1	N-P		10.3	1.970	9.5	-		
9/SG-3.	KM. 18+000 Rt 13 M.			A-4						100	99.5	45.3	N-P		11.0	1.837	5.0	-		
9/SG-4.	KM. 23+000 Lt 15 M.			A-4					100	99.9	99.3	37.2	N-P		11.0	1.746	12.5	-		
9/SG-5.	KM. 30+500 Lt 10 M.			A-4					100	99.3	97.5	43.5	N-P		10.6	1.888	31.0	-		
LATERITE																				
9/L-1	KM. 544+000 Lt 200 M. Khon Kaen - Udon Thani	Laterite	16,000	A-1-a	100	98	90	59	34	22	17	11	24.2	4.3	8.0	2.360	53.5	0.20	57.6	65.5
9/L-2	KM. 517+200 Lt 350 M. Khon Kaen - Udon Thani	Laterite	20,000	A-2-4	100	95	84	48	26	20	15	13	23.3	9.9	5.4	2.319	26.0		40.8	70.0
9/L-3	KM. 13+950 Lt 300 M. Kumphawapi - Sri Tart	Laterite	84,000	A-2-4	100	90	81	46	28	23	22	12	24.0	9.1	7.4	2.233	39.5	0.24	46.6	67.6
9/L-4	KM. 9+700 Rt 300 M. Route Udon Thani - Sakon Nakhon	Laterite	57,000	A-2-4		100	98	76	44	37	31	10	25.1	9.1	8.0	2.270	39.4	0.14	39.4	66.7

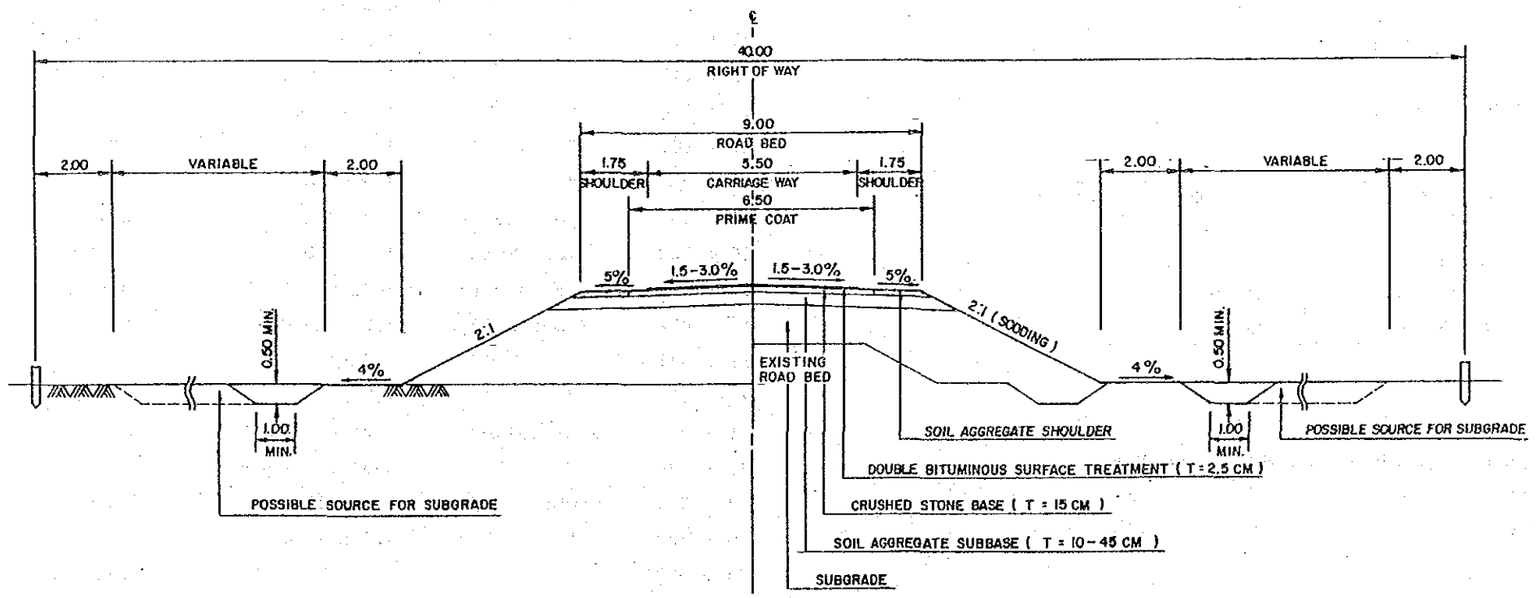
9.4.2 Preliminary Design

9.4.2.1 Design Criteria

Design Standard	:	F4
Geometric Design Criteria	:	DOH (Provincial Highway)
Typical Cross Section	:	as shown in Figure 9.4.2
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 9-1/9-4.

