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APPENDIX A

APPENDIX A / ANNEXE A
STAFFING, INTERVIEWS AND REFERENCES/
CADRES, ENQUETES ET REFERENCES

A.1 STAFFING/CADRES

Dr. U.R. Abdus-Samad	: Project Manager and Chief Economist/Engineer; Directeur du Projet et Chef Economiste/Ingénieur
C.F. Van Cook	: Transportation Economist Economiste de Transport
E.J. Bonhomme	: Rural development Economist Economiste de Développement Rural
Dr. A.S. Quandt	: Socio-Anthropologist Sociologiste/Anthropologiste
P.J. Couniotakis	: Civil/Highway Engineer Ingénieur Civil et de Chaussées
I.D. Perrine	: Soils/Materials Engineer Ingénieur de Mechanique des Sols
N. Pandya	: Structural Engineer Ingenieur de Ponts
C.A. Bingham	: Environmental Planner Spécialiste pour l'Environment
N.B. Herring	: Road Maintenance Specialist Spécialiste en l'Entretien Routier
M.J. Tolmé	: Equipment Specialist Spécialiste en Equipement

A.2 INTERVIEWS/ENQUETES

A.2.1 GENERAL

Gouvernement de la République du Mali (G.R.M.)

Ministère des Travaux Publics et du Tourisme (MTPT), Ministre, Djibrail Diallo. Oct. 1979. Bamako, Mali.

MTPT, Chef du Cabinet, M. Mohammad Alhusseyn Touré. Oct. 1979. Bamako, Mali.

MTPT, Direction Nationale des Travaux Publics (DNTP). Directeur Général, M. H. Bathily. Août et Oct. 1979. Bamako, Mali.

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Gouverneur de Première Région, Chef de Battalion, Zoumana Traoré. Août et Oct. 1979. Kayes, Mali.

Maire de Nioro du Sahel. Août 1979. Nioro du Sahel, Mali.

U.S. Department of State

USAID, Mali. Director of Mission, M. Ronald Levin. Sept. et Oct. 1979. Bamako, Mali.

USAID, Mali. Deputy Director, M. G. Eaton. Sept. 1979. Bamako, Mali.

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USAID, Mali. Program Attaché and Liaison Officer, M. B. Dao. Août et Oct. 1979. Bamako, Mali.

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A.2.2 ENGINEERING, CONSTRUCTION & MAINTENANCE/ETUDES TECHNIQUES

Entreprises

Abu. Directeur, M. Koniafski. Oct. 1979. Bamako, Mali.

Agence Berlier. Directeur. Oct. 1979. Bamako, Mali.

Keita, Aliou. Directeur. Oct. 1979. Bamako, Mali.

Mali-Travaux. Directeur, M. Touré. Oct. 1979. Bamako, Mali.

Manutention Africaine (Caterpillar & Landrovers). Directeur. Oct. 1979. Bamako, Mali.

SATCM. Chef d'Agence, M. Patrick Eveillard. Oct. 1979. Bamako, Mali.

SONETRA. Directeur. Oct. 1979. Bamako, Mali.

S.N.T.P. Directeur d'Agence, M. Pierre Charlier et Chef de Comptabilité, M. J. C. LeKeux. Oct. 1979. Bamako, Mali.

G.R.M. (Ministère des Travaux Publics)

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MTPT, DNTP. Chef de la Section des Routes, Division Technique, M. Hamu Touré. Oct. 1979. Bamako, Mali.

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G.R.M. (Ministère des Travaux Publics) (Continued)

MTPT, DNTP. Direction Régionale. Chef d'Atelier, M. Bemba Diabaté. Oct. 1979. Nioro, Mali.

MTPT, DNTP. Chef de Division (Routes, Ponts et Chaussées), M. Sylla. Août 1979. Bamako, Mali.

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MTPT, DNTP, Centre de Perfectionnement, M. Ouattaro. Oct. 1979 Bamako, Mali.

MTPT, DNTP, Centre National de Recherche et d'Experimentation. Directeur, M. Nianti Bouare. Août 1979. Bamako, Mali.

MTPT, DNTP, Centre National de Recherche et d'Experimentation. Directeur Adjoint, M. Sissoko. Oct. 1979. Bamako, Mali.

MTPT, DNTP. Diréction Nationale de la Cartographie et de la Topographie. Directeur Général, M. Diadié Traoré. Août et Oct. 1979. Bamako, Mali.

MTPT, DNTP. Service du Matériel. Directeur, M. A. Sako. Oct. 1979. Bamako, Mali.

MTPT, DNTP. Service du Matériel. Chef des Garages, M. Sidibé. Oct. 1979. Bamako, Mali.

G.R.M. (Autre agences)

Direction de la Géologie et des Mines. Chef, Division de Cartes Géologiques, M. Ba et Chef Adjoint, M. Sirmaké. Soût 1979.

Ministère de l'Hydraulique, Chef Brigade Centrale Hydrologique, M. Sidibé. Oct. 1979. Bamako, Mali.

Regie Nationale des Chemins de Fer. Directeur Général, M. Mamadou Sissoko. Août 1979. Bamako, Mali.

RNCF. Chef, Division Commerciale. Oct. 1979. Bamako, Mali.

RNCF. Chef, Division des Etudes, M. Ahmadi Diallo. Août 1979. Bamako, Mali.

RNCF. Chef Adjoint, M. Tounko Danioko. Division des Etudes. Août 1979. Bamako, Mali.

RNCF. Chef, Division de l'Infrastructure et Bâtiments, M. Sicé. Août 1979. Bamako, Mali.

RNCF. Chef, Division de Transportation, M. Mamadou Diallo. Août 1979. Bamako, Mali.

G.R.M. (Autre agences) (Continued)

SEMA. Directeur, Bureau d'Etudes. Oct. 1979. Bamako, Mali.

Service Météorologie. Chef, Section de Renseignements. Oct. 1979. Bamako, Mali.

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MAE. Commerce Exterieur. Chef, M. Emile Dakouo. Août 1979. Bamako, Mali.

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G.R.M.

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APPENDIX B

APPENDIX B

ROAD INVENTORY

The road characteristics which were observed and recorded for each subsection are given below:

- Type of Terrain: flat, rolling, mountainous; also, possibility of flooding and number of water crossings
- Type of Roadway: width and condition of roadway and shoulders. Condition of roadway was rated from 5 (smooth surface without holes or notable irregularities) to 1 (irregular, very deteriorated surface or loose material in almost all the subsection, to such a degree that the average running speed is much less than that which the rest of the road characteristics would allow)
- Geometry: Grades in percent
- Geometry: horizontal alignment. The alignment was rated from 5 (tangent alignment or with very gradual curves) to 1 (many very sharp curves)
- Embankment height; ditch type and condition
- Drainage structures: Type, size, condition
- Bridges: Major characteristics and condition
- Average running speed

The length of each subsection was usually taken to be 1-2kms. Occasionally, when characteristics were homogeneous, some subsection lengths were as large as 5 kms.

The data obtained were based on simplified measures using the odometer, measuring tapes, an altimeter, aerial photographs and engineering judgment. The odometer readings were calibrated on the basis of the stationing of various structures and other monuments measured during an IGN leveling survey, carried out in 1952.

The results of the road inventory, carried out during October 1979, are presented in the tables that follow.

