TABLE 6-13 CLASSIFICATION OF COMMODITIES

Code No.	Commodity Group	Name of Commodity
10	Unprocessed cereals	Dura, Maize
20	Other unprocessed agricultural foodstuffs	Onions, Vegetables, Dates, Aradaib, Beans, Mango, Fruits, Milk, Ganzabeel
31	Unprocessed agricultural cash crops	31. Gum Arabic
32		32. Groundnuts
33		33. Karkadeh
34		34. Watermelon Seeds
35		35. Simsim
36		36. Umbas (Foodstuffs for Animals)
37		37. Cotton
30		30. Others
40	Processed cereal products	Flour, Rice
50	Manufactured foodstuffs	Beer, Wine, Tea, Coffee, Biscuits, Sweets, Salsa, Noodles, Snuff, Cigarettes, Cheese, Peanuts-butter
60	Processed agricultural cash crops	Sugar, Vegetable Oil, Salt, Simsim Oil, Shatta
70	Livestock and products	Live Animals, Animal Skins
80	Other manufactured consumer goods	Window Glass, Tableware, Beds, batteries, Clothing, Soaps, Shoes, Books, Tyres, Car, Paint, Stationery, Medical Goods, Carpets, Paper, Matches, Spare Parts
90	Forestry products	Firewood, Charcoal, Zaaf
100	Mining products	
110	Mineral oil products	Benzine, Fuel
120	Building and construction materials	Cement, Sand, Plaster, Timber, Zinc, Aggregate, Iron, Water pipes
130	Miscellaneous	Barrels, Carton, Tins, Iron Box, Sacks
140	Others	Water, Others

TABLE 6-14-1 COMMODITY MOVEMENT BY TRUCK, 1977

10 (Unprocessed Cereals)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		18.4	2.9	1.0	11.7			4.2	38.2
UM RUABA	05	0.7		0.6	8.7					10.0
RAHAD	08		2.7							2.7
Rest of Project Area	02,03,04,06 07,09,10	3.2	2.4							5.6
KHARTOUM	14	1.1								1.1
PORT SUDAN	16									
West SUDAN	21,22,23,24			2.5		0.7				3.2
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.9	33.7			1.5			1.6	39.7
TOTAL		7.9	57.2	6.0	9.7	13.9			5.8	100.5

TABLE 6-14-2 COMMODITY MOVEMENT BY TRUCK, 1977

20 (Other Unprocessed Agricultural Foodstuffs)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.7	1.4		2.8			0.2	7.1
UM RUABA	05	1.7		1.3	2.1			0.3		5.4
RAHAD	08	6.7	1.8						2.1	10.6
Rest of Project Area	02,03,04,06 07,09,10	0.4								0.4
KHARTOUM	14	3.3		0.6	1.2			0.6	3.0	8.7
PORT SUDAN	16									
West SUDAN	21,22,23,24					6.7				6.7
Rest of SUDAN	11,12,13,15,17 18,19,20,25	5.5			1.5				12.0	19.0
TOTAL		17.6	4.5	3.3	4.8	9.5		0.9	17.3	57.9

TABLE 6-14-3 COMMODITY MOVEMENT BY TRUCK, 1977

30 (Unprocessed Agricultural Cash Crops, Others)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					1.9				1.9
UM RUABA	05									
RAHAD	08					1.0				1.0
Rest of Project Area	02,03,04,06 07,09,10	0.2								0.2
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		0.2				2.9				3.1

TABLE 6-14-4 COMMODITY MOVEMENT BY TRUCK, 1977

31 (Gum Arabic)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.2			23.2	1.6		1.5	28.5
UM RUABA	05	0.3								0.3
RAHAD	08	0.8	1.3						1.8	3.9
Rest of Project Area	02,03,04,06 07,09,10		4.7							4.7
KHARTOUM	14	0.9								0.9
PORT SUDAN	16									
West SUDAN	21,22,23,24		0.8			2.7				3.5
Rest of SUDAN	11,12,13,15,17 18,19,20,25								0.6	0.6
TOTAL		2.0	9.0			25.9	1.6		3.9	42.4

TABLE 6-14-5 COMMODITY MOVEMENT BY TRUCK, 1977

32 (Groundnuts)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.4							0.4
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.4								0.4
PORT SUDAN	16									
West SUDAN	21,22,23,24					1.2			0.4	1.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25	0.2								0.2
TOTAL		0.6	0.4			1.2			0.4	2.6

TABLE 6-14-6 COMMODITY MOVEMENT BY TRUCK, 1977

33 (Karkadeh)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					0.4				0.4
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL						0.4				0.4

TABLE 6-14-7 COMMODITY MOVEMENT BY TRUCK, 1977

34 (Watermelon Seeds)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					6.1	0.8		2.6	9.5
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24					7.9				7.9
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL						14.0	0.8		2.6	17.4

TABLE 6-14-8 COMMODITY MOVEMENT BY TRUCK, 1977

35 (Simsim)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		7.4			7.0			5.4	19.8
UM RUABA	05	0.6								0.6
RAHAD	08		14.4			1.8			6.7	22.9
Rest of Project Area	02,03,04,06 07,09,10	2.0	5.9							7.9
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24					0.6				0.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		2.6	27.7			9.4			12.1	51.8

TABLE 6-14-9 COMMODITY MOVEMENT BY TRUCK, 1977

36 (Umbas; Feed for Animals)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.5	1.2		26.9			2.0	30.6
UM RUABA	05									
RAHAD	08								0.4	0.4
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.4								0.4
PORT SUDAN	16									
West SUDAN	21,22,23,24					1.4				1.4
Rest of SUDAN	11,12,13,15,17 18,19,20,25								2.4	2.4
TOTAL		0.4	0.5	1.2		28.3			4.8	35.2

TABLE 6-14-10 COMMODITY MOVEMENT BY TRUCK, 1977

37 (Cotton)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01									
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.3								0.3
PORT SUDAN	16									
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		0.3								0.3

TABLE 6-14-11 COMMODITY MOVEMENT BY TRUCK, 1977

40 (Processed Cereal Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01			1.5						1.5
UM RUABA	05	0.6			1.2				0.4	2.2
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	1.0						0.1	0.3	1.4
PORT SUDAN	16									
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.0								1.0
TOTAL		2.6		1.5	1.2			0.1	0.7	6.1

TABLE 6-14-12 COMMODITY MOVEMENT BY TRUCK, 1977

50 (Manufactured Foodstuffs)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.7	1.2	0.2	4.5			3.9	10.5
UM RUABA	05	0.5								0.5
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	18.4		1.6				9.6	2.7	32.3
PORT SUDAN	16	1.6								1.6
West SUDAN	21,22,23,24		1.3			6.7				8.0
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.7							0.6	3.3
TOTAL		23.2	2.0	2.8	0.2	11.2		9.6	7.2	56.2

TABLE 6-14-13 COMMODITY MOVEMENT BY TRUCK, 1977

60 (Processed Agricultural Cash Crops)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		3.1	5.6	0.7	2.5			2.9	14.8
UM RUABA	05	4.9		4.8	6.4				2.2	18.3
RAHAD	08	9.2	5.4						2.4	17.0
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	21.6		2.4	0.6			27.8		52.4
PORT SUDAN	16							1.9		1.9
West SUDAN	21,22,23,24					0.4				0.4
Rest of SUDAN	11,12,13,15,17 18,19,20,25	4.9						1.3	4.5	10.7
TOTAL		40.6	8.5	12.8	7.7	2.9		31.0	12.0	115.5

TABLE 6-14-14 COMMODITY MOVEMENT BY TRUCK, 1977

70 (Livestock and Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.3			6.6			1.1	8.0
UM RUABA	05	0.4								0.4
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24					3.2				3.2
Rest of SUDAN	11,12,13,15,17 18,19,20,25								1.2	1.2
TOTAL		0.4	0.3			9.8			2.3	12.8

TABLE 6-14-15 COMMODITY MOVEMENT BY TRUCK, 1977

80 (Other Manufactured Consumer Goods)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		1.0	1.8	0.5	2.6			0.5	6.4
UM RUABA	05	0.7			0.1			0.3	0.6	1.7
RAHAD	08	0.6								0.6
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	31.9		2.2	0.7			10.8	3.0	48.6
PORT SUDAN	16	0.3			1.2					1.5
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.1		1.5		0.9			1.5	6.0
TOTAL		35.6	1.0	5.5	2.5	3.5		11.1	5.6	64.8

TABLE 6-14-16 COMMODITY MOVEMENT BY TRUCK, 1977

90 (Forestry Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	0.2		1.2			0.3	1.8
UM RUABA	05				1.2				0.4	1.6
RAHAD	08	3.9								3.9
Rest of Project Area	02,03,04,06 07,09,10	3.8	1.6			1.2				6.6
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24					1.6				1.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.0	1.2						4.6	6.8
TOTAL		8.7	2.9	0.2	1.2	4.0			5.3	22.3

TABLE 6-14-17 COMMODITY MOVEMENT BY TRUCK, 1977

100 (Mining Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01									
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
West SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL										0

TABLE 6-14-18 COMMODITY MOVEMENT BY TRUCK, 1977

110 (Mineral Oil Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	1.8						1.9
UM RUABA	05			1.2				0.6		1.8
RAHAD	08		0.9							0.9
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	4.2			0.1			4.6		8.9
PORT SUDAN	16	4.1								4.1
West SUDAN	21,22,23,24		0.1							0.1
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		8.3	1.1	3.0	0.1			5.2		17.7

TABLE 6-14-19 COMMODITY MOVEMENT BY TRUCK, 1977

120 (Building and Construction Materials)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.7	0.5		2.8			0.7	6.7
UM RUABA	05	2.9		0.6	4.5					8.0
RAHAD	08	12.5								12.5
Rest of Project Area	02,03,04,06 07,09,10	0.2	6.4			0.9			1.3	8.8
KHARTOUM	14	7.8		0.9				3.5	1.8	14.0
PORT SUDAN	16	1.6								1.6
West SUDAN	21,22,23,24					1.9				1.9
Rest of SUDAN	11,12,13,15,17 18,19,20,25	19.3	0.9			4.0			1.9	26.1
TOTAL		44.3	10.0	2.0	4.5	9.6		3.5	5.7	79.6

TABLE 6-14-20 COMMODITY MOVEMENT BY TRUCK, 1977

130 (Miscellaneous)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		1.0	3.3	0.2	2.9			5.3	12.7
UM RUABA	05	1.3		0.6	1.9					3.8
RAHAD	08	1.5								1.5
Rest of Project Area	02,03,04,06 07,09,10	2.4	1.5							3.9
KHARTOUM	14	5.1						0.2		5.3
PORT SUDAN	16	0.2								0.2
West SUDAN	21,22,23,24			1.5		0.3			0.5	2.3
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.2	1.5			1.0			1.0	4.7
TOTAL		11.7	4.0	5.4	2.1	4.2		0.2	6.8	34.4

TABLE 6-14-21 COMMODITY MOVEMENT BY TRUCK, 1977

140 (Others)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	0.3	2.8	2.7			0.5	6.4
UM RUABA	05	0.1			0.4					0.5
RAHAD	08	1.2								1.2
Rest of Project Area	02,03,04,06 07,09,10	1.5								1.5
KHARTOUM	14	6.3						2.3		8.6
PORT SUDAN	16									
West SUDAN	21,22,23,24					1.3				1.3
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.1				1.8			0.3	3.2
TOTAL		10.2	0.1	0.3	3.2	5.8		2.3	0.8	22.7

TABLE 6-14-22 COMMODITY MOVEMENT BY TRUCK, 1977

TOTAL

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	West SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		40.8	21.7	5.6	105.7	2.4		31.0	207.2
UM RUABA	05	15.0		9.1	26.6			1.2	3.7	55.6
RAHAD	08	36.5	26.5			2.8			13.4	79.2
Rest of Project Area	02,03,04,06 07,09,10	13.8	22.8			2.1			1.3	40.0
KHARTOUM	14	102.9		7.8	2.7			59.7	10.8	183.9
PORT SUDAN	16	7.8			1.2			1.9		10.9
West SUDAN	21,22,23,24		2.2	4.0		36.9			0.9	44.0
Rest of SUDAN	11,12,13,15,17 18,19,20,25	42.0	37.3	1.5	1.5	9.3		1.3	32.3	125.2
TOTAL		218.0	129.6	44.1	37.6	156.8	2.4	64.1	93.4	746.0

TABLE 6-15 OD TABLE OF PASSENGER MOVEMENT BY ROAD, 1977

(All types of vehicles) 1)

(Person per day)

ZONE		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
EL OBEID	01		69.3			127.7		1.8	197.8 (41.5)	2.8	15.8	7.8	122.4	4.1	299.4 (11.0)	0.6	7.5		38.4	4.9	1.0						901.3 (52.5)
GEIFIL	02					15.0							2.4														86.7
ET TAIYARA	03																										
SHAMAGATTA	04					305.1							1.8		12.9		1.2										321.0
UM RUABA	05						82.9	38.7	170.7											55.8	34.5		0.3	5.7			836.0
ABU HAMRA	06																										82.5
SEMEIH	07														4.2												44.7
RAHAD	08											9.9	37.8		36.9								6.1				459.2 (41.5)
NAWA	09																										2.8
EL AIN	10														1.7												17.5
TENDELTI	11																			3.3	0.6		1.3				22.9
KOSTI-SENNAR	12																			1.5	112.2		1.4	1.3			280.8
WAD MEDANI	13																				10.2						14.3
KHARTOUM	14																			22.5	76.5	2.3	15.8	124.0			596.2 (11.0)
KASSALA	15																										0.6
PORT SUDAN	16																							0.6			9.3
MALAKAL	17																										
EL ABBASIYA	18																										38.4
NUBA MOUNTAIN	19																										88.0
KADUGLI-DILLING	20																										235.0
WAU-JUBA	21																										2.3
EN NAHUD	22																										24.9
NYALA	23																										131.6
BARA	24																										
ATBARA	25																										
TOTAL																											4,196.0 (105.0)

Note: 1) Figures in parentheses indicate those of bus and are included in the total figure .

TABLE 6-16 RAILWAY GOODS HANDLED AT THE FOUR STATIONS

Station	Year	Forwarded			Received			Total		
		Goods Tons	Parcels Tons	Live-stock No.	Goods Tons	Parcels Tons	Live-stock No.	Goods Tons	Parcels Tons	Live-stock No.
EL OBEID	1970/71	76,575	564	67,581	139,171	2,031	-	215,746	2,595	67,581
	1971/72	77,207	448	47,795	148,973	2,422	-	226,180	2,870	47,795
	1972/73	94,089	507	43,065	110,056	2,345	9	204,145	2,852	43,074
	1973/74	68,673	413	37,629	135,104	2,224	48	203,777	2,637	37,677
	1974/75	91,308	300	22,860	98,040	3,108	420	189,348	3,408	23,280
	1975/76	66,859	2,535	32,398	147,283	7,388	1,237	214,142	9,923	33,635
RAHAD	1970/71	13,132	681	8,539	8,329	678	594	21,461	1,359	9,133
	1971/72	9,576	342	1,310	6,602	475	2,446	16,178	817	3,756
	1972/73	6,701	238	-	6,708	324	87	13,409	562	87
	1973/74	13,534	3,409	415	9,784	654	141	23,318	4,063	556
	1974/75	7,392	348	360	8,568	420	420	15,960	768	780
	1975/76	11,598	370	-	7.906	472	55	19,504	842	55
SEMEIH	1970/71	4,858	17	35	2,285	63	46	7,143	80	81
	1971/72	15,886	15	9	2,491	55	16	18,377	70	25
	1972/73	11,792	13	-	785	47	-	12,577	60	-
	1973/74	13,415	-	-	1,492	-	-	14,907	-	-
	1974/75	3,552	11	-	2,232	24	-	5,784	35	-
	1975/76	5,487	2	-	2,094	7	-	7,581	9	-
UM RUABA	1970/71	31,056	149	4,196	21,276	758	164	52,332	907	4,360
	1971/72	20,099	219	2,497	21,097	850	14	41,196	1,069	2,511
	1972/73	20,613	138	455	14,328	2,686	-	34,941	2,824	455
	1973/74	17,059	104	2,430	14,574	685	-	31,633	789	2,430
	1974/75	16,596	65	1,460	11,480	408	-	28,076	473	1,460
	1975/76	22,621	96	4,159	8,877	317	-	31,498	413	4,159
TOTAL	1970/71	125,621	1,411	80,351	171,061	3,530	804	296,682	4,941	81,155
	1971/72	122,768	1,024	51,611	179,163	3,802	2,476	301,931	4,826	54,087
	1972/73	133,195	896	43,520	131,877	5,402	96	265,072	6,298	43,616
	1973/74	112,681	3,926	40,474	160,954	3,563	189	273,635	7,489	40,663
	1974/75	118,848	724	24,680	120,320	3,860	840	239,168	4,584	25,520
	1975/76	106,565	3,003	36,557	166,160	8,184	1,292	272,725	11,187	37,894

Source: Saudan Railways Corporation, 1977

TABLE 6-17 PASSENGER BOOKINGS AT THE FOUR STATIONS

Station	Year	Class 1st	2nd	3rd	4th	Total
El Obeid	1970/71	3,894	9,594	37,364	44,107	94,959
	1971/72	3,390	7,960	30,076	53,716	95,142
	1972/73	4,307	9,337	36,030	59,574	109,248
	1973/74	4,255	8,712	33,886	43,492	90,345
	1974/75	5,979	9,660	40,556	28,114	84,309
	1975/76	6,171	9,844	36,854	39,605	92,474
Rahad	1970/71	353	1,063	5,352	44,530	51,298
	1971/72	390	977	5,565	41,198	48,130
	1972/73	476	966	5,583	37,782	44,807
	1973/74	446	933	5,747	28,577	35,703
	1974/75	324	576	4,145	23,298	28,343
	1975/75	522	1,068	5,922	23,712	31,224
Semeih	1970/71	39	122	786	9,252	10,199
	1971/72	31	63	579	7,092	7,765
	1972/73	34	122	662	6,689	7,507
	1973/74	79	126	607	4,600	5,412
	1974/75	34	68	494	3,432	4,028
	1975/76	60	122	362	2,634	3,168
Um Ruaba	1970/71	666	1,772	7,243	46,585	56,266
	1971/72	692	1,658	6,291	45,190	53,831
	1972/73	938	1,621	7,256	38,322	48,137
	1973/74	884	1,558	6,533	27,869	36,844
	1974/75	646	1,128	5,630	23,366	30,770
	1975/76	637	883	6,317	25,490	33,327
TOTAL	1970/71	4,952	12,551	50,745	144,474	212,722
	1971/72	4,503	10,658	42,511	147,196	204,868
	1972/73	5,755	12,046	49,531	142,367	209,699
	1973/74	5,664	11,329	46,773	104,538	168,304
	1974/75	6,983	11,432	50,825	78,210	147,450
	1975/76	7,390	11,907	49,455	91,441	160,193

Source: Ibid

ANNEX Ⅵ－20 鉄道旅客ＯＤ表の作成

20.1 インタビューの対象列車および旅客

現地調査された鉄道旅客の特性は，本文第Ⅵ章に示され，この調査実数は下記表６－１８－１にまとめられている。この表にあるように主要列車は全て調査した。この表の調査旅客数にもとずき，次節２０－２および２０－３のように日平均旅客数が推定される。

ANNEX VI-20

TABLE 6-18-1 RAILWAY PASSENGERS INTERVIEWED

Date	Direction	Type of Train	Number of Passengers Interviewed	Capacity of Train (seats)	Ramarks (Service times/week)
May 17	El Obeid → Khartoum	Express	1,175	961	2
20	Khartoum → El Obeid	- " -	713	961	2
18	Khartoum → El Obeid	Normal	731	758	5
19	El Obeid → Khartoum	- " -	834	758	5
21	El Obeid → Khartoum	- " -	380	758	5
19	Nyala → Khartoum	- " -	1,035	758	4 1)
20	Khartoum → Nyala	Express	722	961	3 1)

Note: 1) Same number of trains are served for the opposite direction.