FIGURE 9.4.2 TYPICAL CROSS SECTION



PROVINCIAL HIGHWAY (CLASS F4)

9.4.2.2 Special Conditions in Designing

Partial Employment of New Route

Since the existing road at the south end was destroyed by flooding and has remained without restoration, a new route was employed on this portion because of the following reasons:

Physical condition
The section facing the Lampao River is being eroded especially by flooding. The total length of the route is not changed by employing the new route.

Construction costs
The construction costs required for the new route are not higher than those for the existing route because costs for erosion control structures would also be required on the existing route.

9.4.2.3 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			
Traffic/road link	1	2	3	4	1	2	3	4
Heavy bus	5	4	—	—	13	12	—	—
Medium truck	30	19	—	—	35	26	—	—
Heavy truck	8	8	—	—	13	12	—	—

- Cumulative number of ESA in one direction by road link

Road link	1	2	3	4
7 years (10^6)	0.054	0.042	-	-

2) Design CBR values

Road link	1	2	3	4
Design CBR (%)	6.9	13.2	-	-

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
	15 cm	10 cm	-	-

4) Overlay required in 7 years
DBST resurfacing

9.4.2.4 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
1 + 150	Timber Bridge	4.5 x 15.0	RC Bridge	9.0 x 15.0
2 + 927	" "	4.5 x 5.0	Box Culvert	2-2.4 x 2.4 x 18.0
3 + 101	" "	4.5 x 12.0	RC Bridge	9.0 x 15.0
10 + 747	" "	4.5 x 10.0	" "	9.0 x 12.0
12 + 720	" "	4.5 x 9.0	" "	9.0 x 10.0
12 + 962	" "	4.5 x 15.0	" "	9.0 x 15.0
13 + 949	" "	4.5 x 10.0	" "	9.0 x 10.0
15 + 857	Pipe Culvert	3-Ø1.0 x 12.4	Box Culvert	2-2.4 x 2.4 x 18.0
16 + 122	Timber Bridge	4.5 x 30.0	RC Bridge	9.0 x 30.0
16 + 239	Pipe Culvert	3-Ø1.0 x 13.5	Box Culvert	2-2.4 x 2.4 x 18.0
17 + 482	Timber Bridge	4.5 x 25.0	RC Bridge	9.0 x 30.0
19 + 341	" "	4.5 x 12.0	" "	9.0 x 15.0
20 + 122	" "	4.5 x 5.0	Box Culvert	2-2.4 x 2.4 x 18.0
21 + 935	Pipe Culvert	3-Ø1.0 x 13.7	" "	1-2.4 x 2.4 x 18.0
26 + 678	" "	3-Ø1.0 x 10.3	" "	1-2.4 x 2.4 x 18.0
27 + 366	Timber Bridge	4.5 x 15.0	RC Bridge	9.0 x 20.0
29 + 337	" "	4.5 x 10.0	" "	9.0 x 15.0
34 + 050	-	-	Box Culvert	2-2.4 x 2.4 x 18.0

9.4.3 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 9.4.2. Financial costs with breakdown into local and foreign currency portions, economic costs and residual values were estimated as follows and in 9.4.4:

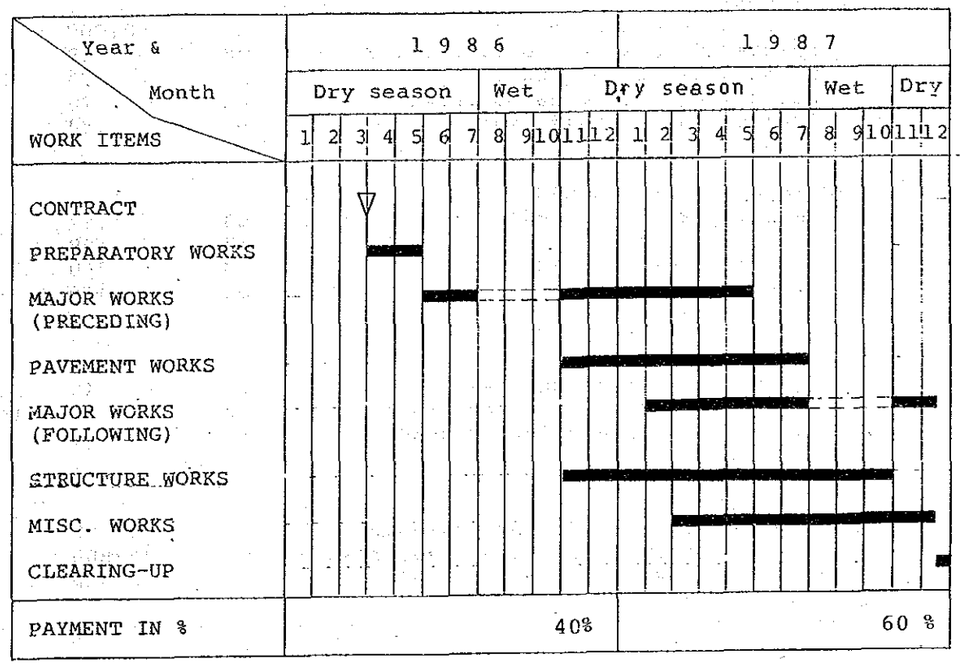
			(baht)
IM—9	L = 34.3 km		
	Financial cost	:	80,463,000
	Economic cost	:	67,569,000
	Residual value	:	30,295,000

The required road maintenance costs are shown in Table 9.4.3.

9.4.4 Construction and Disbursement Schedules

IM—9 **Length = 34.3 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 - 9)

(Unit : Million Baht)

	1986			1987			Total		
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total
Construction Cost	16.4	15.7	32.1	24.7	23.6	48.3	41.1	39.3	80.4
Price Contingency	3.4	2.1	5.5	8.2	4.9	13.1	11.6	7.0	18.6
Total	19.8	17.8	37.6	32.9	28.5	61.4	52.7	46.3	99.0
	(0.73)	(0.66)	(1.39)	(1.22)	(1.06)	(2.27)	(1.95)	(1.71)	(3.67)

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

TABLE 9.4.2 CONSTRUCTION QUANTITIES AND COSTS
(ROUTE IM—9 Length = 34.3 km)

DBST

Item	Unit	Financial Unit Rate B	Quantity	Financial Cost 1000 B Total	Local	Foreign	Economic Cost %	Economic Cost 1000 B	Residual Value %	Residual Value 1000 B
EARTHWORK							83		90	
Clearing & Grubbing	ha	10,000	85	850						
Roadway Excavation, Unclassified	m3	19	0	0						
Embankment, Common Soil	m3	38	330,000	12,540						
Embankment, Selected Material	m3	70	0	0						
Replacement of Soft Spot	m3	88	3,400	299						
Sub Total				13,689	6,981	6,708		11,362		10,226
SUBBASE & BASE COURSES							83		50	
Subbase, Soil Aggregate	m3	112	41,900	4,693						
Aggregate Base*	m3	429	33,500	14,372						
Cement Stabilized Base	m3	390	0	0						
Shoulder, Soil Aggregate	m3	120	12,800	1,536						
Sub Total				20,600	11,124	9,476		17,098		8,549
SURFACE COURSES							85		50**	
Asphaltic Prime/Tack Coat	m2	12	223,000	2,676						
Double Bituminous Surface Treatment*	m2	40	188,700	7,548						
Asphaltic Concrete Surfacing**	t	750	0	0						
Sub Total				10,224	4,499	5,725		8,690		0
STRUCTURES							83		50	
RC Pipe Culvert (D 1.0m Equivalent)	m	2,000	1,489	2,978						
RC Box Culvert (2.4mx2.4m Equivalent)	m	18,800	216	4,061						
RC Bridg (W=9.0m L=10m Equivalent)	m	46,500	187	8,696						
Sub Total				15,734	7,867	7,867		13,059		6,530
Total (a)				60,248	30,471	29,776		50,210		25,305
INCIDENTALS							83		0	
Miscellaneous Work ((a)x7%)	ls			4,217	2,109	2,109		3,500		0
CONTRACT AMOUNT (b)				64,465	32,580	31,885		53,711		25,305
PHYSICAL CONTINGENCIES ((b)x10%) (c)	ls			6,447	3,258	3,189		5,371		2,530
ENGINEERING AND SUPERVISION							85		0	
(((b)+(c))x10%) (d)	ls			7,091	2,836	4,255		6,027		0
LAND ACQUISITION							100		100	
Highly Developed Land	ha	50,000	48	2,400						
Less Developed Land	ha	15,000	4	60						
Sub Total (e)	ls			2,460	2,460	0		2,460		2,460
PROJECT COST ((b)+(c)+(d)+(e))				80,463	41,135	39,328		67,569		30,295
AVERAGE COST PER KM				2,346						