Table B.1

Summary of Average Road Characteristics

Road Section	Total length (km)	Roadway Width (m)	Profile Grades %	Surface Condition (1-5)	Average Speed km/h	Alignment km	Alignment Type
KAYES-DIALAKA	33	4-5+	0-3	3-4+	50-60+	54	3-4+
	14	4-5	0-3	2-3	40-50	14	2-3
	12	3-4	0-3	2-3	30-40	14	1-2
	6	3-4	0-3	1-2	20-30		
	16	3-4	3-5+	1-2	10-20		
DIALAKA-SANDARE	5	4-5	0-3	3-4	50-60	9	3-4
	4	3-4	0-3	2-3	30-40	12	2-3
	2	3-4	0-3	2-3	20-30	40	1-2
	5	3-4	0-3	1-2	20-30		
	7	3-4+	3-5	2-3	20-30		
	9	3-4	3-5	1-2	10-20		
	13	3-4	3-8	2-3	20-30		
	6	3-4	8-12	1-2	5-10		
SANDARE-NIORO	13	4-5	0-3	3-4+	50-60	45	3-4
	6	3-5	0-3	3-4	40-50	8	2-3
	25	3-4	0-3	[illegible]-4	30-40	54	1-2
	7	3-4	0-3	2-3	20-30		
	28	3-4	0-3	1-2	10-20		
	4	3-4	3-5	3-4	30-40		
	10	3-4	3-5	2-3	20-30		
	13	3-4	3-5	1-2	10-20		
	1	3-4	5-8	2-3	20-30		
DIALAKA-YELIMANE	5	3-4	0-3	3-4	50-60	26	3-4
	16	3-4	0-3	3-4	40-50	27	2-3
	17	3-4	0-3	2-3	30-40	15	1-2
	30	3-4	0-3	1-2	20-30		

Table B.2

Road Characteristics - Kayes-Dialaka

Section From km to km	Length (km)	Roadway Width (m)	Grades %	Surface Condition (1-5)	Av. Speed km/h
1-10	9	4-5	0-3	3-4	60+
10-17	7	4	0-3	2-3	50-60
17-27	10	4-5	0-3	3-4	60+
27-29	2	5-6	0-3	3-4	60+
29-34	5	4-5	0-3	3-4	60+
34-48	14	4-5	0-3	2-3	40-50
48-57	9	3-4	3-5	1-2	10-20
57-69	12	3-4	0-3	2-3	30-40
69-71	2	3-4	0-3	1-2	20-30
71-77	8	3-4	3-8	1-2	10-20
77-78	1	3-4	3-8	1-2	10-20
78-82	4	4-5	0-3	1-2	20-30

Table B.3

Road Characteristics - Dialaka-Sandaré

Section From km to km	Length (km)	Roadway Width (m)	Grades %	Surface Condition (1-5)	Av. Speed km/h
82-84	2	3-4	0-3	2-3	30-40
84-85	1	3-4	0-3	1-2	20-30
85-86	1	4-5	3-5	2-3	20-30
86-88	2	4-5	3-5	1-2	20-30
88-92	4	3-4	0-3	1-2	20-30
92-94	2	3-4	3-5	1-2	10-20
94-96	2	3-4	0-3	1-2	20-30
96-97	1	3-4	3-8	2-3	20-30
97-102	5	3-4	8-12	2-3	5-10
102-104	2	3-4	0-3	2-3	30-40
104-108	4	3	3-8	2-3	20-30
108-109	1	3	8-12	1-2	5-10
109-116	7	3-4	3-8	2-3	20-30
116-123	7	3-4	3-5	2-3	20-30
123-130	7	3-4	3-5	1-2	10-20
130-132	2	3-4	0-3*	1-2	20-30
132-134	2	3-4	0-3*	2-3	20-30
134-137	3	3-4	0-3*	1-2	20-30
137-139	2	4-5	0-3*	3-4	50-60
139-140	1	4-5	0-3	1-2	20-30
140-143	3	4-5	0-3*	3-4	50-60

* some short sections have steeper slopes

Table B.4

Road Characteristics - Sandaré-Nioro

Section From km to km	Length (km)	Roadway Width (m)	Grades %	Surface Condition (1-5)	Av. Speed km/h
143-147	4	3-4	0-3	1	10-20
147-149	2	3-4	0-3 *	3-4	40-50
149-156	7	-3	0-3*	1	10-20
156-157	1	3-4	3-5	2-3	20-30
157-158	1	3-4	0-3	2-3	20-30
158-159	1	3-4	3-5	2-3	20-30
159-163	4	3-4	0-3	1-2	10-20
163-164	1	3-4	5-8	2-3	20-30
164-168	4	3-4	3-5	1-2	10-20
168-170	2	-3-	3-5	3-2	20-30
170-173	3	3-4	3-5	1-2	10-20
173-174	1	3-	0-3	2-3	20-30
174-180	6	3-4	3-5	1-2	10-20
180-181	1	3-4	3-5	2-3	20-30
181-199	18	3-	0-3	2-3	30-40
199-204	5	3-4	0-3	2-3	20-30
204-217	13	3-4	0-3	1-2	10-20
217-221	4	3-4	3-5	3	30-40
221-228	7	3-4	0-3	2-3	30-40
228-233	5	3	3-5	2-3	20-30
233-237	4	4-5	0-3	3-4	40-50
237-250	13	4-5	0-3	3-4	50-60

* some short sections have steeper slopes

Table B.5

Road Characteristics - Dialaka-Yelimané

Section From (km)	Length (km)	Roadway Width (m)	Grades %	Surface Condition (1-5)	Av. Speed km/h
0-5	5	3-4	0-3	3-4	50-60
5-10	5	3-4	0-3	2-3**	30-40
10-20	10	3+	0-3	1-2**	20-30
20-35	15	3-	0-3	1-2**	20-30
35-44	9	3-4	0-3	2-3**	30-40
44-49	5	3-	0-3	1-2	20-30
49-65	16	3-	0-3*	3-4	40-50
65-68	3	3-	0-3*	2-3	30-40

* some short sections have steeper slopes

** several sections washed away, traffic uses trails

Table B.6

Inventory of Existing Small Drainage Structures

Kayes - Dialaka

Station	Type*	Dimensions(m)	Condition	Comments
2 + 71	PC	3- 21m long	Filled	Needs Replacement
5 + 80	PC	Ø @ 0.5	Broken	Needs Replacement
9 + 00	PC	Ø	Filled	Needs Replacement
11 + 84	BC	1.40 x 3.00	Some erosion	Insufficient
12 + 50	PC	Ø @ 0.5	Broken	Needs Replacement
13 + 00	PC	Ø @ 0.5	Broken	Needs Replacement
13 + 94	PC	Ø @ 0.5	Broken	Needs Replacement
20 + 50	PC	Ø @ 0.5	Half filled	Needs Replacement
21 + 66	PC	Ø @ 0.5	Completely eroded	Needs Replacement
22 + 00	PC	Ø @ 0.5	Completely eroded	Needs Replacement
23 + 70	PC	Ø @ 0.5	Half filled	Needs Replacement
26 + 12	PC	Ø @ 0.5	Good	-----
27 + 59	PC	Ø @ 0.5	Good	-----
30 + 81	PC	Ø @ 1.0		Needs Replacement
31 + 00	BC	1.40 x 3.00	Good	-----
36 + 51	PC	Ø @ 0.5	Completely filled	Needs Replacement
38 + 00	PC	Ø @ 0.5	Good	-----
40 + 17	PC	Ø @ 0.5	Filled	Needs Replacement
42 + 50	PC	Ø	Filled	Needs Replacement
44 + 92	PC	Ø @ 0.6	Filled	Needs Replacement
49 + 09	PC	Ø @ 0.6	Filled-eroded	Needs Replacement
49 + 44	PC	Ø @ 0.6	Filled-eroded	Needs Replacement
49 + 64	BC	1.50 x 3.00	Good	-----
49 + 79	PC	Ø @ 0.6	Broken	Needs Replacement
51 + 05	PC	Ø @ 0.6	Filled	Needs Replacement
57 + 00	PC	Ø @ 0.5	Broken	Needs Replacement
58 + 00	PC	Ø @ 0.8	Half filled-eroded	Needs Replacement

Table B.6 (Continued)