20.2 鉄道旅客OD分布パターンの推定

インタビューの結果，得られた旅客のOD分布パターンは，列車の種類によって異るため，これを次のような方法で補正し，El Obeid—Um Ruaba の区間の鉄道旅客のODパターンを推定した。

すなわち，何れの列車も乗車効率は同じとし，各列車の旅客のODパターンを方向別，列車タイプ別の1日当りの容量で重みづけし，全旅客のODパターンとした。1列車旅客数と週当りの運行回数は調査して表6－18－1に示される。列車の旅客容量は，表6－19に示される。

20.3 分布交通量

鉄道旅客のODパターンと El Obeid, Rahad, Semein 駅の旅客数より，鉄道旅客OD表は日平均量として推定した。表6－18－2の合計値にはこの3駅の実数と他のマス目のODパターンの推定値の合計が記されている。

TABLE 6-18-2 OD TABLE OF RAILWAY PASSENGER

(Persons per day)

ZONE		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
EL OBEID	01					59.6	0.3	1.2	3.4			7.0	106.1	43.7	303.9	9.2	5.2	0.5				0.6		1.3		8.1	552.1
GEIFIL	02																										
ET TAIYARA	03																										
SHAMAGATTA	04																										
UM RUABA	05							1.9	51.1													3.7	4.3	5.2			125.8
ABU HAMRA	06												2.0	0.9	1.1												4.3
SEMEIH	07											9.9	2.6		0.3		2.6										18.5
RAHAD	08											7.5	38.7	18.7	72.4	1.7	0.7									3.5	197.7
NAWA	09												0.3	0.2													0.5
EL AIN	10												0.9		0.9												1.8
TENDELTI	11																						0.7	6.0			31.1
KOSTI-SENNAR	12																						6.7	98.9	1.6		259.8
WAD MEDANI	13																					1.7	9.1	75.4	0.9		150.6
KHARTOUM	14																			0.3	3.7	2.6	27.9	246.9	2.0		662.0
KASSALA	15																			0.2	0.6		0.9	7.6			20.2
PORT SUDAN	16																				0.7		0.4	3.2			12.8
MALAKAL	17																							0.7			1.2
EL ABBASIYA	18																										
NUBA MOUNTAIN	19																										0.5
KADUGLI-DILLING	20																										5.0
WAU-JUBA	21																										8.6
EN NAHUD	22																									2.6	52.6
NYALA	23																									0.9	446.1
BARA	24																									1.3	5.8
ATBARA	25																										16.4
TOTAL																											2,573.4

TABLE 6-19 ESTIMATE OF TRAIN CAPACITY

Train Type / Class	Express		Normal		Local	
	No. of Coaches	Capactiy (seats)	No. of Coaches	Capacity (seats)	No. of Coaches	Capacity (seats)
Sleeper	2	26	1	13	0	-
1st Class	2	64	1	32	1	16
2nd Class	2	96	1	48	1	24
3rd Class	3	225	3	225	1	75
4th Class	5	550	4	440	1	110
Buffet	1	-	0	-	0	-
Luggage	1	-	1	-	0	-
Brake Wagon	1	-	0	-	0	-
Total	17	961	11	758	4	225

Source: Interview at El Obeid Station.

ANNEX Ⅵ－２１　走行費用の算定

２１.１　代表車の走行特性

走行費用算定の対象とする代表車は，乗用車として，Toyota，Corolla 1200，バン／ピックアップとして，Toyota Land Cruiser Pick-up，中型トラックとして，Bedford（６トン車）大型トラックとして，Fiat 682（11トン車），およびバスとして，Bedford（６トン車）の改造車を選定した。

これらの代表車の走行特性は，次表６－２０－１～表６－２０－４に示される。これら，平均走行速度，年間走行距離，耐用キロ，年間平均走行時間の間には，相互に関連があり，現地におけるインタビュー，走行調査等によって決められた。

２１.２　償却費および利子，その他

ｉ）車輌，タイヤ，車体価格

現地供給業者からのヒアリングおよび車輌を輸入した時の関連書類等を彼等から得て車輌価格および価格を構成する費目についての分析を行った。この結果は表６－２０－５に示される。

ファイナンシャルコストは車の市場価格であり，これから関連する諸税（輸入関税，Development Tax，Bank Exchange Tax等）を差引いたものがエコノミックコストとなる。エコノミックコストは外貨部分と内貨部分（国内輸送費，取扱手数料，港湾荷役費用等）から構成される。

訪問調査の結果より車輌の残存価値を推定した。

タイヤについては，対象地域で最もよく利用されているタイヤタイプについて車輌価格と同様に，その価格を算定した。それを表６－２０－６に示す。

スーダンにおいては，中型トラックおよびバスの車体は現地で製造されることが多い。車体の構造，タイプも種々あるが次表６－２０－７に示される価格は，それらの平均的な値を示し

TABLE 6-20-1 AVERAGE RUNNINC SPEED

(km/hr)

Road Surface	Vehicle Type	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved Road		85	75	60	60	60
Gravel Road		70	65	52	52	52
Hard Surface Track		60	55	45	43	45
Loose Sand Track		-	35	28	25	28

TABLE 6-20-2 ANNUAL KILOMETRAGE

(000 km)

Road Surface	Vehicle Type	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved Road		20.00	31.25	70.00	75.00	84.00
Gravel Road		16.00	27.50	60.00	63.33	72.00
Hard Surface Track		12.00	22.50	52.00	55.00	62.00
Loose Sand Track		-	18.75	33.33	35.00	40.00

TABLE 6-20-3 VEHICLE LIFE KILOMETRAGE

(000 km)

Road Surface	Vehicle Type	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved Road		200	250	420	450	420
Gravel Road		160	220	360	380	360
Hard Surface Track		120	180	310	330	310
Loose Sand Track		-	150	200	210	200

TABLE 6-20-4 AVERAGE OPERATING HOURS PER ANNUM

(hours/year)

Road Surface	Vehicle Type	Car	Van pick-up	Medium Truck	Heavy Truck	Bus
Paved Road		-	-	1,170	1,250	1,400
Gravel Road		-	-	1,150	1,220	1,380
Hard Surface Track		-	-	1,160	1,280	1,380
Loose Sand Track		-	-	1,190	1,400	1,430

The residual value of vehicles was estimated from interviews in the area. Table 6-20-6 shows the price of a set of tyres. The most popular tyre type was selected for the analysis.

TABLE 6-20-5 PRICE OF REPRESENTATIVE VEHICLE, 1977 1) (LS)

Vehicle Type	Foreign Exchange	Local Component	Economic	Taxes & Duties	Financial	Salvage Value (%)
Car (Toyota Corolla)	1,170	933	2,103	2,146	4,249	15
Van/Pick-up (Toyota Pick-up)	2,487	1,126	3,613	1,897	5,510	15
Medium Truck 2) (Bedford)	3,541	1,326	4,867	1,533	6,400	30
Heavy Truck (Fiat 682)	11,312	1,542	12,854	6,374	19,228	30
Bus 2) (Bedford)	3,541	1,326	4,867	1,533	6,400	30

Source: Interviews with dealers.

Notes: 1) Including tyres

2) Excluding the prices of locally manufactured bodies. They are shown in Table 6-20-7.

TABLE 6-20-6 PRICE OF A SET OF TYRES, 1977

Vehicle Type	Type of Tyre Used	Price (LS) Financial	Price (LS) Economic	Number of Tyres
Car,	600-12-4PR	70.000	49.996	4
Van/pick-up	750-16-8PR	200.000	139.984	4
Medium Truck	Front: 900-20-12PR Rear :1200-20-16PR	181.400 353.400	126.966 227.368	4
Heavy Truck	1200-20-16PR	1,060.200	742.062	6
Bus	Front: 900-20-12PR Rear :1200-20-16PR	181.400 353.400	126.966 227.368	4

Source: Interviews with dealers

Bodies of buses and medium trucks are usually manufactured in the Sudan. Although types and structures of bodies vary, prices shown in Table 6-20-7 are considered to indicate the average price.

TABLE 6-20-7 PRICE OF LOCALLY MANUFACTURED BODY, 1977

(LS)

	Financial	Economic
Medium Truck	1,500	1,095
Bus	2,500	1,825

Source: Interviews with dealers

ii) 償却費および利子費の算定

自動車の償却費および利子費は次式によって算定した。

$$D = (C - R) \times \frac{i \times (1+i)^n}{(1+i)^n - 1} \times \frac{n}{LM}$$

この式中

D = 償却費および利子費（mm/km）

C = タイヤを除く車輌価格（LS）

R = 車輌の残存価格（LS）

i = 利子率（10%）

n = 車輌の耐用年数（年）

LM= 車輌の耐用走行距離（km）

iii) 保険費用

保険費用は車種によって異り，現地保険会社からのヒアリングによれば，次表6－20－8のようになっている。

TABLE 6-20-8 INSURANCE FEES

(LS)

Type of Vehicle	Financial	Economic	Basis of Calculation
Car	147.5	125.3	On the first LS 1,000 5%, on the balance 3% of the total price of the vehicle
Van/Pick-up	185.3	157.5	
Medium Truck	192.0	163.2	3% of the total price of the vehicle
Heavy Truck	576.8	490.3	
Bus	222.0	188.7	On the first LS 1,000 6%, on the balance 3% of the total price of the vehicle. Not insurable for passengers

Source: Blue Nile Insurance Company, Sudan

(V) 運転手および助手の賃金

業務用トラックの運行は，ドライバーおよび２人の助手によって行われるケースがスーダンでは最も多い。現地でのドライバーと輸送業者に対するインタビューから，その平均値をもって，表６－２０－９に示されるものを月額賃金とした。

TABLE 6-20-9 AVERAGE MONTHLY WAGES OF DRIVERS AND ASSISTANTS 1)

(LS/month)

	Driver	Assistant I	Assistant II
Medium Truck	65	23	12
Heavy Truck	65	23	12
Bus	70	23	12

Source: Interviews with drivers and transport companies.

Note : 1) Wages include salaries and monetary fringe benefits.

賃金のエコノミック コストは，収入から所得税を差引いたものとして算定した。所得税率は次表６－２０－１０のようになっている。

TABLE 6-20-10 TAXATION (INCOME TAX) FOR RESIDENTS

(per year)

Income (LS)	On the first 400	Following 200	400	1,000	1,000	2,000	2,000	2,000	More than 9,000
Percent	0	5	10	15	20	30	40	50	60

Source: Ministry of National Planning

V) 車輌登録費等

自動車の所有者は表６－２０－１１に示す Licencing fees, Town development fees と Services fees からなり車種によって異る金額を毎年支払わなければならない。

TABLE 6-20-11 ANNUAL LICENSE FEES BY VEHICLE TYPE, 1977

(LS)

Vehicle Type	Licensing Fees	Town Development Fees	Service Fees	Total
Car	8	1	2	11
Van/Pick-up	9	1	2	12
Medium Truck	23	3	2	28
Heavy Truck	23	3	10	36
Bus	23	3	2	28

Source: Kordofan Province Authorities and El Obeid Municipal Council.

Vi) 燃料消費

対象地域における特殊な道路状況下で燃料消費の推定には，困難さが予想されたため，現地調査時に燃料消費量をインタビュー項目に加えた。ルースサンド（Loose Sand）および固結粘土（Hard Surface Clay）路面の道路についてはもっぱら現地でのインタビューと，トヨタピックアップによる走行調査の結果にもとずいた。

砂利（Gravel）および舗装道については，現地での走行調査に加えて，Quantification of Road User Savings, IBRD 等の資料を参考にした。この分析結果は表６－２０－１２に示される。

なお，燃料の価格は El Obeid と Khartoum で調査し，表６－２０－１３は示される平均値を使用した。

Vii) オ イ ル

オイルの消費量は現地調査および“Quantification of Road User Savings, IBRD”から表６－２０－１４のように推定した。表６－２０－１５はオイル価格を示すものである。

TABLE 6-20-12 FUEL CONSUMPTION

(liters per 1,000 km)

Road Surface	Vehicle Type: Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved	80	200	250	300	250
Gravel	100	250	300	390	300
Hard Surface	120	300	375	480	375
Loose Sand	-	450	600	900	600

Price of fuel was surveyed at both Khartoum and El Obeid and the average price is used for the analysis.

TABLE 6-20-13 PRICE OF FUEL IN KHARTOUM AND EL OBEID AREAS

LS/Gallon
(LS/liter)

	With Tax	Without Tax
Benzine (Gasoline)	0.460 (0.1012)	0.240 (0.0528)
Gasoline (Diesel)	0.368 (0.0810)	0.312 (0.0686)

Source: Shell Oil Company, Sudan

vii) Oil consumption

Oil consumption was estimated, as shown in Table 6-20-14, from the results of the field survey and "Quantification of Road User Savings, IBRD". Table 6-20-15 shows the price of engine oil.

TABLE 6-20-14 OIL CONSUMPTION

(liters per 1,000 km)

	Vehicle Type				
Road Surface	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved	1.1	1.4	2.3	6.8	2.3
Gravel	1.3	1.6	2.6	7.8	2.6
Hard Surface	1.6	1.9	3.1	9.4	3.1
Loose Sand	-	2.5	4.0	12.2	4.0

TABLE 6-20-15 PRICE OF ENGINE OIL

LS/Gallon
(LS/Liter)

	With Tax	Without Tax
For Gasoline Engine	2.350 (0.517)	2.039 (0.449)
For Diesel Engine	1.855 (0.408)	1.589 (0.350)

Source: Shell Oil Company, Sudan

viii) タイヤ費

タイヤの摩耗は路面状況によって大きく異る。固結粘土（Hard Surface Clay）およびルースサンド（Loose Sand）の路面については，主として現地ドライバー，修理工場からのヒアリングによった。その他については“Quantification of Road User Savings, IBRD”等の資料をもとに決定した。

表６－２０－１６はそれぞれ異なった路面でのタイヤの耐用年数を示す。タイヤ価格は表６－２０－６に示される。

TABLE 6-20-16 TYRE WEAR

('000 km)

	Vehicle Type				
Road Surface	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved	30	38	45	45	45
Gravel	15	18	23	23	23
Hard Surface	9	10	12	12	12
Loose Sand	-	12	14	14	14

ix) 維持修繕費

プロジェクト地域の道路条件のもとでの維持修繕費は極めて高く，車輛を良好な状態に保つためには，２～３年目以降は年間 LS 2,000 以上の費用（中型トラックの場合）がかかる状況である。表６－２０－１７と表６－２０－１８は車輛の維持修繕費とそれに必要な人件費を示す。それらは現地での自動車販売業者，そして修理工場からのヒヤリングおよび他の調査報告書と文献を分析して決定された。

TABLE 6-20-17 MAINTENANCE: PARTS

(% of depreciable value/1,000 km)

Road Surface	Vehicle Type				
	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved	0.13	0.14	0.13	0.12	0.13
Gravel	0.16	0.20	0.19	0.18	0.19
Hard Surface	0.45	0.50	0.50	0.47	0.50
Loose Sand	-	0.78	0.78	0.73	0.78

TABLE 6-20-18 MAINTENANCE: HOURS OF LABOUR

(hours/1,000 km)

Road Surface	Vehicle Type				
	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus
Paved	0.75	0.9	3.0	3.5	3.0
Gravel	1.0	1.3	4.9	5.7	4.9
Hard Surface	2.0	2.6	9.8	11.4	9.8
Loose Sand	-	3.6	13.7	16.0	13.7

X) 管理費

業務用車については走行費の１０％とした。

Xi) 道路勾配による補正

走行費用は道路の勾配の影響を受ける。道路勾配の変化は走行速度が変化することによってたいていの費用項目がその影響を受けるが，対象地域の道路が殆んど平坦であることと，燃料消費以外の項目はその影響も小さいことから，ここでは道路勾配と燃料消費との関係だけを考慮した。表６－２０－１９にこの結果を示すが，これは主として“Quantification of Road User Savings, IBRD”に依っている。ここでは０～３％までの道路勾配は平坦とみ

なしている。

TABLE 6-20-19 PERCENTAGE INCREASE OF FUEL CONSUMPTION DUE TO A CHANGE IN ROAD GRADIENT

(%)

Gradient	Car	Van/Pick-up	Truck, Bus
0 - 3%	100	100	100
3 - 5%	110	124	143

12) 雨季の走行費用

路面タイプのうち固結粘土（Hard Surface Clay）とルース・サンド（Loose Sand）路面上の走行費用は降雨によって影響を受ける。特に固結粘土は降雨によって路面がぬかるみ化し，著しく走行困難となる。Loose Sandの場合は雨によって路面が締り，逆に路面の走行条件はよくなるが，砂丘地帯の随所に発生する流水によって通行が遮断されたり，これを迂回するために走行距離が長くなったりする。

これらの影響を厳密に推定することは極めて困難であり，ここでは雨季の期間中（6～9月の4ケ月間）について固結粘土上の走行費用は乾季の走行費用の50％増しとして，ルースサンドの走行費用は雨季・乾季とともに変化しないものと推定した。

ANNEX VII

TABLE 7-1 TRAFFIC ON PROPOSED ROAD, 1977[1)]

(Vehicles per day)

Type of Vehicle	Section 01 - 10	10 -09	09-08	08-07	07-06	06-05	Average
	Distance[2)] (Km) 23.5	23.5	21.0	20.0	25.0	21.6	134.6
Small Vehicles	7.2	5.8	5.6	4.1	3.7	3.7	5.0
Medium Trucks	109.9	109.7	108.9	121.0	130.8	134.7	119.2
Large Trucks	4.4	4.4	4.4	4.9	4.5	4.5	4.5
Buses	1.5	1.5	1.5	0.2	0.2	0.2	0.9
Total	123.0	121.4	120.4	130.2	139.2	143.1	129.6

Notes: 1) Normal Traffic is quoted in 9.03, CHAPTER IX.
Neither diverted nor generated traffic is included.

2) This section is between RAHAD and SEMEIH.

TABLE 7-2 TRAFFIC AND STANDARD AXLE NUMBERS ESTIMATED: RAHAD - SEMEIH

(Vehicles/day)

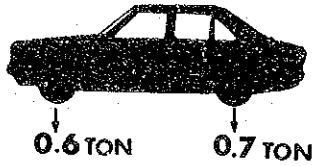
		Growth Rate per Year		Traffic: Trucks: Medium Truck	Trucks: Large Truck	Trucks: Total	Buses	Small Vehicles	Total
	1977		Feasibility	120.9	5.0	125.9	0.2	4.1	130.2
1	78		Detailed	128.0	6.7	134.7	0.2	4.4	139.3
2	79		Design	135.5	8.6	144.1	0.2	4.7	149.0
3	80			141.9	12.3	154.2	0.2	5.0	159.4
4	81		Construction	150.1	14.9	165.0	0.3	5.4	170.7
5	82			158.9	17.7	176.6	0.3	5.8	182.7
6	83		Open 1st Year	166.2	22.7	188.9	0.3	6.2	195.4
7	84	7%	2	173.9	28.3	202.2	0.3	6.6	209.1
8	85		3	181.7	34.6	216.3	0.3	7.0	223.6
9	86		4	189.8	41.7	231.5	0.4	7.5	239.4
10	87		5	200.6	47.1	247.7	0.4	8.1	256.2
11	88		6	209.3	55.7	265.0	0.4	8.6	274.0
12	89		7	221.2	62.4	283.6	0.5	9.2	293.3
13	90		8	230.6	72.8	303.4	0.5	9.9	313.8
14	91		9	243.4	81.2	324.6	0.5	10.6	335.7
15	92	-----	10	253.6	93.8	347.4	0.6	11.3	359.3
16	93		11	262.6	102.1	364.7	0.6	11.9	377.2
17	94		12	271.9	111.1	383.0	0.6	12.5	396.1
18	95		13	277.4	124.7	402.1	0.6	13.1	415.8
19	96		14	287.1	135.1	422.2	0.7	13.7	436.6
20	97		15	297.0	146.3	443.3	0.7	14.4	458.4
21	98	5%	16	302.6	162.9	465.5	0.7	15.2	481.4
22	99		17	312.8	176.0	488.8	0.8	15.9	505.5
23	2000		18	323.2	190.0	513.2	0.8	16.7	530.7
24	1		19	328.7	210.1	538.8	0.9	17.5	557.2
25	2		20th Year	339.5	226.3	565.8	0.9	18.4	585.1
A			Total	5,073.2	2,124.8	7,198.0	11.5	234.3	7,443.8
B	Accumulated Traffic Volume over 20 Years, A x 365			1,851,718	775,552	2,627,270	4,198	85,520	2,716,988
C	Equivalent Factors of a Standard Axle Number			0.3533	2.6906	-	0.0614	0.0036	-
D	Total Accumulated Standard Axle Numbers B x C			654,212	2,086,390	2,740,602	258	308	2,714,168
E	Diverted Traffic and Others D x 10%			65,421	208,639	274,060	26	31	274,117
F	Total Accumulated Standard Axle Numbers D + E			719,633	2,295,029	3,014,662	284	339	3,015,285
G	Accumulated Standard Axle Numbers on One Side of Carriageway			359,817	1,147,514	1,507,331	142	170	1,507,643