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

TABLE 9.4.3 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	242.1	20.6	0.40	1.53	16,112	332	261.0	20.6	0.00	1.18	13,242	273	59
1	1994	339.4	20.6	0.62	1.69	17,777	366	344.7	20.6	0.00	1.18	13,242	273	93
	2002	535.2	20.6	0.95	1.92	20,179	416	507.9	20.6	0.00	1.18	13,242	273	143
	1988	249.6	13.7	0.42	1.54	16,241	222	263.6	13.7	0.00	1.18	13,242	181	41
2	1994	336.3	13.7	0.62	1.68	17,725	243	341.8	13.7	0.00	1.18	13,242	181	61
	2002	500.5	13.7	0.95	1.92	20,179	276	487.4	13.7	0.00	1.18	13,242	181	95
	1988	245.1	34.3			16,164	554	262.0	34.3			13,242	454	100
TOTAL	1994	338.2	34.3			17,757	609	343.5	34.3			13,242	454	155
	2002	521.3	34.3			20,179	692	499.7	34.3			13,242	454	238

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 = 1.25 + 0.70 * A1
WITH PROJECT CASE KB = 1.18 + 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

9.5 EVALUATION

9.5.1 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.

COSTS AND BENEFITS STATEMENT OF ROUTE IM - 9

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	TOTAL COST	TOTAL BENEFIT
1986	27,028	0	0	0	0	33,904	0
1987	40,541	0	0	0	0	45,406	0
1988	0	1,282	7,061	100	8,443	0	7,538
1989	0	1,698	7,504	109	9,311	0	7,423
1990	0	2,114	7,947	118	10,180	0	7,246
1991	0	2,530	8,391	128	11,048	0	7,021
1992	0	2,946	8,834	137	11,917	0	6,762
1993	0	3,362	9,277	146	12,785	0	6,477
1994	0	3,778	9,721	155	13,654	0	6,176
1995	12,508	3,970	10,357	165	14,492	5,658	5,853
1996	0	4,162	10,993	176	15,331	0	5,528
1997	0	4,354	11,629	186	16,170	0	5,206
1998	0	4,546	12,266	196	17,008	0	4,889
1999	0	4,738	12,902	207	17,847	0	4,581
2000	0	4,930	13,538	217	18,685	0	4,282
2001	0	5,122	14,175	228	19,524	0	3,995
2002	-30,295	5,314	14,811	238	20,363	-5,535	3,720
TOTAL	49,782	54,846	159,406	2,506	216,757	79,433	86,699
DISCOUNTED	79,433	20,873	64,824	1,003	86,699		

NET PRESENT VALUE : 7,266

BENEFIT/COST RATIO : 1.09

INTERNAL RATE OF RETURN : 13.1 %

FIRST YEAR RATE OF RETURN : 9.5 %

OPTIMUM OPENING YEAR : 1988

SENSITIVITY TESTS

ITEM	CASE		
	BASE	1	2
NET PRESENT VALUE	7,266	-4,649	-5,739
BENEFIT/COST RATIO	1.09	0.95	0.93
INTERNAL RATE OF RETURN	13.1 %	11.4 %	11.1 %
FIRST YEAR RATE OF RETURN	9.5 %	8.3 %	8.1 %
COSTS	BASE	+15%	BASE
BENEFITS	BASE	BASE	-15%

9.5.2 Social Impact

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

Construction Cost (million baht)	:	67.6
	:	2.48
1) General Accessibility Benefit (million baht)	:	1.33
2) Education Benefit (million baht)	:	0.057
3) Medical Care Benefit (million baht)	:	3.87
4) Total Social Benefits (million baht) (1+2+3)	:	5.72
5) Social Benefit/Cost Ratio ($\times 10^{-2}$)	:	14
6) Ranking by Social Benefits	:	9.67
7) Weighted Production Value Gain/Cost ($\times 10^{-2}$)	:	8
8) Ranking by 7	:	15.39
9) Combined Ratio ($\times 10^{-2}$)		
Overall Ranking	:	13

9.5.3 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 improved with the opening year 1988.