Station	Type	Dimensions(m)	Condition	Comments
61 + 08	PC	Ø	Filled	Needs Replacement
61 + 48	PC	Ø @ 0.8	Filled	Needs Replacement
62 + 24	PC	Ø @ 0.8	Broken-Filled	Needs Replacement
70 + 21	PC	Ø @ 0.8	Good	------
72 + 00	PC	Ø @ 0.5	Good	------
73 + 28	PC	Ø @ 1.5	Good-some erosion	Needs Repair
74 + 50	PC	2 Ø @ 0.6	Half Filled	Needs Replacement

* PC - Pipe Culvert

BC - Box Culvert

Table B.7

Inventory of Existing Small Drainage Structures

Dialaka-Sandaré

Station	Type *	Dimensions(m)	Condition	Comments
82 + 68	BC		Completely filled and covered	Needs Replacement
85 + 87	BC	2- 1.80 x 1.70	Half Filled	Needs Replacement
86 + 43	BC	1.20 x 1.00	Filled	Needs Replacement
93 + 92	small bridge		Good	
93 + 98	small bridge		Good	
94 + 10	PC	3 Ø @ 0.5	Filled	Needs Replacement
98 + 00	PC	Ø @ 0.5	Destroyed	Needs Replacement
141 + 00	PC & Ford	Ø @ 1.0	Eroded	Needs Replacement

* PC - Pipe Culvert

BC - Box Culvert

Table B.8

Inventory of Existing Small Drainage Structures

Sandaré-Nioro

Station	Type *	Dimensions(m)	Condition	Comments
147 + 80	PC	2 Ø @ 1.0	Filled	Needs Replacement
154 + 60	PC	2 Ø @ 0.5	Filled	Needs Replacement
156 + 50	Ford	30 x 5m	Eroded downstream	Needs Repairs
174 + 34	Ford	20 x 4m	Some erosion	Needs Repairs
177 + 00	PC	2 Ø@ 1.00	Good	------
178 + 00	PC	2 Ø@ 1.00	Good	------
178 + 00	PC	2 Ø@ 1.00	Good	------
193 + 96	PC	1 Ø @1.50,4Ø@1.00	Good	------
194 + 08	PC	2Ø@ 0.5	Half filled	Needs Replacement
204 + 00	PC	2Ø @ 0.5	Good-some erosion	Needs Repairs
206 + 97	BC	1.50 x 3.00	Good	------
208 + 00	PC	4 Ø @ 0.8	Good	------
209 + 00	Ford	20 x 5m	Not functional	To be removed
211 + 26	BC + PC	Ø@0.8,1.60x1.50	Some erosion	Needs Replacement
216 + 00	Ford	10 x 7m	Eroded	Needs Replacement
219 + 00	PC	3Ø@ 0.5	Filled-eroded	Needs Replacement
220 + 00	PC	Ø@ 0.5	Filled-eroded	Needs Replacement
220 + 62	BC	2-1.20 x 1.20	Filled-eroded	Needs Replacement
223 + 68	BC	2-0.6 x 0.6	Filled-eroded	Needs Replacement
223 + 90	PC	Ø @ 0.5	Filled-eroded	Needs Replacement
224 + 26	PC	2Ø@ 0.5	Some erosion	Needs Replacement
226 + 00	Ford	20 x 4m	Eroded	Needs Replacement
228 + 44	BC	2-1.50 x 1.60	Good	--------
229 + 49	PC	Ø@ 0.8	Good	--------
229 + 67	PC	Ø @ 0.8	Good	--------
243 + 00	Ford	20 x 4	Eroded	Needs Repairs
243 + 50	Ford	10 x 4	Eroded	Needs Repairs
244 + 20	Ford	12 x 4	Filled	Needs Replacement

Table B.8 (Continued)

Station	Type*	Dimensions(m)	Condition	Comments
245 + 20	BC	1.10 x 4.50	Filled	Needs Replacement
246 + 50	Ford	20 x 4	Eroded	Needs Replacement
247 + 00	BC	1 x 1	Eroded	Needs Replacement
248 + 00	BC	.80 x.70	Filled	Needs Replacement
248 + 43	BC	.65 x 2.20	Eroded	Needs Replacement
248 + 71	BC	1.00 x 1.20	Good	--------

* PC - Pipe Culvert

BC - Box Culvert

Table B.9

Inventory of Existing Small Drainage Structures

Dialaka-Yelimané

Station	Type*	Dimensions	Conditions	Comments
0 + 01	BC	1 x 1	Eroded	Insufficient
5 + 80	BC	1 x 1	Eroded	Very Insufficient
7 + 00	BC	1 x 1	Eroded	Very Insufficient
8 + 20	BC	1 x 1	Eroded	Very Insufficient
9 + 30	BC	.80 x.80	Eroded	Very Insufficient
10 + 50	BC	.70 x 1.00	Eroded	Very Insufficient
10 + 60	PC	Ø@ 0.8	Eroded	Very Insufficient
10 + 70	BC	1.50 x 1.90	Eroded	Very Insufficient
10 + 75	BC	1.50 x 1.90	Eroded	Very Insufficient
10 + 80	BC	1.50 x 1.90	Eroded	Very Insufficient
10 + 90	BC	1.50 x 1.90	Embankment washed away	Very Insufficient
11 + 70	BC	1.50 x 1.90	Eroded	Very Insufficient
11 + 90	BC	3-1.90 x 2.50	Embankment washed away	Very Insufficient
14 + 00	BC	1.50 x 2.00	Embankment washed away	Very Insufficient
14 + 30	PC	Ø @ 1.0	Embankment washed away	Very Insufficient
14 + 60	Ford	25 x 5	Deterioration of surface	Needs Repairs
15 + 20	BC	0.80 x 1.0	Embankment washed away	Very Insufficient
16 + 30	BC	Ø@ 1.0	Entire struc. washed away	Very Insufficient
16 + 60	BC	1.50 x 2.00	Embankment washed away	Very Insufficient
17 + 50	BC	1.00 x 1.70	Embankment washed away	Very Insufficient
18 + 70	BC	.80 x.80	Embankment washed away	Very Insufficient
19 + 00	BC	.80 x.80	Embankment washed away	Very Insufficient
21 + 00	BC	.80 x.80		Embankment not const. yet
23 + 30	BC	.80 x.80		Embankment not const. yet
24 + 50	BC	.80 x.80		Embankment not const. yet
26 + 00	PC	2Ø@ 0.80		Embankment not const. yet
26 + 30	PC	2Ø @ 0.80	Embankment washed away	Very Insufficient
27 + 00	PC	2Ø@ 0.80	Embankment washed away	Very Insufficient

Table B.9 (Continued)

Station	Type*	Dimensions	Conditions	Comments
35 + 30	PC	3Ø@ 0.80	Good	-----
35 + 60	BC	2-1.50 x 2.00	Good	-----
36 + 50	PC	2Ø@ 0.80	Filled	Very Insufficient
36 + 80	BC	1.50 x 1.50	Embankment washed away	Very Insufficient
37 + 20	PC	2Ø @ 0.8	Embankment washed away	Very Insufficient
37 + 70	BC		Embankment washed away	Very Insufficient
37 + 80	PC	2Ø@ 0.80	Embankment washed away	Very Insufficient
38 + 00	BC	1.50 x 2.00	Embankment washed away	Very Insufficient
38 + 00	PC	2Ø @ 0.80	Embankment washed away	Very Insufficient
38 + 10	BC	1.00 x 1.50	Embankment washed away	Very Insufficient
38 + 20	PC	3Ø @ 0.80	Embankment washed away	Very Insufficient
38 + 50	PC	2Ø @ 0.80	Embankment washed away	Very Insufficient
38 + 85	Ford	25 x 6m	Silted	Needs Replacement
43 + 50	Ford	6.5 x 6m	Eroded	Needs Replacement
44 + 00	Ford	12 x 6	Completely Silted	Needs Replacement
44 + 60	Ford	15 x 6	Completely Silted	Needs Replacement
44 + 80	Ford		Completely Silted	Needs Replacement
45 + 80	Ford	20 x 6	Some Erosion	Needs Repairs
46 + 00	Ford	15 x 6	Silted	Needs Repairs
46 + 50	Ford	15 x 6	Silted	Needs Repairs
48 + 10	Ford	30 x 7m	Silted	Needs Repairs
48 + 50	Ford	15 x 5m	Silted	Needs Repairs
51 + 60	Ford	35 x 6m	Good	--------
51 + 50	Ford	18 x 6	Eroded	Needs Replacement
51 + 70	PC	Ø @ 0.80	Filled	Insufficient
52 + 00	Ford	20 x 6m	Eroded	Needs Repairs
52 + 50	Ford	20 x 6m	Eroded	Needs Repairs
52 + 85	Ford	25 x 6m	Eroded	Needs Repairs
53 + 50	Ford	13 x 6m	Eroded	Needs Repairs
54 + 00	BC	3-2.00 x 3.00	Eroded	Insufficient