FIG. 7-1

AXLE LOAD OF REPRESENTATIVE VEHICLE

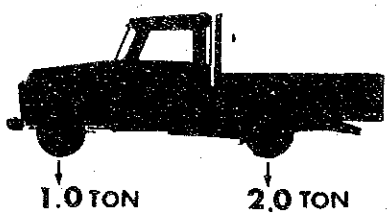
Equivalent Standard Axles

SALOON CAR : TOYOTA COROLLA



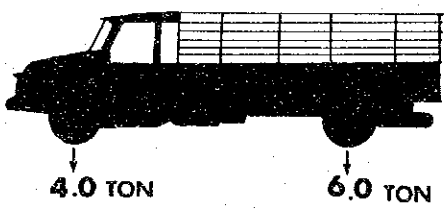
0.0002

FOUR WHEEL DRIVE VAN & PICK-UP : TOYOTA LANDCRUISER PICK-UP



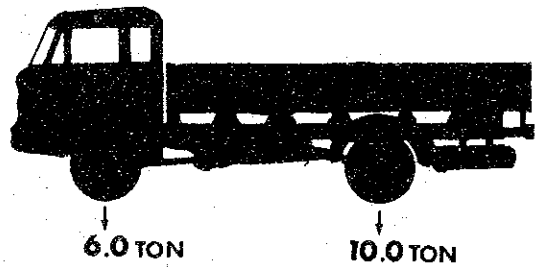
0.0036

TRUCK 6-TON LOADING CAPACITY : BEDFORD



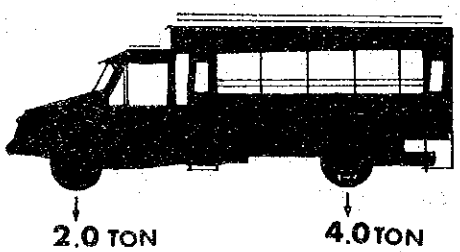
(0.0578 + 0.2955)

HEAVY TRUCK 11-TON LOADING CAPACITY : FIAT 682



(0.2955 + 2.3951)

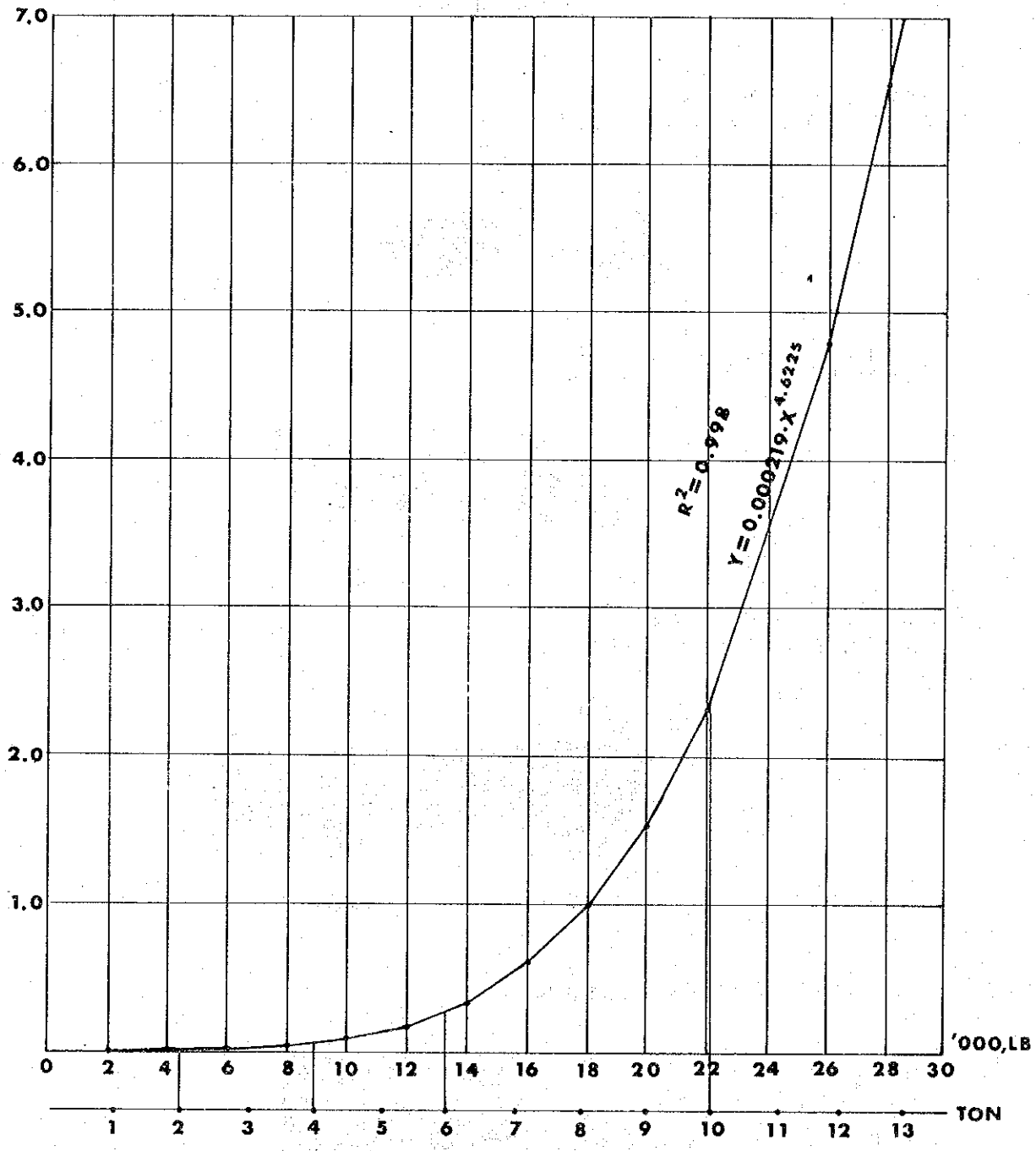
BUS 44-PASSENGER : BEDFORD



(0.0036 + 0.0578)

FIG. 7-2 EQUIVALENCE FACTORS FOR VARIOUS AXLE LOADING.

FLEXIBLE PAVEMENT ; PT = 2.0 SN = 3



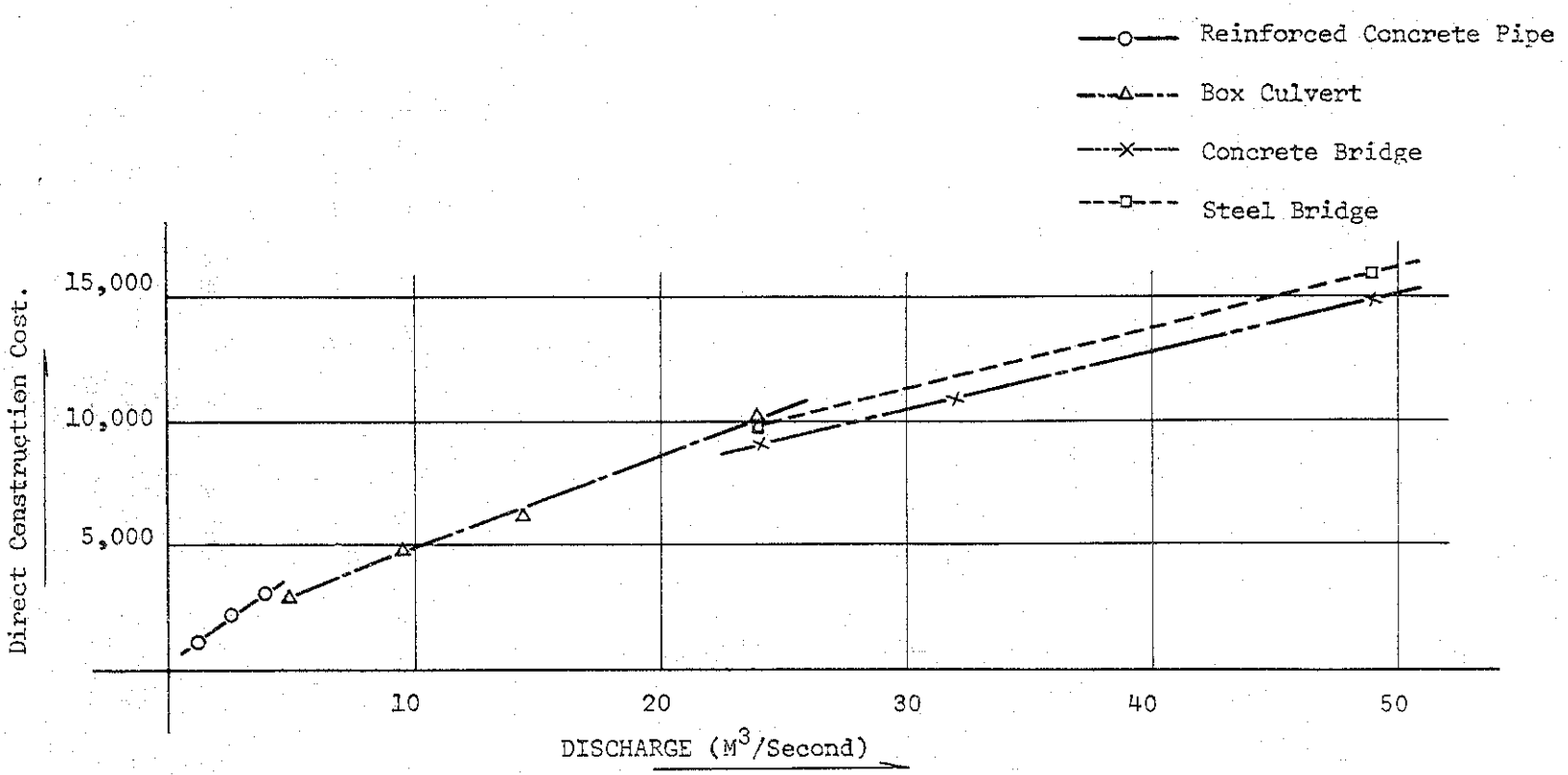
SOURCE : AASHTO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURE 1972

TABLE 7-3 RELATIONSHIP BETWEEN ALLOWABLE DISCHARGE AND THE COST OF STRUCTURE

		Discharge (M^3/Second)	Construction Cost (LS)
PIPE CULVERT	Ø1000 x 1	1.26	1,198
	Ø1000 x 2	2.52	2,167
	Ø1000 x 3	3.78	3,028
BOX CULVERT H. V. (2.0 x 1.5)	1 Cell	4.8	2,999
	2 Cells	9.6	4,738
	3 Cells	14.4	6,255
	4 Cells	24.0	11,000
BRIDGE (CONCRETE)	L=7.0M (1 span)	24.0	9,100
	L=9.0M (1 span)	32	10,744
	L=7.0Mx2 (2 spans)	49	15,037
	L=9.0Mx2 (2 spans)	65	18,384
	L=9.0Mx3 (3 spans)	98	26,021
BRIDGE (STEEL)	L=7.0 (1 span)	24	9,760
	L=14.0 (2 spans)	49	16,100

Note: Comparison in direct construction cost.

FIG. 7-3 RELATIONSHIP BETWEEN DISCHARGE AND THE COST OF STRUCTURES 1)



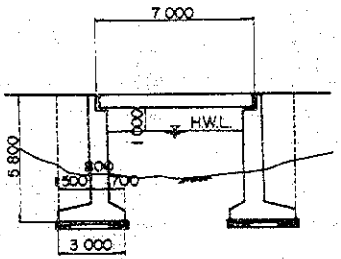
Note: 1) Produced from Table 7-3 in Annex VII-5.

FIG VII - 4 TYPE OF BRIDGE

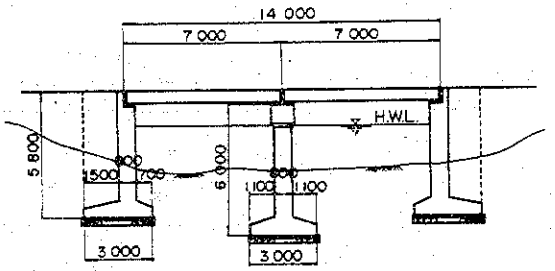
S = 1 : 100

PROFILE

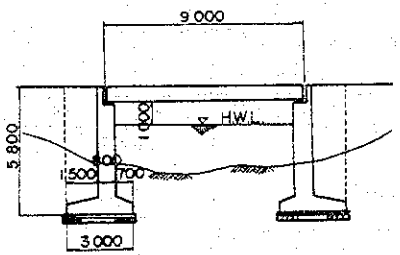
TYPE 1



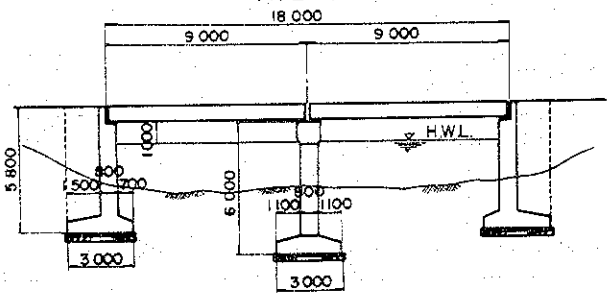
TYPE 3



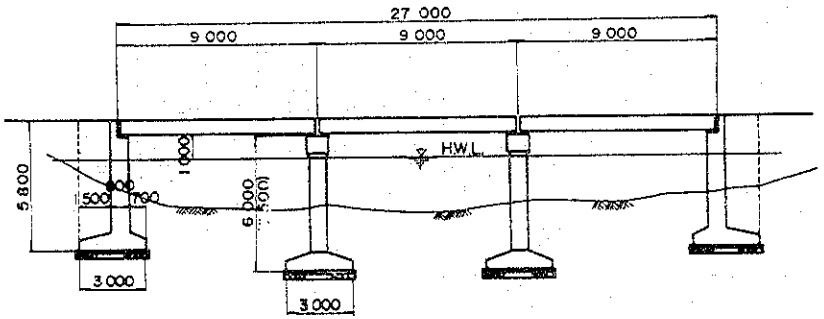
TYPE 2



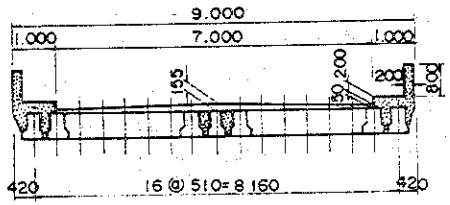
TYPE 4



TYPE 5



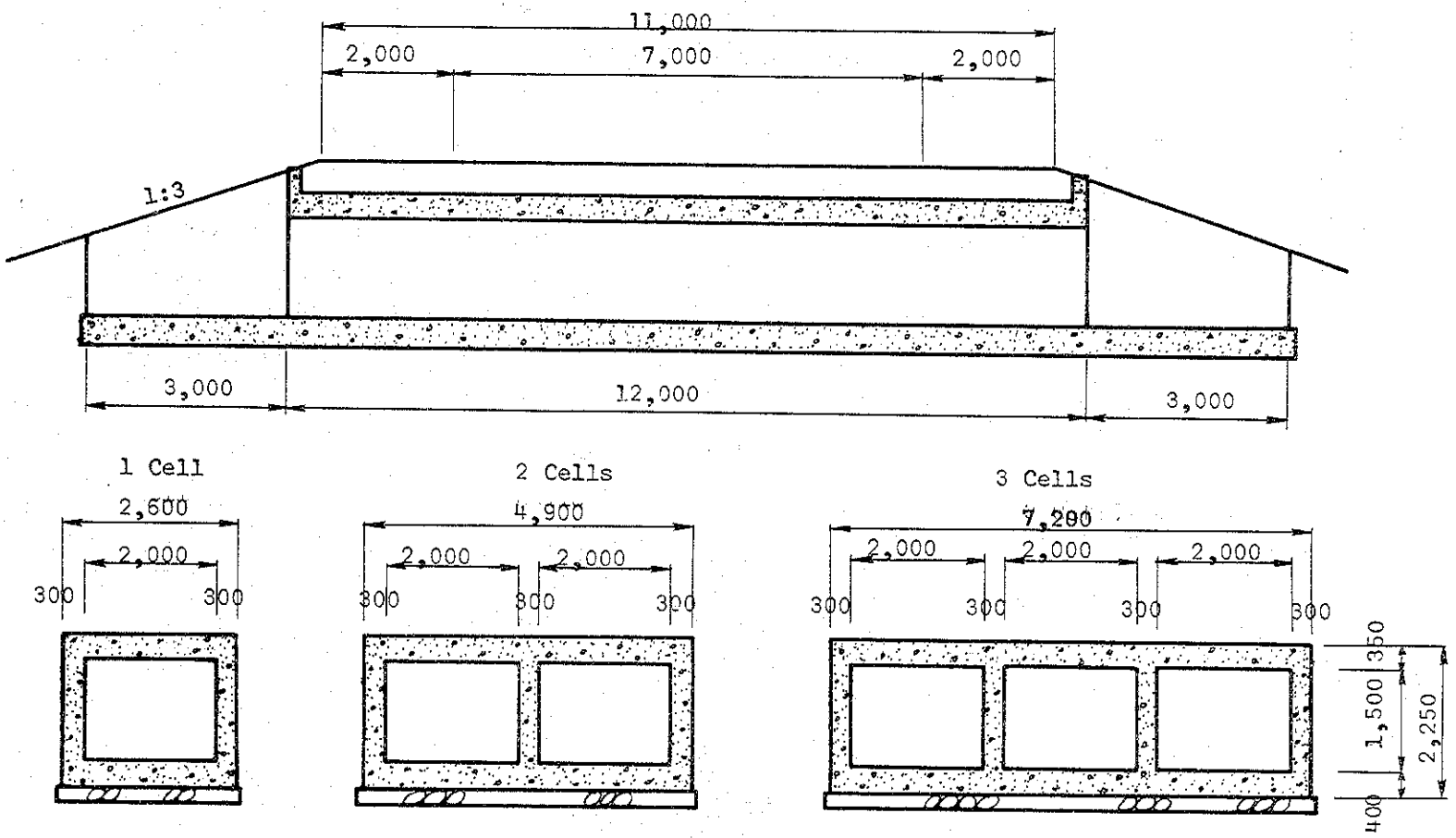
TYPICAL CROSS SECTION S = 1 : 50



Note :

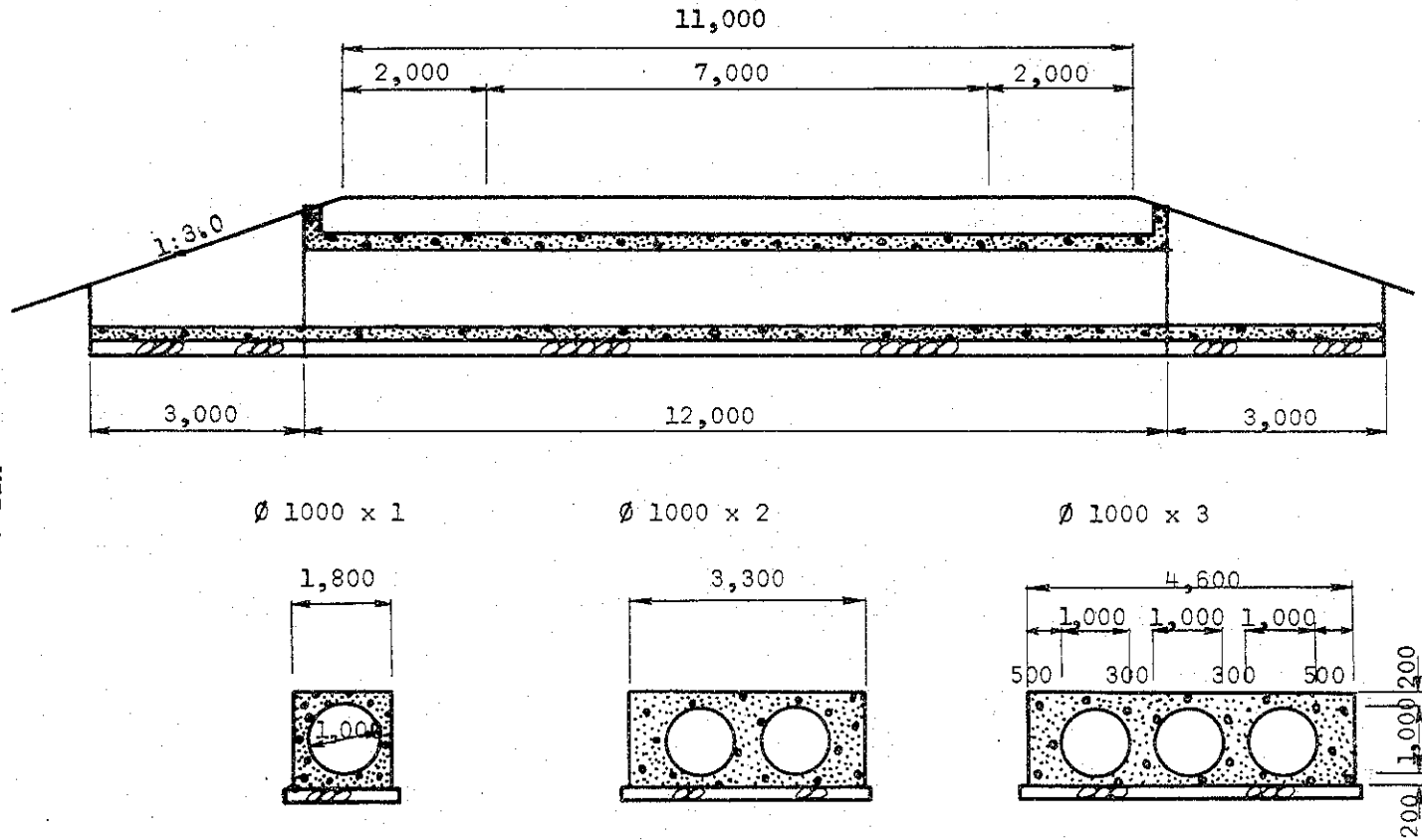
1. TYPE 1 ; L = 7.0 M (1 span)
2. TYPE 2 ; L = 9.0 M (1 span)
3. TYPE 3 ; L = 7.0 M X 2 (2 spans)
4. TYPE 4 ; L = 9.0 M X 2 (2 spans)
5. TYPE 5 ; L = 9.0 M X 3 (3 spans)

FIG. 7-5 TYPE OF BOX CULVERT



Note: Reinforced Concrete

FIG. 7-6 TYPE OF PIPE CULVERT



Note : Refer to Drawings.

TABLE 7-4 BRIDGE STATION, BRIDGE LENGTH AND ESTIMATED DISCHARGE

No.	Route	Station	Discharge	Bridge Length
1	A	6k + 430km	27.7 t/sec	L=9.0m
2	A	12 + 440	33.0	L=9.0
3	A	12 + 730	29.3	L=9.0
4	A	21 + 550	83.6	L=27.0 (9.0x3span)
5	A	22 + 950	78.5	L=27.0 (9.0x3span)
6	A	27 + 120	32.6	L=9.0
7	A	30 + 600	47.2	L=14.0 (7.0x2span)
8	A	45 + 300	30.3	L=9.0
9	A	51 + 900	39.5	L=14.0 (7.0x2span)
10	A	55 + 900	51.6	L=18.0 (9.0x2span)
11	B	13 + 400	67.7	L=27.0 (9.0x3span)
12	B	14 + 300	23.9	L=7.0
13	B	17 + 200	22.9	L=7.0
14	B	20 + 700	76.4	L=27.0 (9.0x3span)
15	B	23 + 900	42.2	L=14.0 (7.0x2span)
16	B	27 + 800	119.4	L=27.0 (9.0x3span)
17	B	28 + 700	22.9	L=7.0
18	B	29 + 550	43.2	L=14.0 (7.0x2span)
19	B	35 + 750	37.1	L=14.0 (7.0x2span)
20	B	36 + 000	53.8	L=18.0 (9.0x2span)
21	B	50 + 600	18.0	L=7.0
22	F	4 + 640	38.6	L=14.0 (7.0x2span)
23	F	7 + 750	56.6	L=14.0 (7.0x2span)
24	F	10 + 000	41.1	L=14.0 (7.0x2span)
25	C	15 + 500	21.8	L=7.0
26	C	18 + 450	17.6	L=7.0
27	C	18 + 900	19.6	L=7.0
28	D	12 + 900	21.8	L=7.0
29	D	15 + 900	17.6	L=7.0
30	D	17 + 700	19.6	L=7.0

TABLE 7-5-1 COMPARISON OF CONSTRUCTION COST: FLAT SLAB BRIDGE, BEAM AND SLAB BRIDGE AND T-BEAM BRIDGE

L = 7.0 m
(LS in Economic Cost)

Item	Flat Slab Bridge	Beam and Slab Bridge	T-Beam Bridge
Precast Beam	-	3,009	-
Concrete A	1,287	-	885
Concrete B	-	175	-
Reinforcement	1,505	125	1,329
Form Work	312	25	678
Scaffolding	360	-	490
Asphalt Pavement	123	123	123
SUBSTRUCTURE	5,602	5,602	5,602
Total	9,189	9,059	9,107

TABLE 7-5-2 COMPARISON OF CONSTRUCTION COST: REINFORCED CONCRETE PIER, BRICK FRAMED PIER AND STONE FRAMED PIER

(LS in Economic Cost)

Item	Reinforced Concrete	Brick	Stone
Concrete B	1,308	-	-
Concrete C	-	1,705	1,916
Reinforcement	401	-	-
Form Work 1)	210	-	-
Scaffolding	288	684	522
Brick Work	-	825	-
Stone Work	-	-	89
FOUNDATION	85	85	85
Total	2,292	3,299	2,612

Note: 1) Form work is composed of using steel pannels. A steel pannel is w 300 m/m x L 1800 m/m with 16.9 kg per sheet.

Breakdown of Price

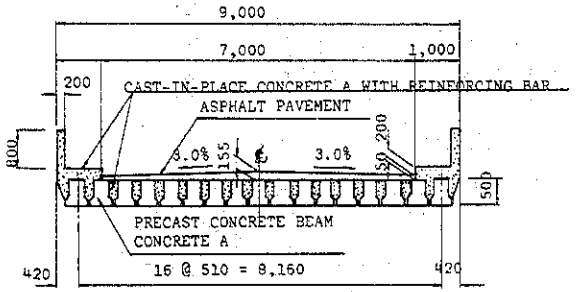
(in LS per m^2)

Steel Form 1.9 sheets/m^2	Foreign Component 5.01	Local Component 3.37	Tax Component 3.02	Total 11.04
6 times for use	0.84	0.56	0.50	1.90
maintenance 15%	0.13	0.08	0.08	0.29
per m^2	0.97	0.64	0.58	2.19

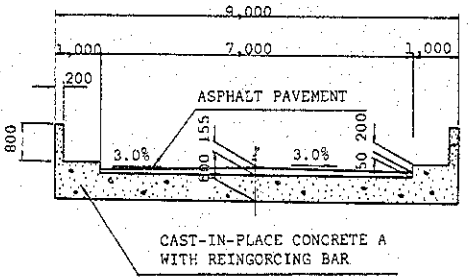
Economic 1.61

FIG. 7-7 COMPARISON OF SUPERSTRUCTURE (Span Length = 7.0 m)

BEAM AND SLAB BRIDGE



FLAT SLAB BRIDGE



T-BEAM BRIDGE

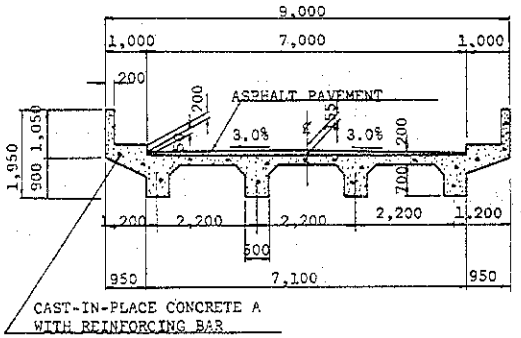
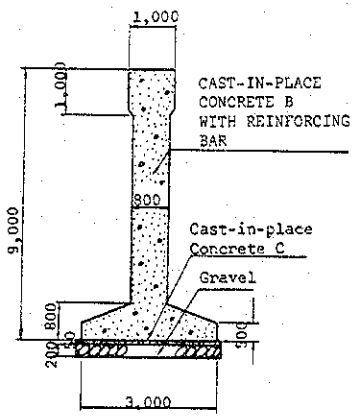
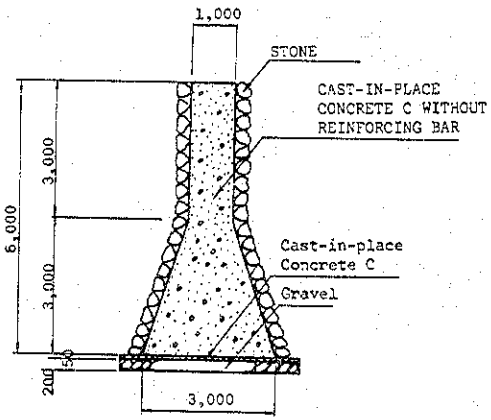


FIG. 7-8 COMPARISON OF SUBSTRUCTURE (PIER) WIDTH = 9.0 m

REINFORCED CONCRETE



STONE FRAMED



BRICK FRAMED

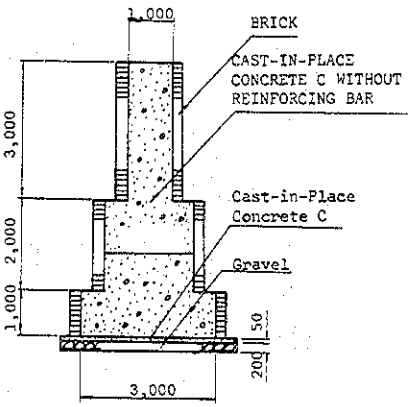


TABLE 7-6 COMPARISON OF CONSTRUCTION COST BETWEEN CORRUGATED METAL PIPE AND REINFORCED CONCRETE PIPE

(Per Place)

Item	Corrugated Metal Pipe ϕ 1000 x 1 (L=20) (LS)	Reinforced Concrete Pipe ϕ 1000 x 1 (L=12.0) (LS)
Pipe	687.6	432.3
Excavation	18.4	5.4
Sand Base	21.3	-
Placing	183.0	-
Covering	212.3	-
Masonry	84.6	-
Concrete B	-	520.3
Form Work	-	67
Reinforcing Bar	-	155
Gravel	-	17.8
Total in Economic Cost	1,207.2	1,198.3

ANNEX Ⅶ－１３ 取得価格

１３.１ 機械設備

機械設備の価格は，供給業者から聴取した。ANNEX Ⅶ－１２は，機械の取得価格と，日率より価格のあるパーセンテージでコストを示しており,一例として,CATERPILLER社のＤ７Ｇの取得価格に基づく詳細を示している。

１３.２ 労　　賃

労賃は，スーダンのRBPCならびにEl Obeid市において，工事担当者から示された数字をもとに，以下のごとく評価されている。

地　　位	時 間 給	日　給（LS）
未熟練工	0.１２	0.９６
熟　練　工	0.２０	1.６０
運　転　者	0.２５	2.００
大　　工	0.２５	2.００
石　　工	0.２５	2.００
機　械　工	0.２５	2.００
職　　長	0.３０	2.４０

１３.３ その他材料

i) 燃料および油脂類

燃料および油脂類の価格は，表７－７に示されている。

TABLE 7-7 BREAKDOWN OF FUEL AND OIL PRICES
(in El Obeid)

(LS/gal)

	Total	Tax	FC[1)]	LC
Fuel				
Benzine (Gasoline)	0.460	0.220	0.10	0.140
Gasoline (Diesel)	0.368	0.056	0.10	0.212
Oil				
Super	2.370	0.311	1.553	0.506
Diesel	1.900	0.293	1.209	0.398

Source: Shell Oil Company, Khartoum

Note: 1) Barrel of crude oil : $10.75
7.37 Barrel = 1 ton of crude oil

ii) セメント

スーダンには，セメント工場が２ケ所 Atbara と Kosti にあり，それぞれ一日最大生産量は，７５０トン，４００トンの能力を持っている。

工場渡し価格は，トン当り２５ＬＳである。

本プロジェクトでは，諸種の単価を計算する上で，使用したセメントの価格はスーダン国内産のものを用いた。このことは，Kosti 工場がやがて増産されると考えたからである。

iii）その他の材料

TABLE 7-8 THE COST OF OTHER MATERIALS

(LS)

Item	Unit	CIF Price Port Sudan	Transport Local Cost	Taxes	Total
Bitumen	T	72.22	11.70	33.58	117.50
Cement	T		40.10	1.65	41.75
Reinforcing Bar	T		243.0	61.0	304.0
Structural Steel	T	156.0	105.0	94.0	355.0
Explosives	kg	0.98	0.15	0.39	1.52
Timber	m^3		150.0	10.0	160.0
Filler	T		18.10	0.55	18.65

ANNEX Ⅶ－１４　単　　価

１４.１　一位代価

一位代価算出に当っては，次によった。

A) Peurifoy R.L "Construction Planning, Equipment and Methods" 1970

B) El Ain 貯水池および El Obeid 空港の工事現場の視察

１４.２　所 得 税

スーダンの所得税は Annex Ⅵ の表６－２０－１０に示される。

１４.３　機械経費

機械設備の取得価格は Annex Ⅷ－１２に示すように Port Sudan のＣＩＦ価格に基づいている。一位代価は機械使用料と運転経費に分けて算出した。機械設備耐用年数と修繕係数は次の表７－９に示す。

なお，修繕係数は当初の取得価格に対する全修繕費の最大パーセンテージ数である。主要機械所要台数は Annex Ⅷ－１１に示す。

１４.４　諸経費と利潤

諸経費と利潤は Annex Ⅶ－１５の表７－１０－１～７に示すように，約４０％を見込んだ。このパーセントは第Ⅷ章で３３％に変更される。

TABLE 7-9 DURABILITY AND REPAIR COEFFICIENT OF MECHANICAL EQUIPMENT

Mechanical Equipment	Economic Year	Durability Hours	Repair Coefficient
Air Compressor	7	6,000	0.75
Asphalt Distributor	8	10,000	0.75
Bull-dozer	8	10,000	0.75
Concrete Mixer	8	8,000	0.75
Concrete Vibrator	4	4,000	0.8
Crawler Drill	5	6,000	0.75
Crushing Plant	12	18,000	0.75
Excavator	8	8,000	0.75
Generator	8	8,000	0.75
Line Painting Unit	4	4,000	0.8
Motor Grader	8	10,000	0.75
Motor Scraper	8	10,000	0.75
Macadam Roller	10	10,000	0.75
Tired Roller	6	8,000	0.75
Soil Compacter	10	10,000	0.6
Tractor Shovel	8	10,000	0.75
Dump Truck	5	10,000	0.75
Flat Body Truck	7	4,000	0.3
Water Tanker	8	10,000	0.75
Fuel Car	8	10,000	0.75
Vibration Roller	5	8,000	0.8
Wheel Loader	8	10,000	0.75
Pump	6	6,000	1.0
Asphalt Plant	10	12,000	0.72
Asphalt Finisher	8	10,000	0.75

TABLE 7-10-1 PRICED BILL OF QUANTITY: ROUTE A

Item			Construction Section 1	2	3	4	Total
Earth Work	Clearing	Quantity (M^2)	1,020,370	1,013,790	905,940		2,952,100
		Rate	0.040	0.040	0.040		0.040
		Summation	41,300	41,000	36,700		119,000
	Filling	Quantity (M^3)	140,836	93,840	70,763		305,439
		Rate	0.637	0.637	0.637		0.637
		Summation	89,900	59,800	45,000		194,700
	Cutting (I)	Quantity (M^3)	336,668	351,630	314,223		1,002,521
		Rate	0.110	0.110	0.110		0.108
		Summation	37,100	38,800	34,700		110,600
	Cutting (II)	Quantity (M^3)	49,546	-	-		49,546
		Rate	0.715	-	-		0.715
		Summation	35,200	-	-		35,200
	Slope Protection	Quantity (M^2)	115,252	95,128	85,007		295,387
		Rate	0.360	0.360	0.360		0.360
		Summation	41,600	34,300	30,600		106,500
	Sub Total		245,100	173,900	147,000		566,000
Pavement Work	Surface	Quantity (M^2)	164,533	164,533	147,000		476,066
		Rate	0.796	0.796	0.829		
		Summation	131,000	131,000	122,000		384,000
	Base	Quantity (M^3)	28,200	28,200	25,200		81,600
		Rate	2.765	2.765	3.496		
		Summation	78,000	78,000	88,100		244,100
	Subbase	Quantity (M^3)	58,703	58,703	52,457		169,863
		Rate	2.623	2.623	3.353		
		Summation	154,000	154,000	175,900		483,900
	Shoulder	Quantity (M^3)	12,361	12,361	11,046		35,768
		Rate	1.905	1.905	1.905		1.905
		Summation	23,600	23,600	21,100		68,300
	Subgrade	Quantity (M^3)	37,673	41,664	44,330		123,667
		Rate	1.278	1.278	1.278		1.278
		Summation	48,200	53,200	56,600		158,000
	Sub Total		434,800	439,800	463,700		1,338,300
Bridge Work	L = 7.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M (1 span)	Quantity (P)	3	2	-		5
		Rate	10,433	10,400	-		
		Summation	31,300	20,800	-		52,100
	L = 7.0M x 2 (2 span)	Quantity (P)	-	1	1		2
		Rate	-	14,800	14,800		14,800
		Summation	-	14,800	14,800		29,600
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-	1		1
		Rate	-	-	18,200		18,200
		Summation	-	-	18,200		18,200
	L = 9.0M x 3 (3 span)	Quantity (P)	2	-	-		2
		Rate	26,350	-	-		26,350
		Summation	52,700	-	-		52,700
	Sub Total		84,000	35,600	33,000		152,600

TABLE 7-10-1 PRICED BILL OF QUANTITY: ROUTE A

Item			Construction Section 1	2	3	4	Total
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	-	-	1.0		1.0
		Rate	-	-	2,900		2,900
		Summation	-	-	2,900		2,900
	2.0 x 1.5 (2 Cells)	Quantity (P)	4.0	2.0	1.0		7.0
		Rate	4,725	4,725	4,600		
		Summation	18,900	9,300	4,600		32,800
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	2.0	-		2.0
		Rate	-	6,200	-		6,200
		Summation	-	12,400	-		12,400
	Sub Total		18,900	21,700	7,500		48,100
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	2	2	2		6
		Rate	1,100	1,100	1,100		1,100
		Summation	2,200	2,200	2,200		6,600
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	1	-	-		1
		Rate	1,900	-	-		1,900
		Summation	1,900	-	-		1,900
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	-	2	2		4
		Rate	-	2,700	2,700		2,700
		Summation	-	5,400	5,400		10,800
	Side Ditch	Quantity (M^3)	400	-	-		400
		Rate	22.25	-	-		22.25
		Summation	8,900	-	-		8,900
	Side Pipe Culvert	Quantity (M)	117	118	105		340
		Rate	22.94	22.94	22.94		22.94
		Summation	2,700	2,700	2,400		7,800
	Sub Total		15,700	10,300	10,000		36,000
Masonry Work	Stone Masonry	Quantity (M^3)	561	-	-		561
		Rate	22.28	-	-		22.28
		Summation	12,500	-	-		12,500
	Sub Total		12,500	-	-		12,500
Total			811,000	681,300	661,200		2,153,500
Overhead and Profit							1,089,500
Economic Cost							3,243,000

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

TABLE 7-10-2 PRICED BILL OF QUANTITY: ROUTE B

Item			Construction Section 1	2	3	4	Total
Earth Work	Clearing	Quantity (M^2)	1,121,640	905,940	1,058,640		3,086,220
		Rate	0.040	0.040	0.040		
		Summation	45,300	36,700	42,800		124,800
	Filling	Quantity (M^3)	104,008	76,759	120,383		301,150
		Rate	0.637	0.637	0.637		
		Summation	66,400	48,900	76,700		192,000
	Cutting (I)	Quantity (M^3)	389,038	314,223	389,038		1,092,299
		Rate	0.110	0.110	0.110		
		Summation	42,900	34,700	42,900		120,500
	Cutting (II)	Quantity (M^3)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Slope Protection	Quantity (M^2)	105,248	85,008	38,720		228,975
		Rate	0.360	0.360	0.360		
		Summation	38,000	30,600	13,900		82,500
	Sub Total		192,600	150,900	176,300		519,800
Pavement Work	Surface	Quantity (M^2)	182,000	147,000	182,000		511,000
		Rate	0.795	0.795	0.856		
		Summation	144,700	117,000	151,000		412,700
	Base	Quantity (M^3)	31,200	25,000	31,200		87,400
		Rate	2.772	2.772	3.500		
		Summation	86,500	69,200	109,200		204,900
	Subbase	Quantity (M^3)	64,948	52,458	64,948		182,354
		Rate	2.623	2.623	3.553		
		Summation	170,600	137,600	217,900		526,100
	Shoulder	Quantity (M^3)	13,676	11,046	13,676		38,398
		Rate	1.905	1.905	1.905		
		Summation	26,300	21,100	26,300		73,700
	Subgrade	Quantity (M^3)	45,913	44,331	36,192		126,436
		Rate	1.278	1.278	1.278		
		Summation	58,700	56,600	46,200		161,500
	Sub Total		486,800	401,500	550,600		1,438,900
Bridge Work	L = 7.0M (1 span)	Quantity (P)	2	1	1		4
		Rate	8,800	8,800	8,800		8,800
		Summation	17,600	8,800	8,800		35,200
	L = 9.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 7.0M x 2 (2 span)	Quantity (P)	-	3	-		3
		Rate	-	15,000	-		15,000
		Summation	-	45,000	-		45,000
	L = 9.0M x 2 (2 span)	Quantity (P)	-	1	1		2
		Rate	-	18,200	18,200		
		Summation	-	18,200	18,200		36,400
	L = 9.0M x 3 (3 span)	Quantity (P)	2	1	-		3
		Rate	26,350	26,600	-		
		Summation	52,700	26,600	-		79,300
	Sub Total		70,300	98,600	27,000		195,900