Table B.9 (Continued)

Station	Type*	Dimensions	Conditions	Comments
54 + 50	Ford	13 x 6m	Embankment washed away	Needs Replacement
56 + 30	PC	2Ø @ 0.80	Eroded	Insufficient
56 + 30	Ford		Failed	Insufficient
56 + 80	Ford	18 x 6m	Heavy Erosion	Needs Repairs
57 + 20	Ford	20 x 6m	Good	------
57 + 50	Ford	25 x 6m	Good	------
57 + 70	PC	Ø @ 0.80	Good	------
57 + 90	Ford	15 x 4.5m	Failed	Needs Replacement
58 + 10	PC	3Ø @ 0.80	Filled	Very Insufficient
58 + 20	Ford	20 x 5	Undermined	Needs Repairs
58 + 50	Ford	15 x 5	Eroded	Needs Repairs
58 + 70	Ford	18 x 5	Eroded	Needs Replacement
61 + 00	PC	Ø@ 0.80	Good	------
61 + 00	PC	2Ø@ 0.90	Good	------
61 + 20	Ford	18 x 5	Eroded	Needs Repairs
66 + 80	Ford +PC	3Ø0.90,25 x 4	Eroded	Needs Repairs

* PC - Pipe Culvert

BC - Box Culvert

APPENDIX C

APPENDIX C

GEOTECHNICAL REVIEW

C.1 SUBGRADE RECONNAISSANCE (July 1979)

(a) KM 1.4 to 58 (village of Ségala)

The purpose of the geotechnical reconnaissance within this sector was to spot check the comprehensive soils study previously made as part of the final design of a new alignment by B.C.E.O.M. In general, the findings and recommendations of BCEOM were verified, details of which are available with the Ministère des Travaux Publics in Bamako.

The proposed alignment generally follows or closely parallels the existing alignment but with a much improved horizontal geometry. Use of long tangents and large radius curves over the flat terrain results in a shortening of the roadway by about six percent. The proposed stationing is utilized herein.

Briefly, subgrade conditions are as follows:

KM 1.4 to 4.150: Silty clays of a P.I. of 14 to 16 and a CBR value, at 95% maximum (AASHTO - 180) density, of 5.

KM 4.150 to 6.250: Compressible, plastic clays of a P.I. of 30 and a design CBR of 4 or lower.

KM 6,250 to 10,500: Less plastic clays with a P.I. of 19 to 25 and CBR values, at 95 maximum density, of 6. A dolerite rock quarry can be developed near KM 7.

KM 10,500 to 14,000: Sandy silts here have a P.I. of 0 to 10 and a design CBR of 15. Laterite is available near KM 11 to 12 of sufficient quality to provide subbase for the preceeding sections.

KM 14,000 to 19,450: Silty clays of a P.I. of 5 to 22 and a design CBR of 6 to 7.

KM 19,450 to 21,150: Plastic clays with P.I. of 19 to 29 and surprisingly high design CBR values of 9 to 16.

KM 21,150 to 25,250: Less plastic clays of P.I. of 16 to 22 and design CBR of 11 to 12.

KM 25,250 to 28,750: Generally a high quality laterite of gravel with fines. The plastic index is 6 to 17 and the CBR at 95 maximum density is 42 to 90. Borrow pits within this area will provide much of the laterite base course from KM 1.4 to 58.

KM 25,750 to 37,200: Subgrade here ranges from sandy silt to silty clays of P.I. of up to 22 and CBR of 13 to 38.

KM 37,200 to 50,500: Here, high quality gravelly laterites provide not only a firm subgrade but also borrow areas which will yield high quality laterite for base course.

KM 50,500 to 52,504: Silty clays of P.I. of 14 to 16 and CBR of somewhat under 11.

(b) KM 58 to 69: The existing road crosses a somewhat higher plateau. Subgrade soils appear to be sandy clays, of such low-bearing capacity that numerous deep ruts have developed. From KM 64 to 67 the road has degenerated into a series of interweaving trails. No high quality borrow is evident for either subbase or base course. A total thickness of pavement of 50 to 60 cm probably will be needed and will have to be borrowed from outside of this sector.

(c) KM 69 to 78 (village of Dialaka): Broken schist is at or near the ground surface resulting in a much coarser gradation within the subgrade soils. A pavement thickness of 20 to 30 cm should prove to be sufficient. Material of base course quality appears to be available near KM 75. The turn-off to Yelimané is at KM 77.

(d) KM 78 to 86 (village of Marena): The existing road lies within a low lying valley between two steep sided mountainous ranges. This sector is reported to be submerged during much of the month of August. Special attention must be directed to flood studies and to the design of an embankment high enough to keep the subbase above flood design storms. Pavement thicknesses of 60 cm will be required above the subgrade soils and/or embankments composed of the clayey soils of this sector. No high quality borrow soils are evident.

(e) KM 86 to 90: Attempts have been made to stabilize the very poor clayey subgrade soils by means of hand placed large cobbles and stones. As many of these stones have punched downward into the subgrade, the riding surface is very rough. Where this rough macadum is stable and can be salvaged, a 30 cm base course will be needed. However, most of this sector will probably require a 50 cm pavement thickness. A gravel quarry is visible in the vicinity of KM 90.

(f) KM 90 to 96: (hillside construction for steeply climbing profile)

Within the northern three kilometers of this six kilometer sector, the alignment climbs to the level of the upper plateaus. Almost all construction within these three kilometers will be of the side hill construction. Roadway excavation will be in broken schist, which, if properly processed, should yield base course material. A sharp hairpin turn is at KM 94. Side hill ditches and embankment slopes will need erosion protection.

(g) KM 96 to 144 (village of Sandaré at KM 137: The initial 4 kilometers of this sector are in rolling to hilly terrain which flattens to a more level plateau thereafter. Broken schist is at or near the surface for about 50% of this sector and only a 30 cm leveling base course will be needed. Other low lying, flat clayey areas, having poor drainage, will require 50 to 60 cm of subbase and base over embankments which will be needed to prevent roadway flooding. A large ridge of laterite gravel is to the right of the alignment at KM 104. In general, the clayey sand subgrade soils are sensitive to moisture.

(h) KM 144 to 171 (village of Diola): Broken schist is at or near the surface throughout most at this sector. When rock is more deeply buried, the clayey sand soils are moisture sensitive, and erosion and traffic wear-and-tear have worn the road to a level lower than the surrounding ground. Here the roadway is a longitudinal drainage channel resulting in accelerated erosion and in nearly impossible trafficability. Traffic has created informal bypasses of such areas. With proper drainage the soils of this area should provide good support and 30 cm of base course will be needed. However, in numerous isolated areas poor drainage and clayey subsoils will require at least a 60 cm cover. Broken schist of base course quality should be available near KM 154 and 157.