TABLE 7-10-2 PRICED BILL OF QUANTITY: ROUTE B

Item			Construction Section				Total
			1	2	3	4	
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	1	-	1		2
		Rate	2,900	-	2,900		2,900
		Summation	2,900	-	2,900		5,800
	2.0 x 1.5 (2 Cells)	Quantity (P)	5	4	1		10
		Rate	4,725	4,725	4,600		6,633
		Summation	23,700	18,900	4,600		47,200
	2.0 x 1.5 (3 Cells)	Quantity (P)	3	-	1		4
		Rate	4,740	-	4,740		4,740
		Summation	18,800	-	4,740		23,540
	Sub Total		45,400	18,900	12,240		76,540
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	2	2	4		8
		Rate	1,100	1,100	1,100		1,100
		Summation	2,200	2,200	4,400		8,800
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	-	-	2		2
		Rate	-	-	2,700		2,700
		Summation	-	-	5,400		5,400
	Side Ditch	Quantity (M^3)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Side Pipe Culvert	Quantity (M)	130	105	130		365
		Rate	22.30	22.30	22.30		22.30
		Summation	2,900	2,400	2,900		8,200
	Sub Total		5,100	4,600	12,700		22,400
Masonry Work	Stone Masonry	Quantity (M3)	1,148	-	-		1,148
		Rate	22.28	-	-		22.28
		Summation	25,700	-	-		25,700
	Sub Total		25,700	-	-		25,700
Total			825,900	674,500	778,840		2,279,240
Overhead and Profit							1,154,300
Economic Cost							3,433,540

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

TABLE 7-10-3 PRICED BILL OF QUANTITY: ROUTE C

Item			Construction Section 1	2	3	4	Total
Earth Work	Clearing	Quantity (M^2)	1,025,931	1,198,259	983,592		3,207,782
		Rate	0.040	0.040	0.040		0.040
		Summation	41,500	48,300	39,800		129,600
	Filling	Quantity (M^3)	254,570	256,966	24,456		535,992
		Rate	0.637	0.637	0.637		
		Summation	162,700	164,100	15,400		342,200
	Cutting (I)	Quantity (M^3)	314,972	389,038	341,156		945,166
		Rate	0.110	0.110	0.110		
		Summation	34,700	42,900	37,700		115,300
	Cutting (II)	Quantity (M^3)	70,200	-	-		70,200
		Rate	0.710	-	-		0.710
		Summation	50,100	-	-		50,100
	Slope Protection	Quantity (M^2)	228,459	186,005	92,295		506,759
		Rate	0.362	0.451	0.451		
		Summation	82,700	84,000	41,600		208,300
	Sub Total		371,700	339,300	134,500		845,500
Pavement Work	Surface	Quantity (M^2)	161,000	182,000	159,633		502,633
		Rate	0.831	0.898	0.898		
		Summation	133,800	163,500	143,400		440,700
	Base	Quantity (M^3)	27,600	31,200	27,360		86,160
		Rate	3.496	4,387	4.959		
		Summation	96,500	136,900	135,700		369,100
	Subbase	Quantity (M^3)	57,454	64,948	56,954		179,356
		Rate	3.353	4.261	4.814		
		Summation	192,800	276,800	274,200		743,800
	Shoulder	Quantity (M^3)	12,098	13,676	11,993		37,767
		Rate	1.905	2.339	2.643		
		Summation	23,300	32,000	31,700		87,000
	Subgrade	Quantity (M^3)	80,566	94,627	107,013		282,206
		Rate	1.278	1.278	1.278		
		Summation	103,200	103,200	137,300		343,700
	Sub Total		549,600	712,400	722,300		1,984,300
Bridge Work	L = 7.0M (1 span)	Quantity (P)	2	-	-		3
		Rate	8,800	-	-		8,800
		Summation	26,400	-	-		26,400
	L = 9.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 7.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 3 (3 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		26,400	-	-		26,400

TABLE 7-10-3 PRICED BILL OF QUANTITY: ROUTE C

Item			Construction Section 1	2	3	4	Total
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	2	4	4		10
		Rate	2,900	2,975	2,225		
		Summation	5,800	11,900	8,900		26,600
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		5,800	11,900	8,900		26,600
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	6	6	6		18
		Rate	1,133	1,133	1,133		1,133
		Summation	6,800	6,800	6,800		20,400
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	6	13	5		24
		Rate	2,000	2,000	2,000		2,000
		Summation	12,000	26,300	10,000		48,300
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	4	-	5		9
		Rate	2,775	-	2,775		4,240
		Summation	11,100	-	13,900		25,000
	Side Ditch	Quantity (M^3)	780	-	-		780
		Rate	22.25	-	-		22.25
		Summation	17,400	-	-		17,400
	Side Pipe Culvert	Quantity (M)	115	130	114		359
		Rate	22.94	22.30	22.94		
		Summation	2,500	2,900	2,500		7,900
	Sub Total		49,800	360,00	33,200		119,000
Masonry Work	Stone Masonry	Quantity (M3)	1,972	2,337	-		4,309
		Rate	22.28	22.28	-		58.75
		Summation	44,200	52,500	-		96,700
	Sub Total		44,200	52,500	-		96,700
Total			1,047,500	1,152,100	898,900		3,098,500
Overhead and Profit							1,570,100
Economic Cost							4,668,600

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

TABLE 7-10-4 PRICED BILL OF QUANTITY: ROUTE D

Item			Construction Section 1	2	3	4	Total
Earth Work	Clearing	Quantity (M^2)	836,828	1,023,804	919,285		2,779,911
		Rate	0.040	0.040	0.040		
		Summation	33,800	41,400	37,100		112,300
	Filling	Quantity (M^3)	104,841	85,827	78,299		268,967
		Rate	0.637	0.637	0.637		
		Summation	66,900	54,700	49,800		171,400
	Cutting (I)	Quantity (M^3)	237,913	296,567	305,096		839,576
		Rate	0.110	0.110	0.110		
		Summation	26,200	32,600	33,700		92,500
	Cutting (II)	Quantity (M^3)	286,464	301,004	71,466		658,934
		Rate	0.715	0.715	0.715		
		Summation	204,800	215,300	50,900		471,000
	Slope Protection	Quantity (M^2)	99,625	107,167	88,830		295,627
		Rate	0.362	0.451	0.451		
		Summation	36,000	48,300	40,200		124,500
	Sub Total		367,700	392,300	211,700		971,700
Pavement Work	Surface	Quantity (M^2)	140,033	17,500	15,200		466,233
		Rate	0.831	0.898	0.898		
		Summation	115,900	157,300	135,900		409,100
	Base	Quantity (M^3)	24,000	30,038	25,920		79,958
		Rate	3.491	4.957	4.957		
		Summation	83,800	148,900	128,500		361,200
	Subbase	Quantity (M^3)	49,959	62,451	53,956		166,366
		Rate	3.352	4.816	4.816		
		Summation	167,500	300,800	259,800		728,100
	Shoulder	Quantity (M^3)	10,519	13,150	11,361		35,030
		Rate	1.929	2.643	2.643		
		Summation	20,300	34,800	30,000		85,100
	Subgrade	Quantity (M^3)	27,840	36,366	40,958		105,164
		Rate	1.278	1.278	1.278		
		Summation	35,500	46,400	52,300		134,200
	Sub Total		423,000	688,200	606,500		1,717,700
Bridge Work	L = 7.0M (1 span)	Quantity (P)	3	-	-		3
		Rate	8,800	-	-		
		Summation	26,400	-	-		26,400
	L = 9.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 7.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 3 (3 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		26,400	-	-		26,400

TABLE 7-10-4 PRICED BILL OF QUANTITY: ROUTE D

Item			Construction Section				Total
			1	2	3	4	
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	-	8	2		10
		Rate	-	3,000	2,900		
		Summation	-	24,000	5,800		5,800
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		-	24,000	5,800		29,800
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	4	4	9		17
		Rate	1,100	1,100	1,100		
		Summation	4,400	4,400	10,100		18,900
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	3	3	-		6
		Rate	1,966	1,966	-		3,033
		Summation	5,900	5,900	-		11,800
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	1	2	-		3
		Rate	2,600	2,700	-		
		Summation	2,600	5,400	-		8,000
	Side Ditch	Quantity (M^3)	1,640	2,072	484		4,196
		Rate	22.25	22.25	22.25		
		Summation	36,800	46,500	10,800		94,100
	Side Pipe Culvert	Quantity (M)	100	125	108		333
		Rate	22.94	22.30	22.30		35.90
		Summation	2,300	2,800	2,400		7,500
	Sub Total		52,000	65,000	23,300		140,300
Masonry Work	Stone Masonry	Quantity (M3)	146	-	-		146
		Rate	21.91	-	-		22.28
		Summation	3,200	-	-		3,200
	Sub Total		3,200	-	-		3,200
Total			872,300	1,169,500	847,300		2,889,100
Overhead and Profit							1,463,200
Economic Cost							4,352,300

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II)is road excavation.

TABLE 7-10-5 PRICED BILL OF QUANTITY: ROUTE E

Item			Construction Section				Total
			1	2	3	4	
Earth Work	Clearing	Quantity (M^2)	1,283,320	589,454	892,108		2,443,844
		Rate	0.040	0.040	0.040		
		Summation	52,000	23,700	36,000		111,700
	Filling	Quantity (M^3)	81,225	31,986	68,237		181,448
		Rate	0.637	0.637	0.637		
		Summation	51,700	20,200	43,500		115,400
	Cutting (I)	Quantity (M^3)	343,173	145,142	233,423		721,665
		Rate	0.110	0.110	0.110		
		Summation	37,900	15,800	25,700		79,400
	Cutting (II)	Quantity (M^3)	773,130	553,091	395,778		1,722,179
		Rate	0.751	0.715	0.715		
		Summation	553,500	395,900	283,200		1,232,600
	Slope Protection	Quantity (M^2)	134,784	61,625	97,989		322,907
		Rate	0.362	0.362	0.362		
		Summation	48,700	27,700	44,300		120,700
	Sub Total		743,800	483,300	432,700		1,659,800
Pavement Work	Surface	Quantity (M^2)	217,033	98,033	156,133		471,199
		Rate	0.838	0.895	0.895		
		Summation	180,300	87,800	140,200		408,300
	Base	Quantity (M^3)	37,200	16,800	26,760		80,760
		Rate	3.500	4.952	4.952		
		Summation	130,200	83,200	132,700		346,100
	Subbase	Quantity (M^3)	77,675	34,972	55,706		168,354
		Rate	3.354	4.816	4.816		
		Summation	260,600	168,400	268,300		697,300
	Shoulder	Quantity (M^3)	16,307	7,364	11,730		35,401
		Rate	1,920	2,643	2,643		
		Summation	31,300	19,500	31,000		81,800
	Subgrade	Quantity (M^3)	65,057	29,934	31,042		126,033
		Rate	1.278	1.278	1.278		
		Summation	83,300	38,100	39,600		161,000
	Sub Total		685,700	397,000	611,800		1,694,500
Bridge Work	L = 7.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M (1 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 7.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	L = 9.0M x 3 (3 span)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		-	-	-		-

TABLE 7-10-5 PRICED BILL OF QUANTITY: ROUTE E

Item			Construction Section 1	2	3	4	Total
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	8	1	2		11
		Rate	3,000	2,900	2,900		
		Summation	24,000	2,900	5,800		32,700
	2.0 x 1.5 (2 Cells)	Quantity (P)	3	4	1		8
		Rate	4,733	4,725	4,600		
		Summation	14,200	18,900	4,600		37,700
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		38,200	21,800	10,400		70,400
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	4	1	6		11
		Rate	1,100	1,100	1,132		
		Summation	4,400	1,100	6,800		12,300
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Side Ditch	Quantity (M^3)	3,156	1,720	2,680		7,556
		Rate	22.50	22.50	22.50		
		Summation	70,900	38,500	60,200		169,600
	Side Pipe Culvert	Quantity (M)	155	70	111		336
		Rate	22.59	21.42	22.59		
		Summation	3,500	1,500	2,500		7,500
	Sub Total		78,800	41,100	69,500		189,400
Masonry Work	Stone Masonry	Quantity (M3)	-	-	-		-
		Rate	-	-	-		-
		Summation	-	-	-		-
	Sub Total		-	-	-		
Total			1,546,500	943,200	1,124,400		3,614,100
Overhead and Profit							1,811,200
Economic Cost							5,425,300

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

TABLE 7-10-6 PRICED BILL OF QUANTITY: ROUTE F

Item			Construction Section				Total
			1	2	3	4	
Earth Work	Clearing	Quantity (M^2)	1,601,741	965,596	457,145	1,796,279	4,820,761
		Rate	0.040	0.040	0.040	0.040	
		Summation	64,900	38,900	18,400	72,700	194,900
	Filling	Quantity (M^3)	202,799	79,337	24,495	144,812	451,443
		Rate	0.637	0.637	0.637	0.637	0.637
		Summation	129,400	50,600	15,500	92,400	287,900
	Cutting (I)	Quantity (M^3)	493,030	219,957	93,793	450,088	1,246,867
		Rate	0.110	0.110	0.110	0.110	
		Summation	54,400	24,200	9,000	49,800	137,400
	Cutting (II)	Quantity (M^3)	213,961	648,808	607,832	1,282,760	2,753,361
		Rate	0.715	0.715	0.715	0.715	
		Summation	152.900	464,300	434,900	918,300	1,970,400
	Slope Protection	Quantity (M^2)	296,121	109,686	52,361	198,598	656,766
		Rate	0.362	0.362	0.451	0.451	
		Summation	107,400	39,600	23,500	89,800	260,300
	Sub Total		509,000	617,600	501,300	1,223,000	2,850,900
Pavement Work	Surface	Quantity (M^2)	239,066	170,500	79,200	305,200	793,966
		Rate	0.838	0.838	0.925	0.925	
		Summation	200,700	142,800	72,500	282,600	698,600
	Base	Quantity (M^3)	40,980	29,220	13,572	52,358	136,130
		Rate	4.963	4.963	6.882	6.882	
		Summation	203,400	145,000	93,400	360,700	802,500
	Subbase	Quantity (M^3)	85,307	60,828	28,252	10,888	330,764
		Rate	4.816	4.816	6.272	6.272	
		Summation	411,000	292,900	177,200	68,200	949,300
	Shoulder	Quantity (M^3)	17,963	12,809	5,950	22,927	59,649
		Rate	1.920	1.920	2.643	2.643	
		Summation	34,500	24,600	15,700	61,000	135,800
	Subgrade	Quantity (M^3)	67,238	39,844	15,743	65,025	187,851
		Rate	1.278	1.278	1.278	1.278	
		Summation	86,100	50,900	20,000	83,300	240,300
	Sub Total		935,700	656,200	378,800	855,800	2,826,500
Bridge Work	L = 7.0M (1 span)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
	L = 9.0M (1 span)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
	L = 7.0M x 2 (2 span)	Quantity (P)	3	-	-	-	3
		Rate	14,800	-	-	-	14,800
		Summation	44,400	-	-	-	44,400
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
	L = 9.0M x 3 (3 span)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
	Sub Total		44,400	-	-	-	44,400

TABLE 7-10-6 PRICED BILL OF QUANTITY: ROUTE F

Item			Construction Section				Total
			1	2	3	4	
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	15	7	4	12	38
		Rate	3,000	3,000	2,975	3,000	
		Summation	45,000	21,000	11,900	36,000	113,900
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	1	-	1	2
		Rate	-	4,600	-	4,600	
		Summation	-	4,600	-	4,600	9,200
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
	Sub Total		45,000	25,600	11,900	40,600	123,100
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	-	3	1	6	10
		Rate	-	1,100	1,100	1,133	
		Summation	-	3,300	1,100	6,800	11,200
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	-	-	-	1	1
		Rate	-	-	-	1,900	1,900
		Summation	-	-	-	1,900	1,900
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	2	-	-	-	2
		Rate	2,700	-	-	-	2,700
		Summation	5,400	-	-	-	5,400
	Side Ditch	Quantity (M^3)	1,000	3,860	2,284	5,404	12,428
		Rate	22.50	22.50	22.50	22.50	
		Summation	22,500	86,600	51,300	121,500	281,900
	Side Pipe Culvert	Quantity (M)	177	122	56	218	573
		Rate	22.59	22.95	21.42	22.95	
		Summation	4,000	2,800	1,200	5,000	13,000
	Sub Total		31,900	92,700	53,600	135,200	313,400
Masonry Work	Stone Masonry	Quantity (M3)	761	250	-	220	1,231
		Rate	22.59	22.00	-	22.00	
		Summation	17,000	5,500	-	4,800	27,300
	Sub Total		17,000	5,500	-	4,800	
Total			1,583,000	1,397,600	945,600	2,259,400	6,185,600
Overhead and Profit							3,058,000
Economic Cost							

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

TABLE 7-10-7 PRICED BILL OF QUANTITY: ROUTE ACCESS ROAD

Item			Construction Section 1	2	3	4	Total
Earth Work	Clearing	Quantity (M^2)	794,761	801,826			1,596,587
		Rate	0.040	0.040			0.040
		Summation	31,790	32,810			64,600
	Filling	Quantity (M^3)	188,817	166,092			354,909
		Rate	0.637	0.637			0.637
		Summation	120,276	106,624			226,900
	Cutting (I)	Quantity (M^3)	299,260	266,341			565,601
		Rate	0.110	0.110			0.110
		Summation	33,068	29,432			62,500
	Cutting (II)	Quantity (M^3)	-	217,989			217,989
		Rate	-	0.710			0.710
		Summation	-	155,800			155,800
	Slope Protection	Quantity (M^2)	48,000	87,360			135,360
		Rate	0.451	0.451			0.451
		Summation	21,666	39,434			61,100
	Sub Total		206,800	364,100			570,900
Pavement Work	Surface	Quantity (M^2)	73,000	64,970			137,970
		Rate	0.898	0.898			0.898
		Summation	65,344	58,156			123,500
	Base	Quantity (M^3)	12,080	12,563			24,643
		Rate	4.957	4.957			4.958
		Summation	59,902	62,298			122,200
	Subbase	Quantity (M^3)	18,201	18,928			37,129
		Rate	4.816	4.816			4.816
		Summation	89,649	91,151			178,800
	Shoulder	Quantity (M^3)	6,320	6,573			12,893
		Rate	2.652	2.652			2.652
		Summation	16,764	17,436			34,200
	Subgrade	Quantity (M^3)	11,403	10,400			21,803
		Rate	1.278	1.278			
		Summation	14,487	13,213			27,700
	Sub Total		244,146	242,254			486,400
Bridge Work	L = 7.0M (1 span)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	L = 9.0M (1 span)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	L = 7.0M x 2 (2 span)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	L = 9.0M x 2 (2 span)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	L = 9.0M x 3 (3 span)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	Sub Total		-	-			-

TABLE 7-10-7 PRICED BILL OF QUANTITY: ROUTE ACCESS ROAD

Item			Construction Section				Total
			1	2	3	4	
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	2	3			5
		Rate	2,980	2,980			2,980
		Summation	5,960	8,940			14,900
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	Sub Total		5,960	8,940			14,900
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	6	5			11
		Rate	1,145	1,145			1,145
		Summation	6,872	5,728			12,600
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	Pipe Calvert (ø1,000 x 3)	Quantity (P)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	Side Ditch	Quantity (M^3)	-	1,128			1,128
		Rate	-	22.30			22.30
		Summation	-	25,200			25,200
	Side Pipe Culvert	Quantity (M)	100	104			204
		Rate	23.00	23.00			23.00
		Summation	2,300	2,400			4,700
	Sub Total		9,172	33,328			42,500
Masonry Work	Stone Masonry	Quantity (M^3)	-	-			-
		Rate	-	-			-
		Summation	-	-			-
	Sub Total		-	-			-
Total			466,078	648,632			1,114,700
Overhead and Profit							551,000
Economic Cost							1,665,700

Notes: 1) (P) ..... Places

2) Cutting (I) is excavation of earth side ditch.

3) Cutting (II) is road excavation.