(i) KM 171 to 199: The alignment traverses silty fine sands of "stabilized" dunes. Throughout most of the sector the road has degenerated into numerous interweaving trails. The initial 2 kilometers of this sector have been paved with schist gravel and are in very good condition where a uniform speed of 60 km/h was easily attained. During a more detailed soils and materials survey which followed this reconnaissance, the roadway was impassable on August 1, 1979 due to 1.25 deep standing water over the roadway immediately southwest of the one meter, four barrel culverts near KM 198. It had rained the previous evening but only 17.3 m of rainfall was recorded at the Nioro Airport, the nearest rainfall recording station. "Stabilized" dunes is intended to mean eolien sands which support a fragile vegetive cover, the root system of which holds the sand in place.

(j) KM 199 to 207: Subgrade soils in this sector consist of silty fine sands containing a significant percentage of very fine soil particles probably in the colloidal range. This grain sizing results in a soil which is very sensitive to moisture, being very slippery in the rainy season and dry and dusty in the dry season. Adequate drainage will be essential. A bridge approach, approximately 1/2 kilometer long in the vicinity of KM 201, is over very soft unstable soils which may require undercutting in order to construct a stable embankment topped with 60 cm of pavement structure. Otherwise 30 cm of base course should be enough for this sector if proper drainage is provided and maintained.

(k) KM 207 to 215: Subgrade soils here contain more course soils than the preceeding sector and are more stable. A 20 cm thickness of base course should be sufficient.

(l) KM 215 to 227: The alignment again crosses "stabilized" dunes similar to those between KM 171 and KM 199. The road here generally is a single track.

(m) KM 227 to 244 (Nioro du Sahel): This sector is in the best condition of the entire road, presumably due to superior maintenance. Subgrade is similar to that from KM 207 to 215.

C.2

LABORATORY TESTS ON REPRESENTATIVE SOILS
AUGUST/SEPTEMBER 1979

September 6, 79

Engineer: TAMS
File : S.050
Site : Kayes-Nioro Road
Subject : Geotechnical tests
Our Re : No. 271/79/CHS/MD

To: The Representative of Consulting Engineering firm TAMS
c/o Mr. George R. Thompson
USAID, Bamako

Following your work order placed with us please find herewith the results of our tests and our invoicing therefor.

In conformity with your request, geotechnical tests on samples taken from Kayes-Nioro Road were made by CE.N.R.EX.

Samples were taken and shipped to the Center by you.

The various tests carried out were as follows:

- Mechanical analysis
- Atterberg limits
- Modified Proctor
- CBR at 4 day imbibition

The following results were obtained: (see attachment)

NOTE: Due to lack of sampling material, performing CBR at 3 strokes for Sta. 157 was not possible.

Approved by the Head
of the C.M.S. Division

S. SISSOKO

The Head of Highway
Soil Section

CH. SYLLA

I - IDENTIFICATION

STA.	Sieve Analysis % passing through sieve (mm)						Atterberg limits		Classification		Observation
	20	10	5	2	1	0,08	LL	IP	HRD	USCS	
81	-	-	99.98	99.85	99.75	93.40	28	16	A-6(10)	CL	Platform Soil
89	-	99.8	99.6	99.5	99.4	94	34.5	17	A-6(11)	CL	
121	-	99	98	94	92	85.5	35	16	A-6(10)	CL	
136	-	-	99.75	99.6	99.4	81.6	20	7	A-4(8)	ML-CL	
157	-	-	99.95	99.90	99.70	50	18	7.5	A-4(0)	SM-SC	
209	-	99	97	96.4	95.7	70					
215	-	-	99.95	99.90	99.80	18.25					
219	-	-	99.99	99.97	99.94	43					
222	-	-	99.99	99.97	99.87	47					
135	86	63	38	31	27	23	27.5	15	A-2-6(0)	GA	Quarry Soil
141	100	91	51.5	36	32	27.50	30	11	A-2-6(0)	GA	
144	75,5	68	55	49	47	34	27	8.6	A-2-4(0)	GA	

2 - BEARING CAPACITY TESTS

STA.	Modified Proctor		C.B.R. (4 days)			C.B.R. 55 strokes	
	s	W % Opt	12 c	25 c	55 c	W % - 2%	W % + 2%
81	1.98	12.25	2.4	4.2	2.4		
89	1.84	12.00	5	5	5.2		
157	2.05	8.5	-	-	-	14	26
215	1.84	9.5	33	21	22		

Direction Nationale des Travaux Publics
Laboratoire National des Travaux Publics
de Bamako

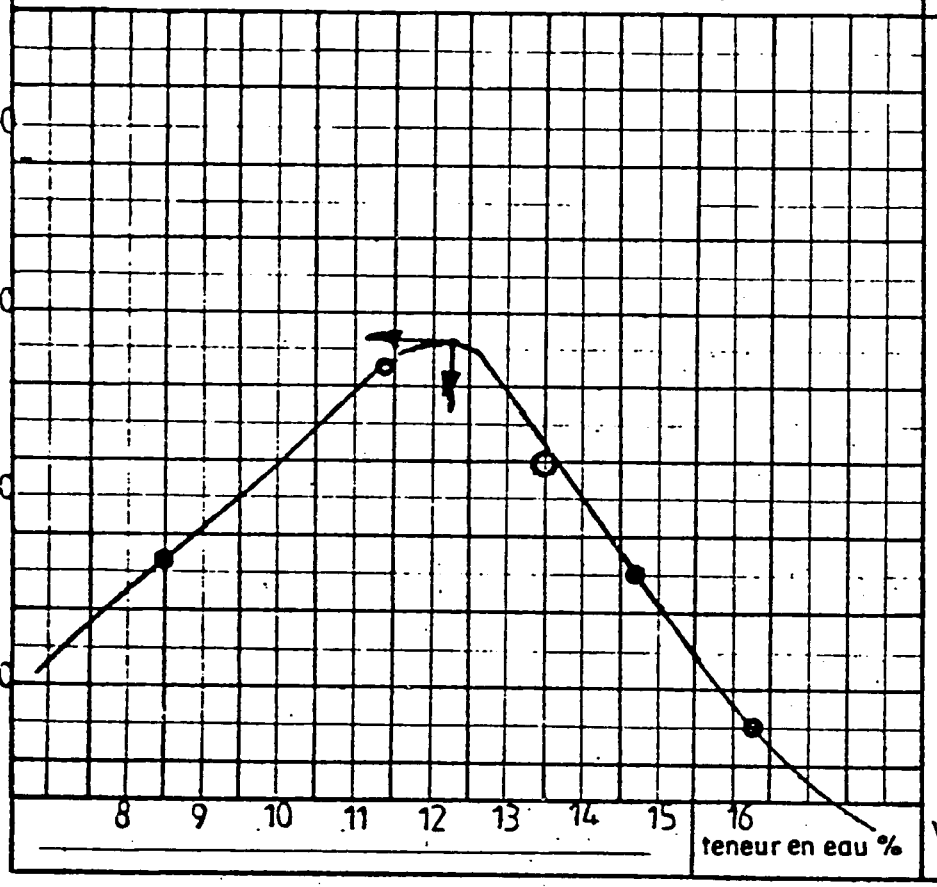
Dossier n° S 050
Echantillon PK 81
Date : 21/08/79

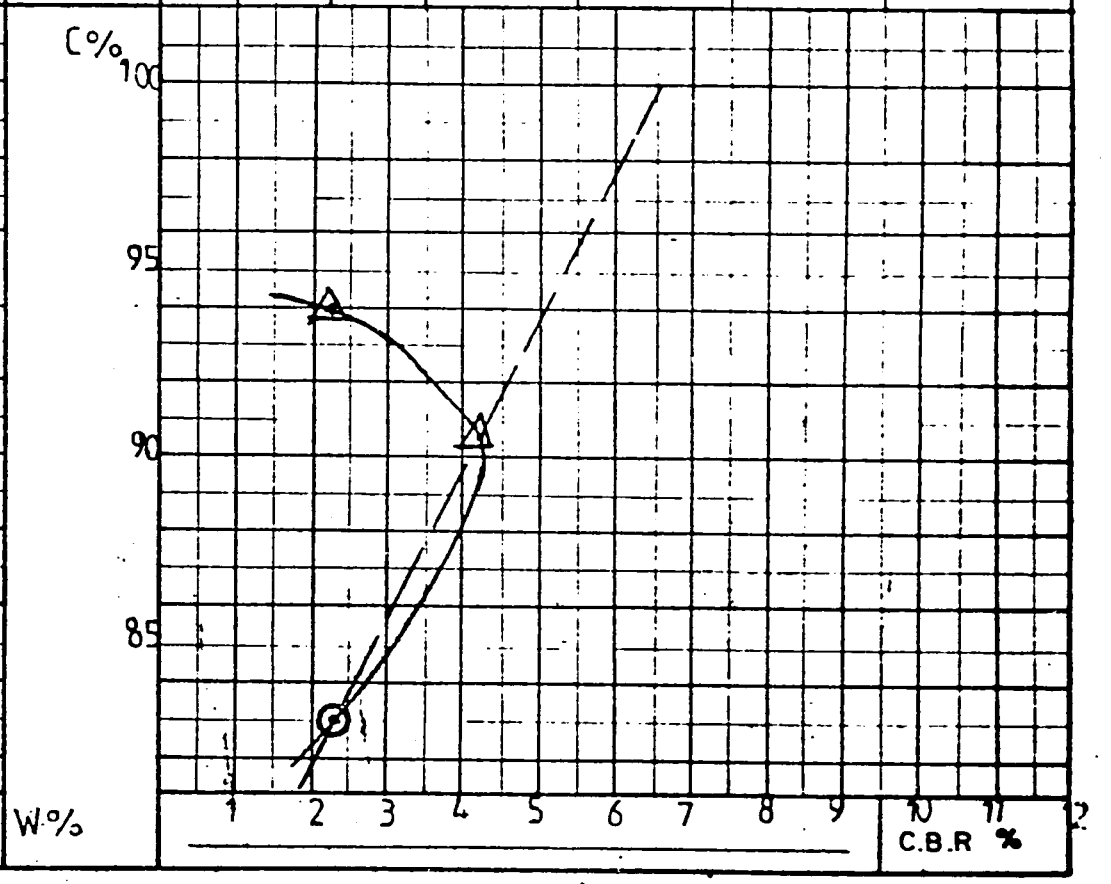
ESSAI PROCTOR - CBR

Route : Kayes - Niono PK 81

Sol de Plate forme

ESSAI PROCTOR MODIFIE	DENSITE SECHE	ESSAI C.B.R	4 j. Immersion Optimal		W % Moulage	W % Moulage	W % Imbibition	Gonflement
DENSITE SECHE MAXIMALE 1,98			Nb coups	□ 55	12,86		12,94	0,81
				Δ 25	12,86		20,14	1,29
TENEUR EN EAU OPTIMALE 12,25%				○ 10	12,86		23,91	1,55





Direction Nationale des Travaux Publics
Laboratoire National des Travaux Publics
de Bamako

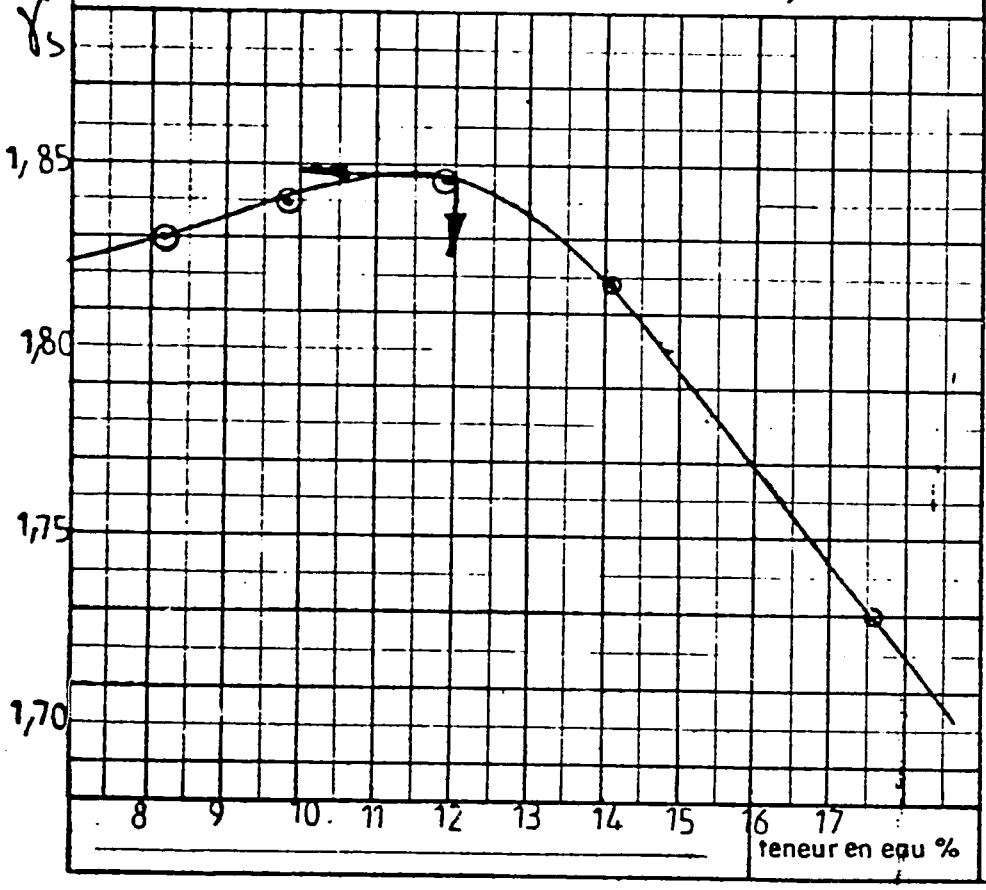
Dossier n° S 050
Echantillon PK 89
Date : 16/08/79