ANNEX Ⅶ－１６　維持修繕費

維持修繕費は，通常２つに区別して算定される。１つは，日常の維持修繕であり，もう一つは定期的修繕である。

１６.１　浸透式舗装

ⅰ）日常の維持修繕

浸透式（DBST）舗装のパッチング等の維持修繕は，破損個所を発見したら破損が拡大しないように直ちに行うことが必要である。

したがって常時作業要員と，機械類を計画配備することが大切である。維持修繕班の編成の一例を表７－１１－１に示す。毎年の維持修繕費は表７－１１－２に示す。

ⅱ）雑　工　事

側溝やカルバートの清掃とその他日常の雑工事は，調査に基づいて，次のように費用計算した。２人が１週間に１日働くとして，

$$\frac{\text{2名作業員}}{\text{7日（1週間）}} \times 260\text{日} \times 0.96\ \text{LS/日} = 71.3\ \text{LS（B）}$$

使用材料，器具その他　：　２５％加算（B×0.25）

エコノミックコスト　：　７０％　（B×0.25×0.70）

＝B（1＋0.25×0.70）＝71.3（1＋0.25×0.70）＝83.8 LS（C）

以上の工事費に，一般管理費として４０％加算する。従って浸透式舗装の年間維持修繕費を次のように示す。

パッチング費	雑工事費	管理費	合計 LS/km
A	C	（A＋C）×0.40	
36	83.8	47.9	168

ⅲ）定期的修繕

車道幅員７mの浸透式舗装の工事費は前出のとおり，3,612 LS/kmである。日平均交通量（ＡＤＴ）５００台以下という条件では７～８年に１回の定期的修繕を行えばよいであろう。

TABLE 7-11-1 A ROAD REPAIR TEAM AND REQUIRED EQUIPMENT

Classification	Quantity	Remarks
Labour		
Foreman	1	General supervision, Technical instruction
Driver for worker transport	1	
Truck driver	1	Material transportation
Roller driver	1	
Bitumen and aggregate spray worker	3	
Rake man	1	Raking and finishing work
Scavenger	1	Cleaning, removal of surplus soils
Guard and traffic man	2	
Machinery		
Labour transport car	1	Transportation of labour and equipment
Truck	1	Transportation of aggregate, bitumen. 4-ton dump-car
Sprayer	1	For tack coat
Roller	1	
Vibroplate	1	
Equipment		
Picks, shovels	1 lot	
Materials		
Aggregate	2 - 3 M^3	
Bitumen	300 L	

TABLE 7-11-2 UNIT COST OF ROAD MAINTENANCE ON BITUMINOUS SURFACED ROAD

		LS/M^2	Economic cost
1.	Prime Coat (or Tack Coat) 1.5 Kg/M^2 MC 70 1.5 x 0.087 (87 LS/T)	0.131	
2.	Aggregate 0.02 x 1.0 x 1.0 x 3.876	0.078	
3.	Spreading and Compaction	0.030	
4.	Bitumen Spreading 1.3 Kg/M^2 MC 70 1.3 x 0.087	0.113	
5.	3/8" Aggregate 0.01 x 1.0 x 1.0 x 3.876	0.039	
6.	Spreading and Compaction	0.020	
7.	Bitumen Spray 1.0 x 0.087	0.087	
8.	Sand Spray 0.005 x 2.335	0.012	
9.	Sub Total	0.510 x 0.84 = 0.428	
10.	Mobilization Cost (5% of 9)	0.025 x 0.95 = 0.024	
11.	Supervising and Engineering (14% of 9)	0.070 x 0.91 = 0.064	
12.	Total		0.516

13. Cost per Kilometer for 7-meter width pavement

= 7.0 x 1,000 x 0.516 = 3,612 LS/KM

14. Assuming annual cost is 1% of the above working cost for roads with less than 500 average daily traffic (ADT)

Annual cost: 3,612 x 0.01 = 36 LS/KM

16.2 その他の舗装

アスファルトコンクリート表層道路の年間維持費と修繕費は，浸透式舗装道路と同じように計算した。これらの費用は，表７－１１－３に示した。

定期的再表層工の積算は，エコノミックコストの項に示される。

ANNEX VII-16

TABLE 7-11-3 SUMMARY OF MAINTENANCE AND REPAIR COST

(LS/km)

ADT (Average Daily Traffic)	Annual Maintenance and Repair Costs	Periodic Resurfacing Costs
DBST W = 7.0 m		
< 500	168	3,612
ASPHALT CONCRETE W = 7.0 m		
>500	138	14,658

ANNEX VIII

TABLE 8-1 MINOR ALTERNATIVES

		Route						
		J. Kordofan Bypass		Rahad Bypass			Um Ruaba Bypass	
		Bypass A	Bypass B	Bypass C	Bypass D	Route E	Bypass F	Route G
Distance	Main (km)	14.2	14.8	13.7	14.2	16.3	6.85	6.56
	Access	-	-	2.66	1.53	-	1.04	-
Minimum Horizontal Alignment (m)		R=1,000	R=2,000	R=5,000	R=3,500	R=400	R=10,000	R=10,000
Maximum Gradient		i=2.60% L=1,350 m	i=0.85 L=2,800	i=2.466 L=650	i=2.76 L=450	i=2.76 L=450	i=0.59 L=800	i=0.975 L=400
Number of Structures	Bridges	2	3	-	-	-	-	-
	Boxes	2	4	-	-	-	-	-
	Pipes	6	4	9	8	8	3	3
Construction Cost (LS)								
Earthwork		367,000	312,000	278,000	293,000	296,000	102,000	71,000
Pavement		377,000	393,000	418,000	433,000	516,000	271,000	269,000
Structure		185,000	222,000	19,000	17,000	17,000	5,000	5,000
Access Road		-	-	135,000	62,000	-	53,000	-
Total in Economic Cost		929,000	927,000	850,000	805,000	829,000	431,000	345,000

TABLE 8-2 COST BY STAGED CONSTRUCTION PLAN

Rahad - Semeih
Distance 20.1 km

	Type A	Type B	Type C	Type D	Type E
1st (1981)					
Earthwork	658	655	647	611	658
Pavement	613	590	533	477	551
Structures	68	68	68	68	68
Sub Total	1,339	1,313	1,248	1,156	1,277
Add. Cost	374	367	348	323	357
Total	1,713	1,680	1,596	1,379	1,634
Cost/km	85.2	83.6	79.4	68.6	81.3
2nd (1996)					
Earthwork	-	-	-	75	-
Pavement	324	324	324	393	324
Sub Total	324	324	324	468	324
Add. Cost	90	90	90	131	90
Total	414	414	414	599	414
Cost/km	20.6	20.6	20.6	29.8	20.6
GRAND TOTAL:	2,127	2,094	2,010	1,978	2,048

ANNEX Ⅷ－3　舗装構成の設計

3.1　設計基準

これらの舗装構成は，３つの舗装基準を用いて検討した。

a) U.S. AASHTO, "AASHTO Interim Guide for Design of Pavement Structure, 1972"

b) U.K. Road Research Laboratory, Road Note 31 : "A Guide to the Structural Design of Bituminous — Surfaced Roads in Tropical and Subtropical Countries" and Road Note 29 : "A Guide to the Structural Design of Pavements for New Roads."

c) UNESCO, "Low Cost Roads, 1971."

3.2　舗装構成

a) AASHTO

i) ９％のCBR値に Kentucky "A" 曲線を適用すると路床上の支持力 "S" は図８－１－１によりS＝5.8として得られる。

地域係数R＝1.0とすれば舗装厚指数SNは，SN＝6.0㎝として決定される。各層の舗装厚は与えられた相対強度係数 a_1～a_3 をもつ次の公式から計算される。

$$SN = a_1 D_1 + a_2 D_2 + a_3 D_3$$

ここに，a_1 ＝ 表層工の相対強度係数 ： DBST＝0.24，AC＝0.44

a_2 ＝上層路盤工の　〃　　： 0.15

a_3 ＝下層路盤工の　〃　　： 0.11

D_1, D_2, D_3 ：それぞれ表層，上層路盤，下層路盤工の厚さ（㎝）

ii) AASHTO基準は交通量の増加によってその延標準車軸数が 0.70×10^6 になる時に５㎝厚の混合瀝青表層工（アスファルトコンクリート）のオーバーレイを施すと判断した。よってそのオーバーレイは１９９６年と予想される。

b) Road Note 31 and 29

この設計基準はAASHTOと同じ延標準車軸数を用いる。

DBST表層工による初期建設のこの道路に Road Note 31 の "150－1,500 Commercial Vehicles Per day" の図８－１－２と Road Note 29 の "Thickness of Subbase" の図８－１－３を舗装厚の設計に用いた。アスファルトコンクリート厚５㎝のオーバーレイは延標準車軸数が 0.5×10^6 に到達する時に施す。それは供用開始後１１年目の１９９３年に行われることになる。

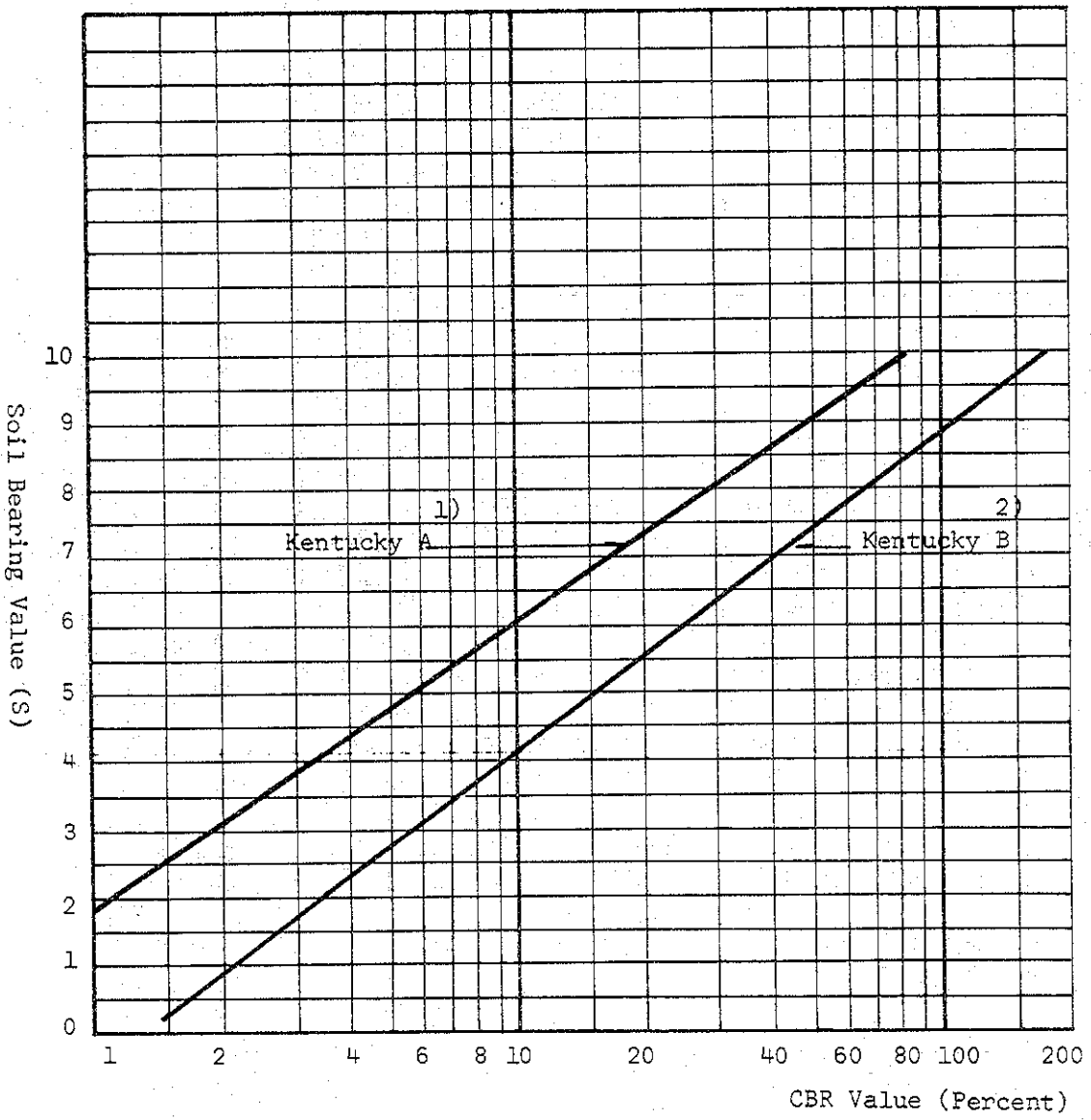
c) Low Cost Roads

Low Cost Roadsの基準を用いた舗装設計は Rood Note 31の結果と同じである。図8－1－4に Low Cost Roads にもとづく舗装構成を示す。

3.3 結　論

これらの設計基準によって決定した舗装厚とコストは Annex Ⅷ－3の表8－3に示される。AASHTO の基準は，結果としてコストが高い。

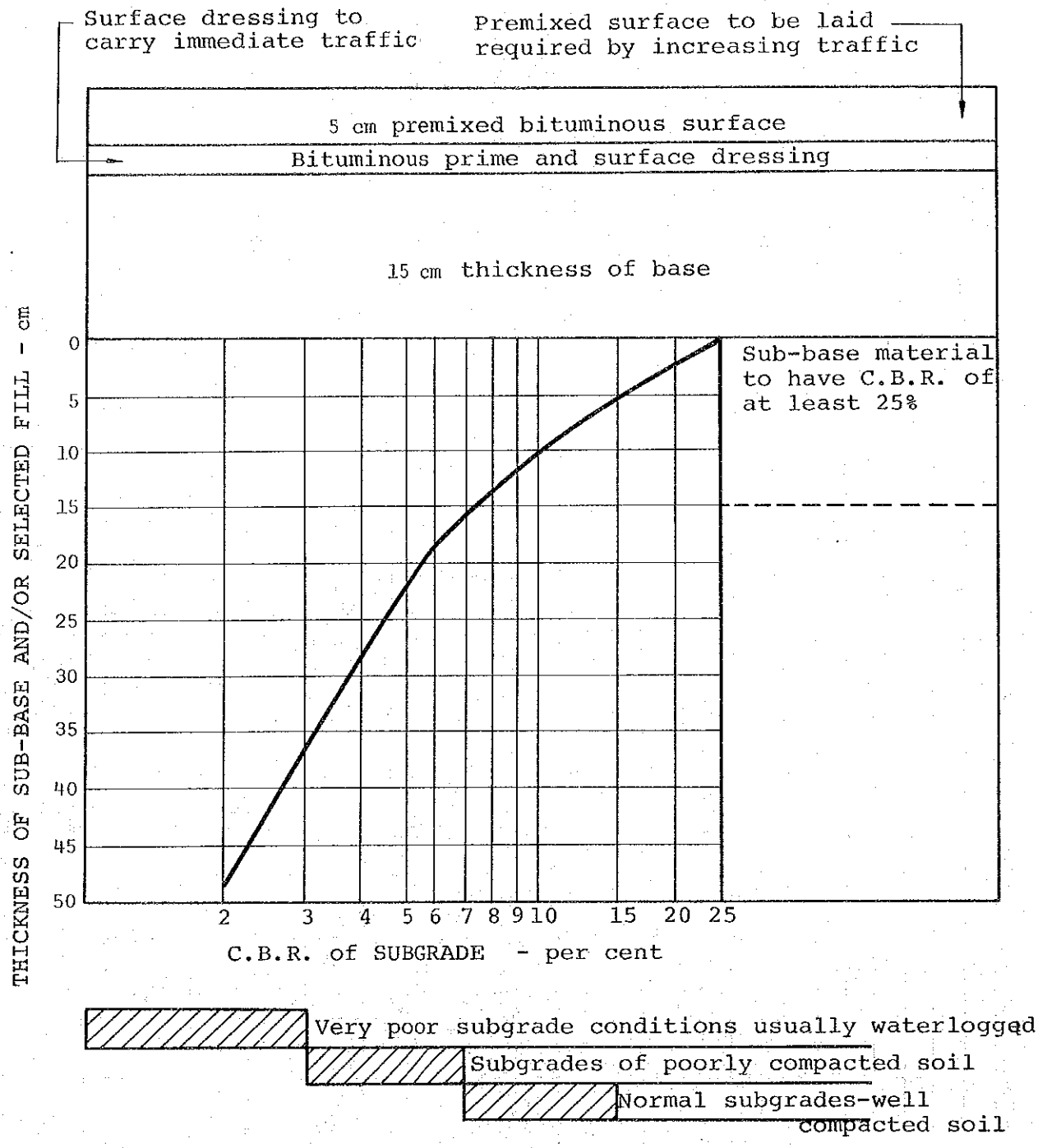
FIG. 8-1-1 AASHTO SOIL BEARING VALUE CHART



Notes: 1) Kentucky A curve uses for the crushed rock base courses.

2) Kentucky B curve uses for the bituminous, stabilized base courses.

Source: Hugh A. Wallace and J. Rogers Martin Asphalt Pavement Engineering (New York, Mc Graw Hill Book Co., 1967, p227, Fig. 10-31. Correlation chart for estimating soil-support values by AASHTO is transformed into this Chart.)



APPROXIMATE GUIDE TO SUBGRADE CONDITIONS

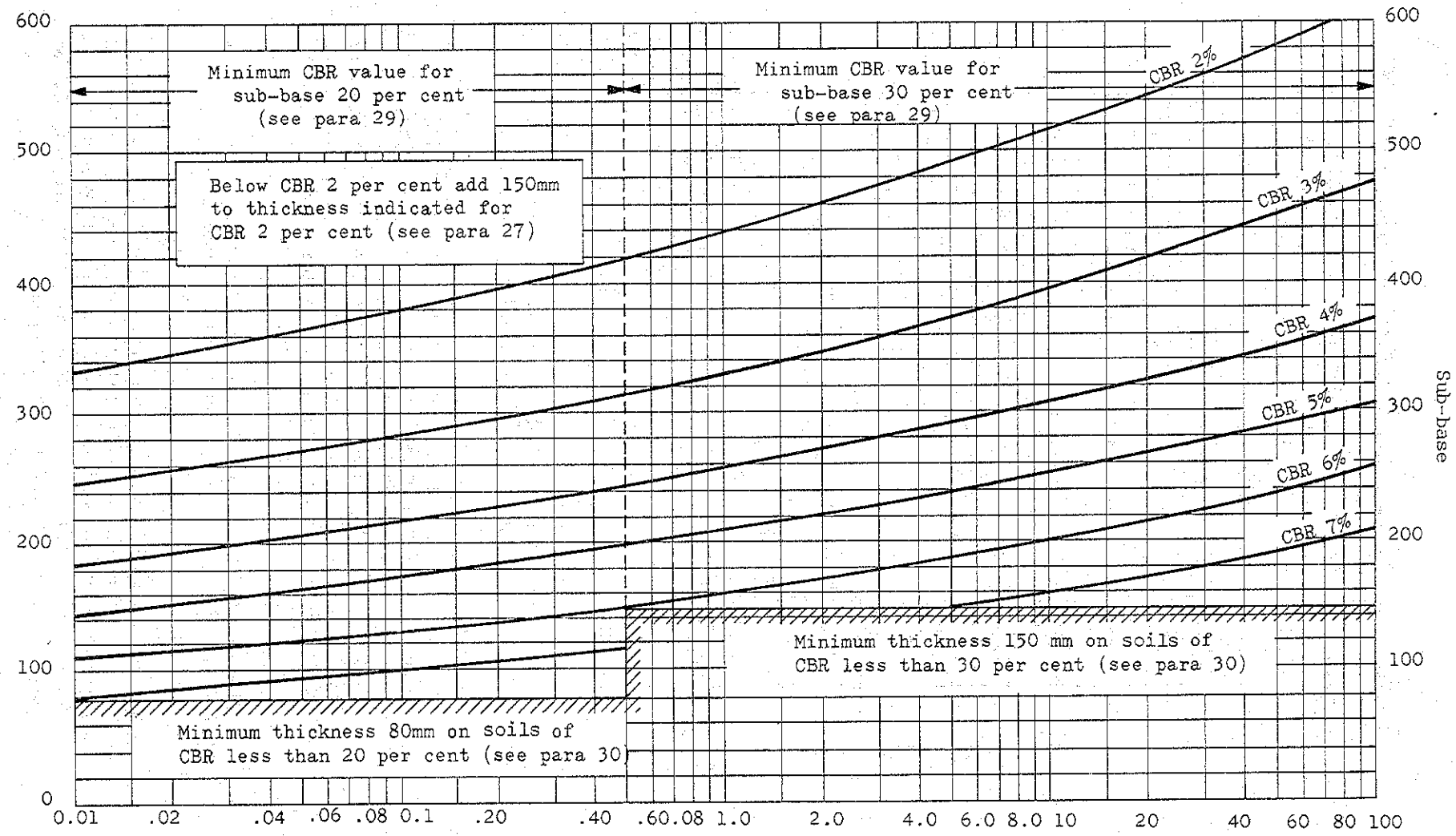
DESIGN CHART 2

(150-1500 commercial vehicles per day)

Source: U.K. RRL, Road Note 31, A Guide to the Structural Design of Bituminous-surfaced Roads in Tropical and Sub-tropical Countries.