ESSAI PROCTOR - CBR

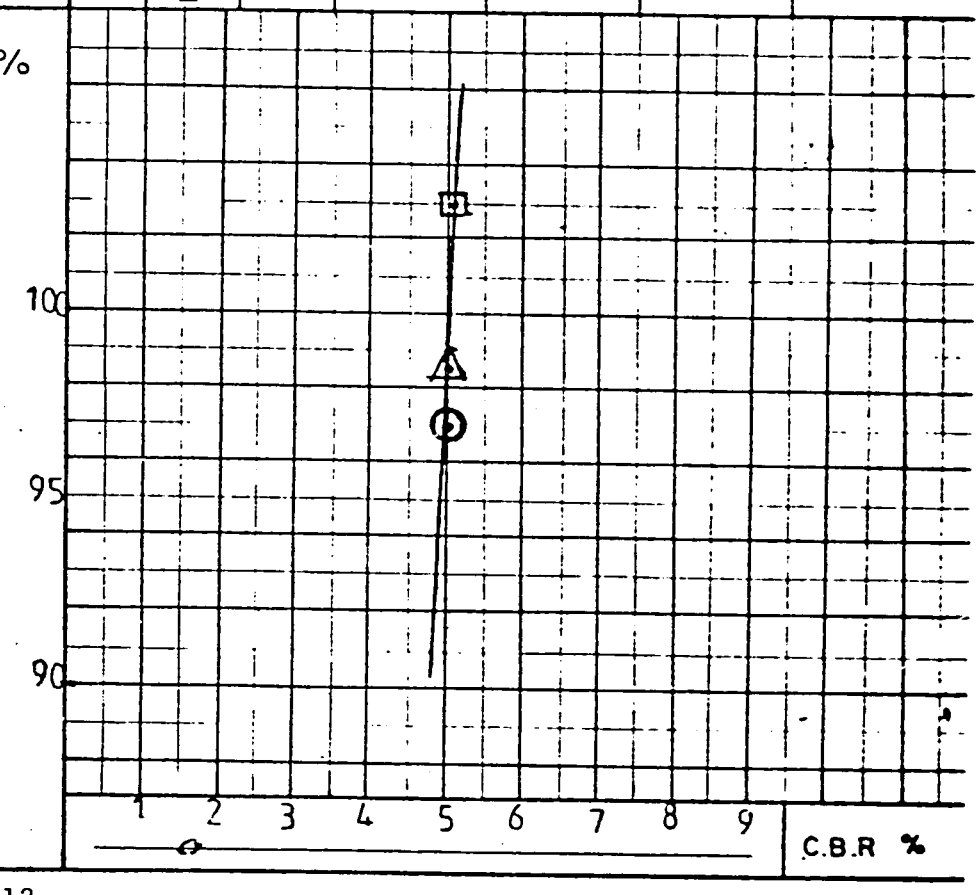
Route : Kayes - Niono PK 89

Sol de Plate forme

ESSAI PROCTOR MODIFIE	
DENSITE SECHE MAXIMALE	1,84
TENEUR EN EAU OPTIMALE	12,00



DENSITE SECHE	ESSAI C.B.R	4 j. Immersion Optimal		W % Moulage	W % Moulage	W % Imbibition	Gonflement
	Nb coups	□ 55		11,86		16,04	0,75
		Δ 25		11,86		18,23	1,21
		○ 10		11,86		18,08	



Direction Nationale des Travaux Publics
Laboratoire National des Travaux Publics
de Bamako

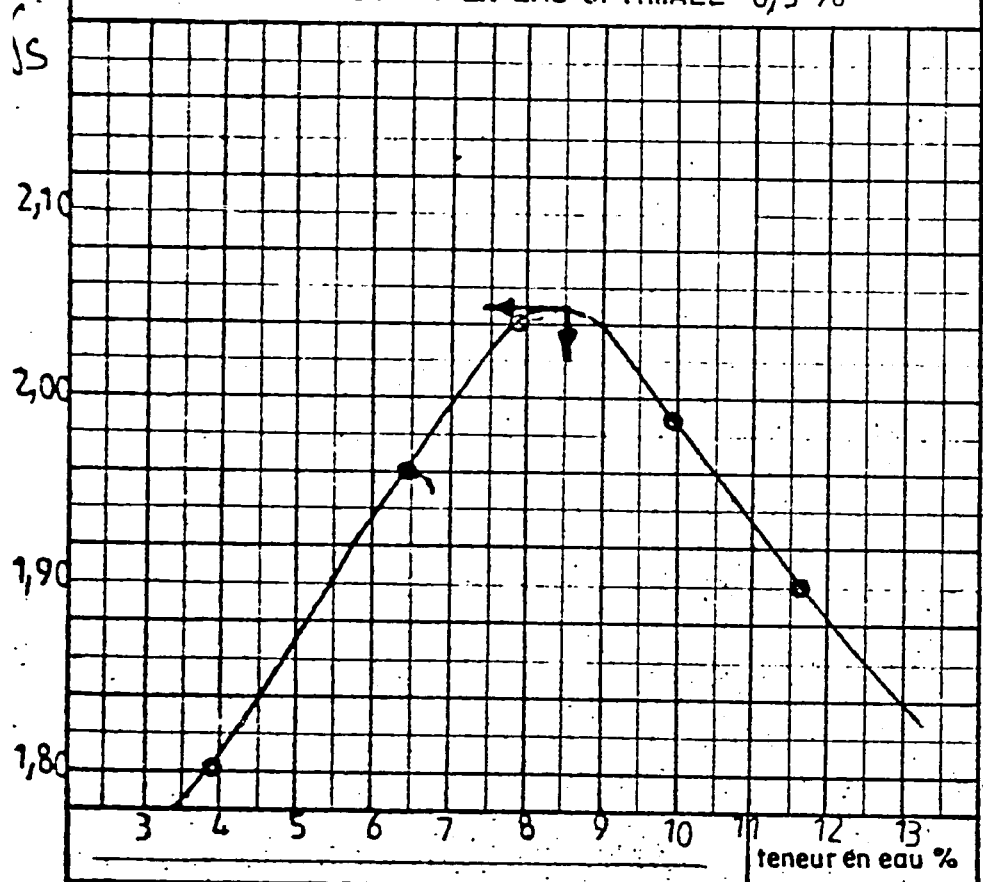
Dossier n° S 050
Echantillon : PK 157
Date : 13 / 03 / 79

ESSAI PROCTOR - CBR

Route : Kayes — Niora : PK 157

Sol de Plate forme

ESSAI PROCTOR MODIFIE	DENSITE SECHE	ESSAI C.B.R	4 j. Immersion	W % + 2%	W % - 2%		Gonflement
			Optimal	Moulage	Moulage	Imbibition	
DENSITE SECHE MAXIMALE 2,05		Nb coups	□ 55		6,34	11,86	0,82
TENEUR EN EAU OPTIMALE 8,5 %				10,35		12,73	0,82



C.B.R %

Direction Nationale des Travaux Publics
Laboratoire National des Travaux Publics
de Bamako