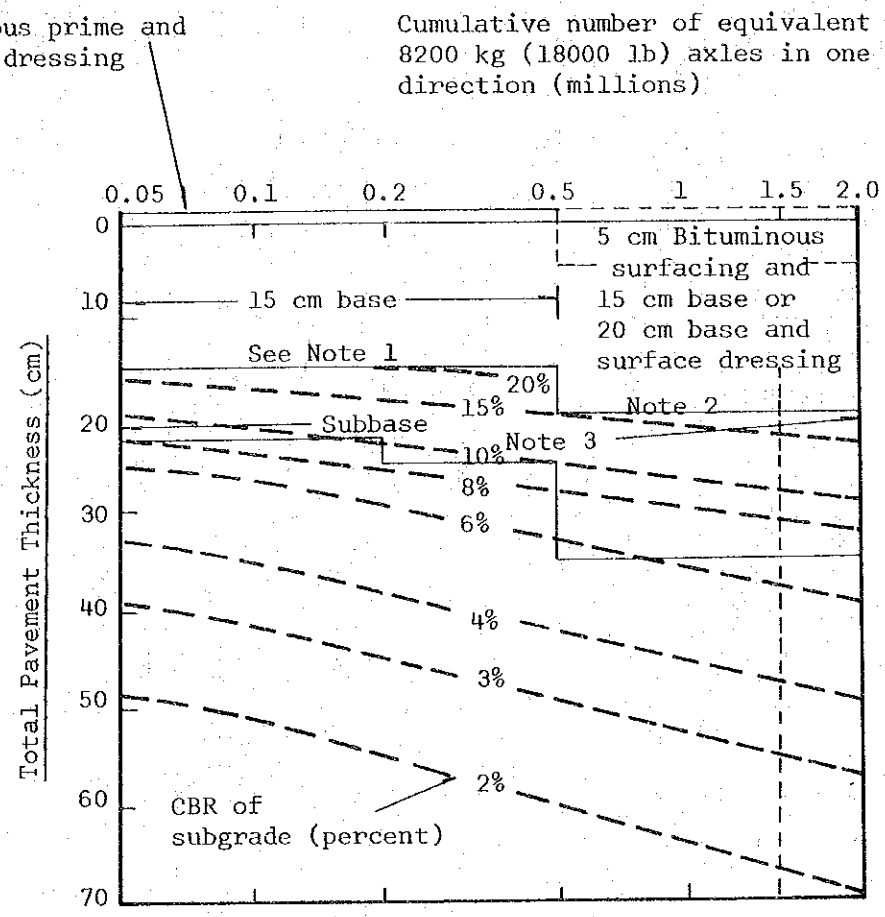
FIG. 8-1-3 THICKNESS OF SUBBASE

ANNEX VIII-3



Source: U.K. RRL, Road Note 29, A Guide to the Structual Design of Pavements for New Roads, 1970, p.25

FIG. 8-1-4 PAVEMENT DESIGN CHART FOR FLEXIBLE PAVEMENTS



Notes: 1) The thickness of thin bituminous surfacing less than 2 cm deep, such as multiple surface dressings, is neglected.

2) The additional thickness required on roads designed to carry more than 0.5 million equivalent 8200 kg axles can be provided at the time of construction by increasing the base thickness to 20 cm under a bituminous prime and surface dressing or by using a 15 cm base under a 5 cm premixed bituminous surfacing. Where an existing road is being strengthened, a 5 cm premixed bituminous surfacing is appropriate for flows up to 2.5 million equivalent 8200 kg axles.

3) Subbase materials are to have a minumum C.B.R. of 25% at the appropriate density and moisture conditions.

4) The pavement thickness shown are average thickness and are subject to normal working tolerances. Thus a nominal 15 cm base layer may occasionally have points with a minimum thickness of 11-12 cm but the average thickness would be expected to be in the range 14-16 cm.

Source: UNESCO Low Cost Roads
(London, Butterworths, 1971)

TABLE 8-3 PAVEMENT STRUCTURE AND COST

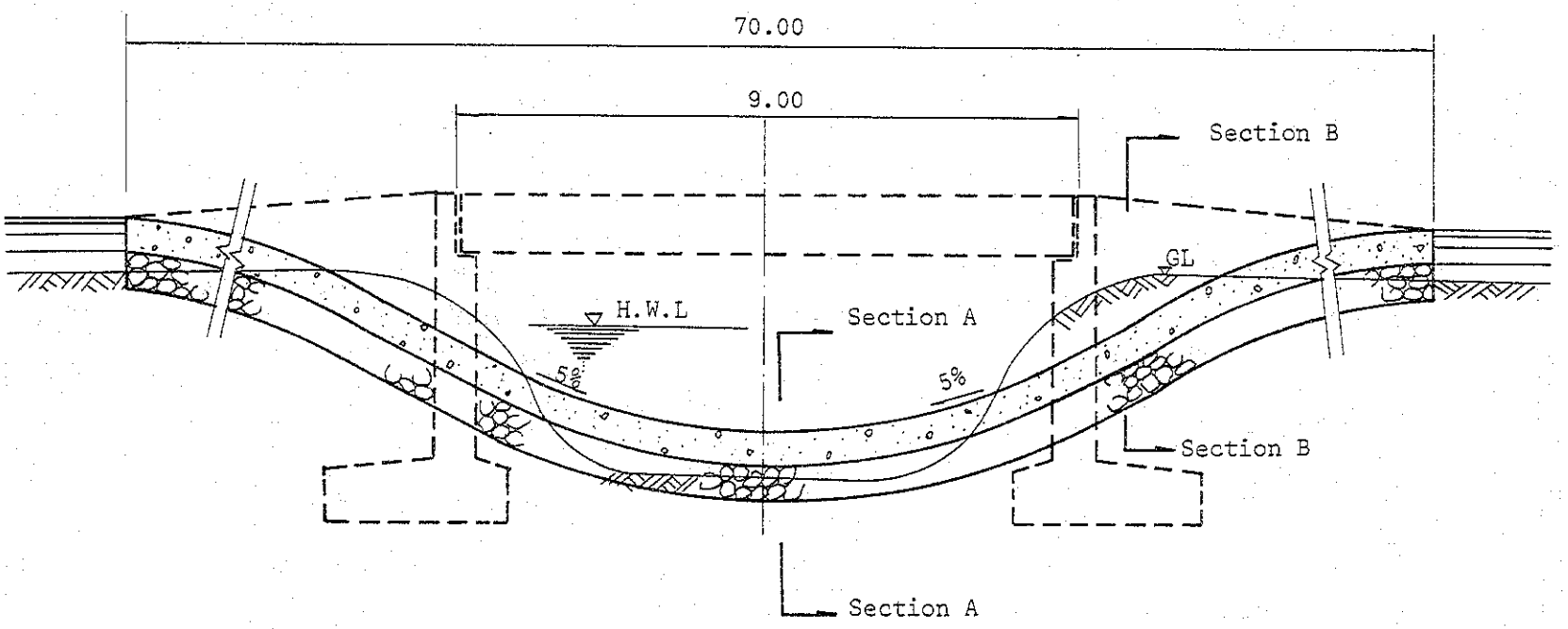
	AASHTO (cm)	R.N. 31 Low Cost Roads (cm)	AASHTO (LS'000)	R.N. 31 Low Cost Roads (LS '000)
The first staged construction				
Double Bituminous Surface Treatment	3	3		
Crushed Rock and/or Gravel Base CBR≧80	15	15		
Gravel Subbase CBR≧25	30	15		
Total	48	33	590	480
Cost/km	-	-	29.3/km	23.9/km
The second staged construction				
Asphalt concrete surfacing	5	5	324	324
Crushed rock and/or gravel base CBR≧80	15	15		
Gravel subbase CBR≧25	30	15		
Total	50	35	324	324
Cost/km	-	-	16.1/km	16.1/km

TABLE 8-4 LIST OF BRIDGES

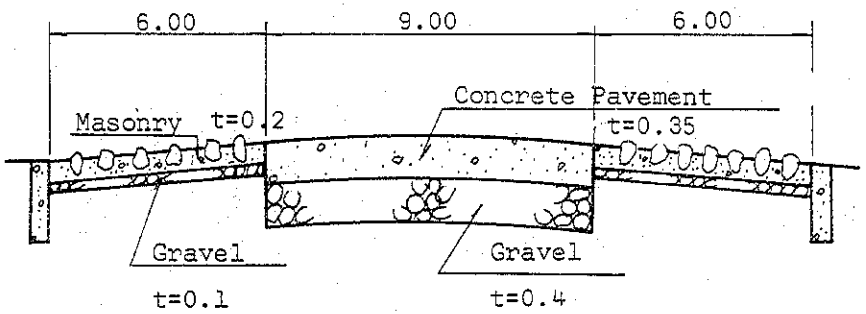
No.	Station	Bridge Length (m)	Name of Watercourse
1	5 + 250	9.0	
2	10 + 790	9.0	
3	11 + 090	9.0	K. El Banat
4	19 + 730	3 x 9.0 = 27.0	K. El Banat
5	21 + 290	3 x 9.0 = 27.0	K. El Baggara
6	25 + 830	9.0	
7	29 + 500	2 x 7.0 = 14.0	
8	43 + 850	9.0	K. Nawa
9	49 + 200	2 x 7.0 = 14.0	"
10	54 + 400	2 x 9.0 = 18.0	"
11	78 + 150	7.0	
12	81 + 050	7.0	
13	82 + 970	7.0	

FIG. 8 - 2 PROFILE OF BRIDGES

PROFILE



Section A-A



Section B-B

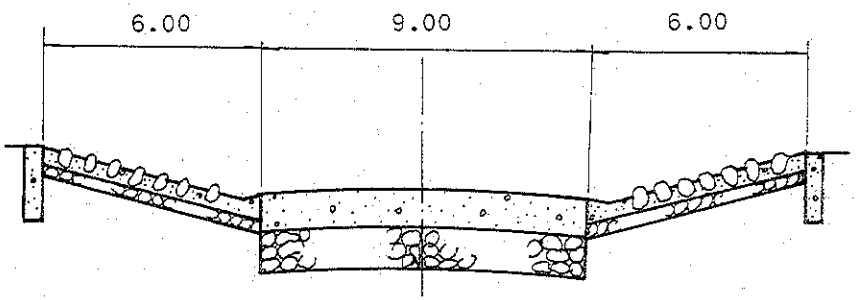


TABLE 8-5 ECONOMIC COST OF BRIDGES

(LS)

	Normal Bridge			Irish Bridge		
	No.	Unit Cost *	Total Cost	No.	Unit Cost *	Total Cost
7 m span	3	14,120	42,360	3	15,100	45,300
9 m span	5	18,760	93,800	5	15,100	75,500
7 m x 2 span	2	22,320	44,640	2	15,100	30,200
9 m x 2 span	1	27,852	27,852	1	22,120	22,120
9 m x 3 span	2	39,340	78,680	2	22,120	44,240
Total			287,332			217,360

Note: * = Unit cost includes all engineering works of approach sections.

TABLE 8-6 ECONOMIC COST OF RAILWAY CROSSING

(LS)

	Bridge	Approach	Crossing	Total
Over Crossing	26,059	107,942	-	134,001
Level Crossing	-	4,325	1,429	5,754

TABLE 8-7-1 CONSTRUCTION COST

Section Town

Distance 2.0 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.040	0.043	68,308	2,700	2,900
2. Earthwork fill	m^3	0.635	0.768	17,987	11,400	13,800
3. Cutting	m^3	-	-	-	-	-
4. Ditch cutting	m^3	0.096	0.102	17,715	1,700	1,800
5. Preparation of formation	m^2	0.075	0.092	12,000	900	1,100
6. Slope protection	m^3	0.343	0.420	9,040	3,100	3,800
7. Subbase	m^3	2.585	3.400	3,560	9,200	12,100
8. Base	m^3	2.710	3.542	2,400	6,500	8,500
9. Prime coat	T	83.4	116.7	18	1,500	2,100
10. Surface (DBST)	m^2	0.542	0.725	12,000	6,500	8,700
11. Shoulder	m^3	1.836	2.416	1,035	1,900	2,500
Sub-Total					45,400	57,300
B. Structures	U					
12. Bridge		-	-	-	-	-
13. Box Culvert 2.0 x 1.5 2 cells	U	4,650	5,600	2	9,300	11,200
14. Pipe	U	-	-	-	-	-
Sub-Total					9,300	11,200
TOTAL					54,700	68,500
Overhead & Profit 33%					20,600	22,600
TOTAL					75,300	91,100

TABLE 8-7-2 CONSTRUCTION COST

Section 1
Distance 22.0 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	786,180	33,400	36,500
2. Earthwork fill	m^3	0.649	0.789	317,436	266,200	250,600
3. Cutting	m^3	0.728	0.883	103,521	75,400	91,400
4. Ditch cutting	m^3	0.115	0.126	183,385	21,000	23,100
5. Preparation of formation	m^2	0.104	0.125	132,000	13,800	16,500
6. Slope protection	m^3	0.374	0.457	136,855	51,200	62,500
7. Subbase	m^3	2.637	3.480	39,138	103,200	136,200
8. Base	m^3	2.784	3.671	26,400	73,500	96,900
9. Prime coat	T	90.91	127.27	198	18,000	25,200
10. Surface (DBST)	m^2	0.559	0.751	132,000	73,800	99,200
11. Shoulder	m^3	1.941	2.538	11,385	22,100	28,900
Sub-Total					691,600	867,000
B. Structures						
12. Bridge 9.0 x 1	U	10,460	12,570	3	31,400	37,700
9.0 x 3	U	26,400	31,850	2	52,800	63,700
Sum				5	84,200	101,400
13. Box Culvert						
2.0 x 1.5 2 cells	U	4,600	5,500	1	4,600	5,500
2.0 x 1.5 3 cells	U	6,200	7,450	2	12,400	14,900
Sum				3	17,000	20,400
14. Pipe ø 1.0 x 1	U	1,130	1,330	7	7,900	9,300
ø 0.6	U	23	27.5	117	2,700	3,200
Sum				124	10,600	12,500
Sub Total					111,800	134,300
TOTAL					803,400	1,001,300
Overhead & Profit					300,400	330,400
TOTAL					1,103,800	1,331,700

TABLE 8-7-3 CONSTRUCTION COST

ANNEX VIII-7

Section 2

Distance 22.0 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	758,847	32,100	35,100
2. Earthwork fill	m^3	0.649	0.789	224,647	145,900	177,200
3. Cutting	m^3	0.707	0.858	13,865	9,800	11,900
4. Ditch cutting	m^3	0.114	0.125	195,620	22,300	24,500
5. Preparation of formation	m^2	0.104	0.125	132,000	13,800	16,500
6. Slope protection	m^3	0.374	0.457	103,680	38,800	47,400
7. Subbase	m^3	2.637	3.480	39,138	103,200	136,200
8. Base	m^3	2.784	3.671	26,400	73,500	96,900
9. Prime coat	T	90.91	127.27	198	18,000	25,200
10. Surface (DBST)	m^2	0.559	0.751	132,000	73,800	99,200
11. Shoulder	m^3	1.941	2.538	11,385	22,100	28,900
Sub-Total					553,300	699,000
B. Structures						
12. Bridge 7.0 x 2	U	14,700	17.600	1	14,700	17,600
9.0 x 1	U	10,400	12,500	2	20,800	25,000
Sum				3	35,500	42,600
13. Box Culvert 2.0 x 1.5 2 cells	U	4,650	5.600	2	9,300	11,200
14. Pipe ϕ 1.0 x 1	U	1,100	1,300	2	2,200	2,600
ϕ 0.6	U	23	27.5	118	2,700	3,200
Sum				120	4,900	5,800
Sub Total					49,700	59,600
TOTAL					603,000	758,600
Overhead & Profit					227,600	250,300
TOTAL					830,600	1,008,900

TABLE 8-7-4 CONSTRUCTION COST

Section 3
Distance 20.4 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	692,161	29,300	32,000
2. Earthwork fill	m^3	0.649	0.789	187,163	121,500	147,600
3. Cutting	m^3	0.723	0.872	20,758	15,000	18,100
4. Ditch cutting	m^3	0.114	0.126	177,007	20,300	22,300
5. Preparation of formation	m^2	0.104	0.124	122,400	12,700	15,200
6. Slope protection	m^3	0.374	0.456	88,769	33,200	40,500
7. Subbase	m^3	3.373	4.456	36,292	122,400	161,700
8. Base	m^3	3.510	4.637	24,480	85,900	113,500
9. Prime coat	T	90.76	126.63	184	16,700	23,300
10. Surface (DBST)	m^2	0.563	0.796	122,400	72,600	37,400
11. Shoulder	m^3	1.942	2.538	10,557	20,500	26,800
Sub-Total					550,100	698,400
B. Structures						
12. Bridge 7.0 x 2	U	14,800	17,800	1	14,800	17,800
9.0 x 2	U	18,200	21,900	1	18,200	21,900
Sum				2	33,000	39,700
13. Box Culvert	U	-	-	-	-	-
14. Pipe ø 1.0 x 1	U	1,130	1,330	7	7,900	9,300
ø 1.0 x 3	U	2,700	3,200	1	2,700	3,200
ø 0.6	U	23	27.5	105	2,400	2,900
Sum				113	13,000	15,400
Sub Total					46,000	55,100
Total					596,100	753,500
Overhead & Profit					226,100	248,600
TOTAL					822,200	1,002,100

TABLE 8-7-5 CONSTRUCTION COST

Section 4

Distance 20.1 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	699,475	29,600	32,300
2. Earthwork fill	m^3	0.649	0.789	245,264	159,200	193,400
3. Cutting	m^3	0.731	0.887	272,773	199,500	241,900
4. Ditch cutting	m^3	0.113	0.124	138,144	15,600	17,100
5. Preparation of formation	m^2	0.104	0.124	120,600	12,500	14,900
6. Slope protection	m^3	0.374	0.457	114,080	42,700	52,200
7. Subbase	m^3	3.373	4.458	35,758	120,600	159,400
8. Base	m^3	3.512	4.639	24,120	84,700	111,900
9. Prime coat	T	91.16	127.62	181	16,500	23,100
10. Surface (DBST)	m^2	0.593	0.795	120,600	71,500	95,900
11. Shoulder	m^3	1.942	2.538	10,402	20,200	26,400
Sub-Total					772,600	968,500
B. Structures						
12. Bridge 7.0 x 1	U	8,900	10,670	3	26,700	32,000
13. Box culvert 2.0 x 1.5 1 cell	U	2,900	3,500	1	2,900	3,500
14. Pipe ø 1.0 x 1	U	1,130	1,330	7	7,900	9,300
ø 1.0 x 2	U	1,970	2,330	3	5,900	7,000
ø 0.6	U	23	27	100	2,300	2,700
Sum				110	16,100	19,000
Sub Total					45,700	54,500
Total					818,300	1,023,000
Overhead & Profit					306,900	337,600
TOTAL					1,125,200	1,360,600

TABLE 8-7-6 CONSTRUCTION COST

ANNEX VIII-7

Section 5

Distance 24.8 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	881,777	37,400	40,800
2. Earthwork fill	m^3	0.649	0.789	332,611	215,900	262,400
3. Cutting	m^3	0.731	0.887	389,703	285,000	345,700
4. Ditch cutting	m^3	0.114	0.126	171,104	19,600	21,600
5. Preparation of formation	m^2	0.104	0.124	148,800	15,400	18,400
6. Slope protection	m^3	0.468	0.581	154,877	72,500	90,000
7. Subbase	m^3	4.832	6.401	44,120	213,200	282,400
8. Base	m^3	4.973	6.583	29,760	148,000	195,900
9. Prime coat	T	92.37	128.70	223	20,600	28,700
10. Surface (DBST)	m^2	0.661	0.884	148,800	98,400	131,600
11. Shoulder	m^3	2.673	3.506	12,834	34,300	45,000
Sub-Total					1,160,300	1,462,500
B. Structures						
12. Bridge		-	-	-	-	-
13. Box culvert 2.0 x 1.5 1 cell	U	3,010	3,640	9	27,100	32,700
14. Pipe ϕ 1.0 x 1	U	1,140	1,340	5	5,700	6,700
ϕ 1.0 x 2	U	2,000	2,350	2	4,000	4,700
ϕ 1.0 x 3	U	2,750	3,250	2	5,500	6,500
ϕ 0.6	U	23	28	125	2,900	3,500
Sum				134	18,100	21,400
Sub Total					45,200	54,100
Total					1,205,500	1,516,600
Overhead & Profit					455,000	500,500
TOTAL					1,660,500	2,017,100

TABLE 8-7-7 CONSTRUCTION COST

ANNEX VIII-7

Section 6

Distance 22.15 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.042	0.046	768,151	32,400	35,400
2. Earthwork fill	m^3	0.649	0.789	268,296	174,200	211,600
3. Cutting	m^3	0.729	0.883	107,311	78,200	94,800
4. Ditch cutting	m^3	0.113	0.124	139,310	15,800	17,300
5. Preparation of formation	m^2	0.104	0.124	132,900	13,800	16,500
6. Slope protection	m^3	0.466	0.578	66,840	31,100	38,600
7. Subbase	m^3	4.832	6.401	39,405	190,400	252,200
8. Base	m^3	4.974	6.584	26,580	132,200	175,000
9. Prime coat	T	91.50	127.50	200	18,300	25,500
10. Surface (DBST)	m^2	0.661	0.883	132,900	87,800	117,300
11. Shoulder	m^3	2.670	3.500	11,463	30,600	40,100
Sub-Total					804,800	1,024,300
B. Structures						
12. Bridge		-	-	-	-	-
13. Box culvert						
2.0 x 1.5 1 cell	U	2,900	3,500	1	2,900	3,500
2.0 x 1.5 2 cells	U	4,600	5,500	1	4,600	5,500
Sum				2	7,500	9,000
14. Pipe ϕ 1.0 x 1	U	1,150	1,350	11	12,600	14,900
ϕ 0.6	U	23	27.5	102	2,500	3,000
Sum				119	15,100	17,900
Masonry	m^2	0.908	1.006	52,885	48,200	53,200
Sub Total					70,800	80,100
Total					875,600	1,104,400
Overhead & Profit					331,300	364,400
TOTAL					1,206,900	1,468,800

TABLE 8-7-8 CONSTRUCTION COST

ANNEX VIII-7

Access D

Distance 1.53 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.040	0.043	60,467	2,400	2,600
2. Earthwork fill	m^3	0.619	0.745	7,917	4,900	5,900
3. Cutting	m^3	0.697	0.833	5,163	3,600	4,300
4. Ditch cutting	m^3	0.094	0.094	4,253	400	400
5. Preparation of formation	m^2	0.076	0.087	9,180	700	800
6. Slope protection	m^3	0.270	0.321	3,740	1,000	1,200
7. Subbase	m^3	3.301	4.357	3,787	12,500	16,500
8. Base	m^3	3.431	4.521	1,836	6,300	8,300
9. Prime coat	T	84.62	115.38	13	1,100	1,500
10. Surface (DBST)	m^2	0.560	0.755	9,180	5,100	6,900
11. Shoulder	m^3	1.820	2.400	1,710	3,100	4,100
Total					41,100	52,500
Overhead & Profit					15,800	17,300
TOTAL					56,900	69,800

TABLE 8-7- 9 CONSTRUCTION COST

ANNEX VIII-7

Access F

Distance 1.04 km

(LS in 1977 Price)

	Unit	Unit Price Economic	Unit Price Financial	Quantity	Economic Cost	Financial Cost
A. Earthwork and Pavement						
1. Clearing	m^2	0.037	0.038	43,591	1,600	1,700
2. Earthwork fill	m^3	0.620	0.750	9,197	5,700	6,900
3. Cutting	m^3	-	-	-	-	-
4. Ditch cutting	m^3	0.060	0.060	3,325	200	200
5. Preparation of formation	m^2	0.064	0.080	6,240	400	500
6. Slope protection	m^3	0.393	0.477	3,562	1,400	1,700
7. Subbase	m^3	4.779	6.294	2,574	12,300	16,200
8. Base	m^3	4.808	6.330	1,248	6,000	7,900
9. Prime coat	T	86.02	118.28	9.3	800	1,100
10. Surface (DBST)	m^2	0.625	0.817	6,240	3,900	5,100
11. Shoulder	m^3	2.410	3.182	1,163	2,800	3,700
Total					35,100	45,000
Overhead & Profit					13,500	14,900
TOTAL					48,600	59,900

TABLE 8-8 QUANTITIES OF MATERIALS TO BE PROCURED

1.	Bitumen	13,000 t
2.	Cement	2,700 t
3.	Reinforcing Bar	480 t
4.	Diesel	3,560,000 Gal.
5.	Lublicant	97,000 Gal.
6.	Grease	58,000 kg
7.	Gasoline	3,800 Gal.
8.	Filler	5,000 t
9.	Concrete Pipe	
	ϕ 1,000 m/m	770 m
	ϕ 600 m/m	740 m
10.	Steel Form	14,000 m^2

TABLE 8-9 COST OF DETAILED DESIGN

(Net of Customs and Taxes)

(1)	Engineering Fees		(LS)
	a. Staff	2,000 LS x 9 Mon x 10 Man	= 180,000
	b. Assistants	300 LS x 6 Mon x 10 Man	= 18,000
(2)	Traveling Allowances (Khartoum - Paris)		
	a. Traveling	500 LS x 16 Time	= 8,000
	b. Per diem	240 LS x 90 Mon	= 21,600
(3)	Field Investigations		
	a. Vehicles	1,000 LS x 8 Mon x 5 Vehi	= 40,000
	b. Transport of Materials		= 3,400
	c. Machine for Survey		= 15,000
	d. Labourer		= 6,000
	e. Office and Lodge		= 32,000
(4)	Soil and Material Tests		
	a. Boring Test		= 10,000
	b. Other Test		= 6,000
(5)	Topographic Maps		= 22,000
(6)	Report and Drawings		= 18,000
		Total	= 380,000

TABLE 8-10 SCHEME FOR WORK ITEMS

	Item	Equipment	Output
1.	Clearing	1 D7G	3,000 m^2/d
2.	Normal Earthwork Filling (compacted)	2 D7G, 1 Motor Scraper (21 cu.yd.), 1 Motor Grader, 2 Tired Roller, 1 Water Tanker	1,000 m^3/d
3.	Cutting	1 D7G	500 m^3/d
4.	Preparation of Formation	1 D7G, 1 Motor Grader 2 Water Tanker	2,500 m^2/d
5.	Sub Base borrow to fill (compacted)	1 Excavator, 1 Motor Grader 2 Tired Roller, 2 Water Tanker	760 m^3/d
6.	Base (as above)	1 Excavator, 1 Motor Grader 2 Tired Roller, 2 Macadam Roller, 2 Water Tanker	760 m^3/d
7.	Prime Coat	1 Asphalt Distributor	16 T/d
8.	Double Bituminous Surface Treatment	1 Asphalt Distributor 2 Motor Grader, 4 Macadam Roller	5,000 m^2/d
9.	Slope Protection	1 Plate Compactor	200 m^2/d
10.	Shoulder	1 Motor Grader, 1 Tired Roller	500 m^3/d

Notes: 1) Annual working days are estimated at 260.

2) Working days for earthwork are 180 - 200.

3) Outputs are calculated by the capacity and the efficiency of each item of mechanical equipment.

TABLE 8-11 REQUIRED QUANTITY OF PRINCIPAL EQUIPMENT

Equipment		1980	1981	1982
Bulldozer D7G		13	14	14
Motor Grader 12'		7	7	7
Motor Scraper	21 cu.yd.	3	3	3
Tired Roller	15 t	7	7	7
Macadam Roller	10 t	6	6	6
Excavator	0.7 cu.yd.	2	2	2
Asphalt Distributor	4 t	2	2	2
Water Tanker	8 t	7	7	7
Wheel Loader	1.9 m^3	2	2	2
Crawler Drill		2	2	2
Crushing Plant	30 t/hr	2	2	2
Dump Truck	11 t	40	40	40

TABLE 8-12-1 ACQUISITION COST OF EQUIPMENT

(LS)

Equipment	Port Sudan CIF Price	Local Component	Import Duty and Taxes	Total	Daily rate As % of Cost
1. Bulldozer D7G with Blade	41 865	15 153	5 860	62 878	0.17
2. Bulldozer D8K with Blade & Ripper	65 000	23 450	10 660	99 110	0.17
3. 623B Motor Scraper (21 cu.yd.)	68 532	24 886	25 014	118 432	0.18
4. Motor Grader (blade width 12')	21 825	8 339	7 965	38 129	0.18
5. 225 Excavator (0.7 cu.yd.)	39 285	14 650	14 338	68 273	0.22
6. Wheel Loader W90 (1.9 m^3)	23 299	8 655	8 504	40 458	0.17
7. Soil Compactor WF22A	46 697	17 043	17 044	80 784	0.17
8. Tractor Shovel D45S (1.2 m^3)	14 459	5 561	5 278	25 298	0.18
9. Tired Roller(15 tons class)	10 454	3 597	5 385	19 436	0.21
10. Macadam Roller (10 tons class)	8 853	2 997	4 559	16 409	0.18
11. Dump Truck (11 tons)	11 499	3 857	7 072	22 428	0.17
12. Flatbed Truck (10 tons)	8 335	2 828	5 127	16 290	0.34
13. Water Tanker (8,000 l.)	8 730	2 957	5 370	17 057	0.18

ACQUISITION COST OF EQUIPMENT (Cont'd.)

(LS)

Equipment	Port Sudan CIF Price	Local Component	Import Duty and Taxes	Total	Daily rate As % of Cost
14. Fuel Tanker (8 tons)	9 127	3 086	5 612	17 825	0.18
15. Asphalt Distributor (4 tons)	12 064	4 040	7 419	23 523	0.18
16. Air Compressor (10.5 m^2/min.)	5 545	1 784	2 023	9 352	0.28
17. Crawler Drill CRF110	8 899	3 315	3 248	15 462	0.33
18. Generator 50HZ EG150	7 561	2 388	3 893	13 842	0.22
19. Concrete Mixer (0.4 m^3)	2 352	943	859	4 154	0.21
20. Concrete Vibrator ϕ2" 3/8	238	134	88	460	0.40
21. Crushing Plant (30 T/Hr)	51 587	15 676	18 829	86 092	0.11
22. Vibration Roller (2.5 tons)	3 621	1 296	1 864	6 781	0.21
23. Asphalt Plant (60 T/Hr)	55 556	20 444	20 280	96 280	0.14
24. Asphalt Finisher (2.4 - 4.5 m)	18 487	6 747	6 970	32 204	0.17
25. Plate Compactor WUP38	1 894	692	783	3 369	0.40
26. Truck Crane NK110	15 873	5 755	5 792	27 420	0.15

Source: The Study Team, June, 1977.

TABLE 8-12-2 COST OF ACQUISITION A D7G (CAT.)

A) Foreign Component

CIF Price	US$	LS
Bare Tractor	94,960	37,683
Angle Blade	10,540	4,182
Total A	105,500	41,865

B) Custom

4, 182 x 25%	1,046
Surcharge CIF x 5%	2,093
Quay Due 1.5%	628
Development Tax 5%	2,093
Total B	5,860

C) Local Component

Remittance CIF x 15%	6,280
Profit 20%	8,373
Transport and Miscellaneous	500
Total C	15,153
Total A + C	57,018
Total A + B + C	62,878

TABLE 8-13 BREAKDOWN OF COST NO. 1

Clearing and Stripping

Item	Foreign Component	Local Component	Tax Component	Total Cost
Equipment				
1 D7G	73.04	26.44	10.22	109.70
Labour				
1 Driver		2.00		2.00
1 Foreman		2.40		2.40
10 Labourers		9.60		9.60
Materials				
Diesel	4.25	9.03	2.38	15.66
Total	77.29	49.47	12.60	139.36
Output 3,000 m^2/day				
LS per m^2	0.026	0.016	0.004	0.046
Overhead & Profit LS per m^2 (33%)				
Foreign Contractor	0.010	0.004	0.001	0.015
Unit Price LS per m^2				
Foreign Contractor	0.036	0.020	0.005	0.061

Economic Cost LS 0.056 per m^2

TABLE 8-14 BREAKDOWN OF COST NO. 2
NORMAL EARTHWORK (Cut to Fill)

Item	Foreign Component	Local Component	Tax Component	Total Cost
Equipment				
2 D 7 G	146.08	52.88	20.44	219.40
1 Motor Scraper	122.24	44.39	44.61	211.24
1 Motor Grader	43.84	15.08	22.58	81.50
2 Tired Roller	38.56	14.73	14.07	67.36
2 Water Tanker	31.52	10.68	19.38	61.58
Labour				
8 Drivers		16.00		16.00
1 Foreman		2.40		2.40
12 Labourers		11.52		11.52
Materials				
Diesel	30.90	65.66	17.33	113.89
Total	413.14	233.34	138.41	784.89
Output 1,000 m^3/day				
LS per m^3	0.413	0.233	0.138	0.784
Overhead & Profit LS per m^3 (33%)				
Foreign Contractor	0.165	0.070	0.023	0.258
Unit Price LS per m^3				
Foreign Contractor	0.578	0.303	0.161	1.042

Economic Cost LS 0.881 per m^3

TABLE 8-15 HOURLY EQUIPMENT OWNERSHIP AND OPERATION COST

(ECONOMIC)

1977 Prices

LS 1.00 = US$2.52

Equipment: Bulldozer D7G HP 200

Item		Calculation	Number	Unit
I.	General Data			
	A. Type of Fuel		Diesel	
	B. Fuel Consumption		4.60	gal/hr
	C. Fuel Cost		0.312	LS/gal
	D. Economic Life		10,000	hours
	E. Economic Life		8	years
II.	Acquisition Costs			
	F. Total Cost CIF		41,865	LS
	G. Cost of Tires		-	LS
	H. Total Cost Less Tires	F - G	41,865	LS
III.	Hourly Ownership Costs			
	I. Depreciation	H/D	4.19	LS/hr
	J. Major Repairs and Overhaul	$\frac{0.75xHx0.975}{D}$	3.06	LS/hr
	K. Interest	$\frac{0.1xFx0.5625}{D/E}$	1.88	LS/hr
	L. Hourly Ownership Cost (Economic)	I + J + K	9.13	LS/hr
IV.	Hourly Operation Costs			
	M. Cost of Fuels	B x C	1.44	LS/hr
	N. Cost of Lubricants and Filters	0.15 x M	0.22	LS/hr
	O. Cost of Tires: a - Depreciation		-	LS/hr
	b - Repairs			
	P. Operation Cost	M + N + O	1.66	LS/hr
V.	TOTAL ECONOMIC COST	L + P	10.79	LS/hr

ANNEX VIII-16

TABLE 8-16 MAINTENANCE AND REPAIR COST
(1983 - 2002)

(LS)

Year		Section 1	2	3	4	5	6	TOTAL
Distance (km)		24.0	22.0	21.93	20.1	24.8	23.19	136.02 km
a)	Maintenance and Repair							
1	1983	4,400	4,000	4,000	3,700	4,500	4,200	24,800
2	1984	"	"	"	"	"	"	24,800
3	1985	"	"	"	"	"	"	24,800
4	1986	"	"	"	"	"	"	24,800
5	1987	"	"	"	"	"	"	24,800
6	1988	"	"	"	"	"	"	24,800
7	1989	"	"	"	"	"	"	24,800
8	1990	78,800	72,200	72,000	66,000	81,400	76,100	446,500
9	1991	4,400	4,000	4,000	3,700	4,500	4,200	24,800
10	1992	"	"	"	"	"	"	24,800
11	1993	"	"	"	"	"	"	24,800
12	1994	3,200	2,900	2,900	2,700	3,300	3,000	18,000
13	1995	"	"	"	"	"	"	18,000
14	1996	"	"	"	"	"	"	18,000
15	1997	"	"	"	"	"	"	18,000
16	1998	"	"	"	"	"	"	18,000
17	1999	"	"	"	"	"	"	18,000
18	2000	"	"	"	"	"	"	18,000
19	2001	"	"	"	"	"	"	18,000
20	2002	"	"	"	"	"	"	18,000
	TOTAL	151,600	138,300	138,100	127,300	156,100	145,100	856,500
b)	Overlay							
	1993	386,300	354,700	352,700	323,700	400,100	373,100	2,190,600

ANNEX IX

TABLE 9-1 TRAFFIC COMPOSITION ON KHARTOUM - WAD MEDANI ROAD (24 HOURS)

Station	12 Km from Khartoum			9 Km from Khartoum			94 Km from Khartoum		
Direction	Khartoum → Wad Medani			Khartoum → Wad Medani			Khartoum → Wad Medani		
Date of Survey	30 May 1977 [2]			21 - 27 Aug. 1976 [1]			21 - 27 Aug. 1976 [1]		
Type of Vehicle	ADT	Percent		ADT	Percent		ADT	Percent	
Passenger Vehicles									
Car.Taxi	379	14.0	-	668	26.8	-	65	14.4	-
4 Wheel Drive	203	7.5	-	251	10.1	-	46	10.2	-
Box	208	7.7	-	-	-		-	-	-
Sub Total	790	29.2	-	919	36.9	-	111	24.6	-
Bus (Large)	219	8.1	-	342	13.8	-	100	22.1	-
Bus (Medium Small)	222	8.2	-	107	4.3	-	6	1.3	-
Sub Total	441	16.3	-	449	18.1	-	106	23.4	-
Total	1,231	45.5	-	1,368	55.0	-	217	48.0	-
Lorries									
Van/pick-up	349	12.9	-	479	19.2	-	44	9.7	-
Medium Truck	815	30.1	73.4	588	23.6	90.6	173	38.3	91.6
Heavy Truck	81	3.0	7.3	32	1.3	7.3	14	3.1	5.0
Truck Trailer	214	7.9	19.3	22	0.9	2.1	4	0.9	3.4
Total	1,459	53.9	100.0	1,121	45.0	100.0	235	52.0	100.0
Other	16	0.6	-	-	-	-	-	-	-
Grand Total	2,706	100.0	-	2,489	100.0	-	452	100.0	-

Sources: 1) RBPC, 1977

2) JICA's project study team, May 30, 1977.

ANNEX Ⅸ－2　転換交通とその便益

当計画道路の完成とともに，鉄道利用の旅客および貨物が道路輸送に転換すると考えられる。この場合は，両輸送手段の運賃，手間賃，所要時間，確実さ等を判断して，いずれを利用するかの決定を利用者は行う。転換によって期待される経済便益は，利用者負担の運賃節約ではなく輸送費用の差額として把握される。転換により生ずる他の便益や損失もあるが，経済的に評価することはむづかしいから，ここでの経済便益の推定には考えないことにした。

鉄道では，過去に投資された既存設備でのサービスを維持する運行費で，エコノミックコスト推定を行い，新しい鉄道への投資は考えないが維持費は考慮している。転換交通に対しては，道路の維持費と資本費用が推定される。資本費用は，車輌の償却費で計測されているが，道路の投資と維持費は転換便益の推定に入っていない。これ等は，プロジェクトの全体の費用，便益の流れで考えられている。

なお，Nyala 方面と Khartoum を結ぶ鉄道輸送は，当計画道路完成による影響を，ほとんど受けないと考えた。

2.1　旅　　客

ⅰ）鉄道旅客の費用

El Obeid-Khartoum 間の１人当り鉄道輸送のエコノミックコストは，表９－２－１のように推定され，人キロ当り LS 0.005 となる。

ⅱ）道路旅客の費用

鉄道より道路へ転換する旅客はすべてバスによると仮定した。１台のバスには，総座席数４４の内３５名が乗車する。従ってバスの償却費は走行費の中に含まれている。道路建設費は基本的なプロジェクトの中に入っている。

ⅲ）旅客の時間価値

地域農民の年間所得は，一世帯当り LS １５５ と推定される。

都市部での世帯についての数値はわからないが，平均 LS ２００～２５０と予測される。LS １５５という数字をもとに旅客の時間当り価値を次のように求めた。

$$LS\ 155 \div 5人 \div (365\ days) \div 24\ hr = 0.0035$$

しかし，時間節約がスーダンの現状の経済規模からみて，どの程度他の経済活動に活かされるかは予測がむずかしい。したがって時間節約価値は経済便益の計算に直接含めないこととした。

iv）鉄道旅客数と転換人数

表Ⅵ－8にゾーン間の鉄道旅客の流動量を示す。一般的に短距離旅客はサービスの多い自動車を利用する。道路建設完了後，プロジェクト地域内の旅客は同じ選択をして，全員バスに転換するとした。

転換旅客人数は，El Obeid－Um Ruaba 間で６０人，El Obeid－Rahad 間で５人，そして Rahad－Um Ruaba の間で５３人である。

これらは表９－２－５に示される。

鉄道の長距離旅客は，その発地着地が全国的に分散している。

表９－２－５に示すように旅客トリップを El Obeid ↔ Khartoum（147人/日）と，Rahad ↔ Khartoum（39人/日）の２つの交通にまとめた。鉄道の３等，４等の料金はバスのそれより安いので，これらの人々の道路への転換はないものとした。

V）転換便益とバス台数

プロジェクト地域での鉄道旅客は過去数年増えていないことと，現地の１００％近い利用効率を考えて,ここ数年の将来は現在の旅客と同じ人数のままと想定した。転換した旅客の 1983 年以降の伸びは通常交通と同じとした。次に示す表９－２－３と表９－２－４は，表９－２－５の要約である。