Dossier n° S 050
Echantillon PK 215
Date : 17/03/79

ESSAI PROCTOR - CBR

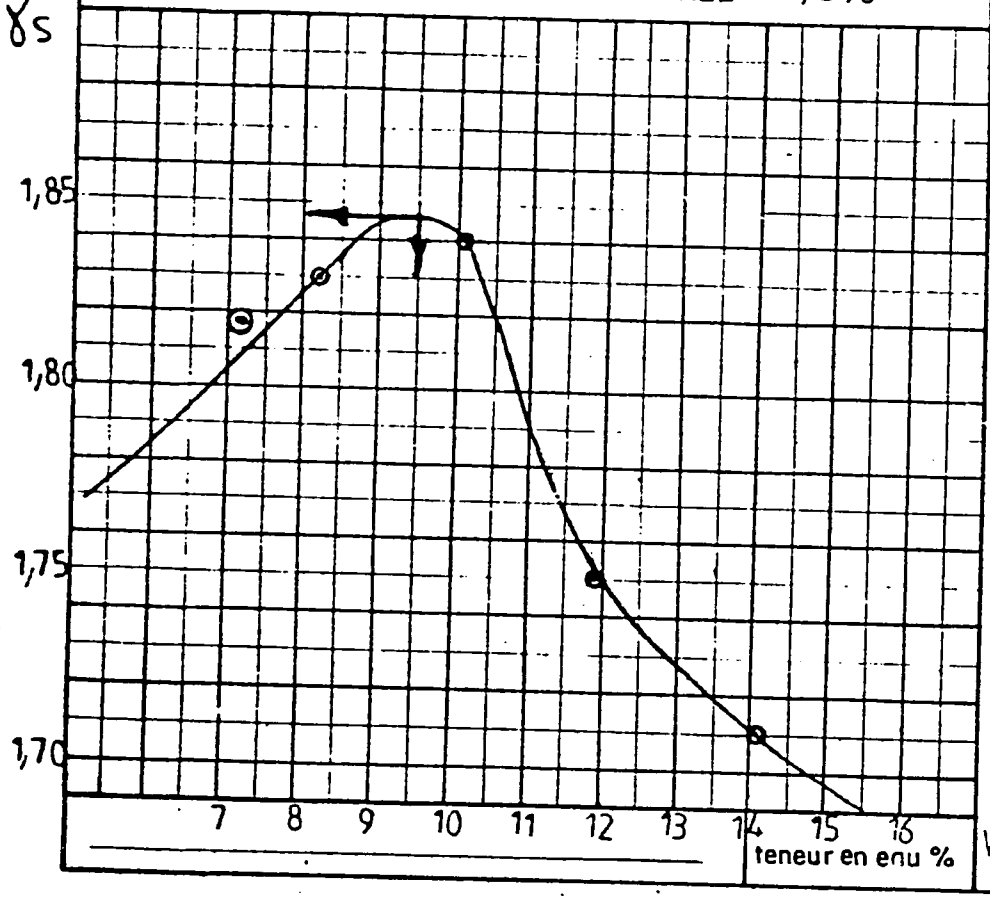
Route : Kayes - Niora PK 215

Sol de Plate forme

ESSAI PROCTOR MODIFIE

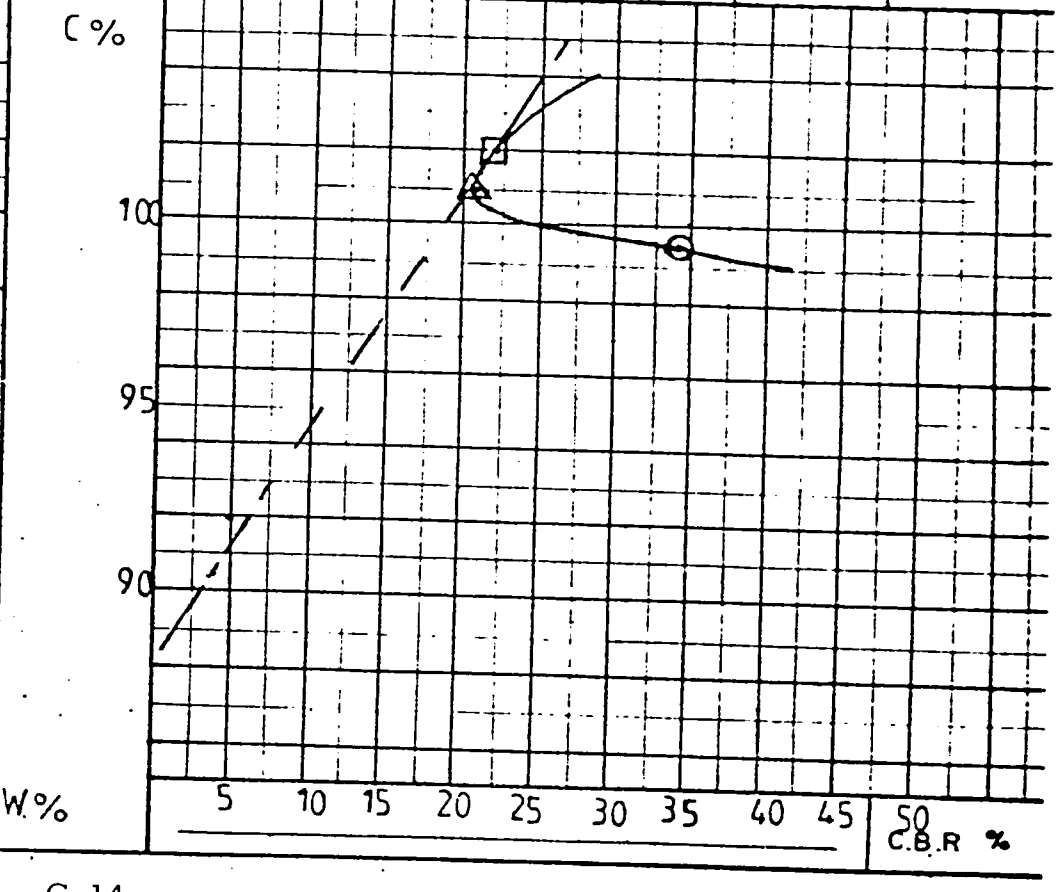
DENSITE SECHE MAXIMALE = 1,845

TENEUR EN EAU OPTIMALE = 9,5%



ESSAI C.B.R

DENSITE SECHE	4 j. Immersion Optimal		W % Moulage	W % Moulage	W % Imbibition	Gonflement
	Nb coups					
		□ 55	8,93		13,19	
		Δ 25	8,93		11,74	
		○ 10	8,93		11,53	



C.3

SOIL AGGREGATE SURVEY OF POTENTIAL BORROW SOURCES

KAYES-NIORO ROAD

Note: The following are extracts "as is" from the B.C.E.O.M. study.

NATURE GEOLOGIQUE DES TERRAINS RENCONTRES

Les bouleversements d'origine volcanique que cette région a subis permet la rencontre de roches et de terrains d'une grande diversité. Nous y trouvons des diorites et des basaltes en blocs erratiques et en éboulis en provenance des collines, ceci en particulier lorsque la route s'incurve vers les falaises. Nous rencontrons aussi des shistes dont la dureté plus faible a permis la formation de dépôts alluvionnaires de graviers et de sables, surtout dans la région de Lambarata.

Sur les plateaux à la sortie de Nioro et dans la région de Sandaré la richesse du sol en argile et l'absence de forte érosion ont permis la formation de roches latéritiques et de gravillons pisolithiques de même origine. Enfin dans les bas-fonds et dans les plaines, les eaux ont déposé des sables alluvionnaires, donc très légèrement argileux et des limons gris foncé à fort retrait.

OBSERVATION SUR LES MATERIAUX ROUTIERS

a) Matériau d'origine Latéritique: Les analyses granulométriques et les limites d'Atterberg effectuées sur ces sols démontrent qu'ils sont parfaitement utilisables (à de rares exception près que nous signalong chaque fois dans les caractéristiques des carrières) pour la mise en place d'une couche d'usure qui formera un véritable béton de sol naturel. La courbe granulométrique est du type B de l'A.A.S.H.O. avec toutefois, une tendance à sortir des faisceaux pour les éléments inférieurs à 0,5 m/m ou à 0,2 m/m dont le pourcentage est légèrement trop élevé. La plasticité moyenne est voisine de 10 ce qui est acceptable dans une région au climat sec.

b) Matériau d'origine shisteux: Les analyses granulométrique donnent généralement des courbes du type B mais ces roches d'origine

argileuse étant friables les limites dépendent en grande partie de leur dureté, et l'indice de plasticité est très variable mais dépasse rarement 15.

Ce gravier de shiste, étant d'emploi moins fréquent et de dureté moindre que le gravillon latéritique, il a été l'objet d'une étude plus approfondie.

Nous avons procédé à divers prélèvements puis déterminé par la méthode de quartage un échantillon présentant la meilleure chance de qualité moyenne.

Nous avons procédé aux essais (limites d'Atterberg et granulométrie) puis nous avons effectué un Proctor simple. 3 couches à 25 coups par couche correspondant à un compactage classique pour une route à moyen traffic.

La densité sèche obtenue a été le 1.89 pour une humidification de 10 % en poids.

Après démoulage et étuvage, nous avons refait une granulométrie et une limite.

Sur la feuille granumlométrique jointe le trait plein correspond à la granulométrie avant compactage et les tirets après compactage.

Nous remarquons une diminution en gravier d'un pourcentage en poids d'environ 3 % et une quantité correspondant d'augmentation de sable moyen fin et silt en même temps que l'I.P. augmentait de 2 unités et LL de 3.

La courbe reste cependant entièrement comprise dans le faisceau de type B de l'A.A.S.H.O. - Ce matériau convient parfaitement en couche d'usure mais la dégradation relativement rapide demandera un entretien constant.

Pour l'extraction de ces carrières de shistes les eaux ayant

déposé successivement au pied des collines les cailloux, puis les graviers, enfin les graviers plus fins et les sables, il faudra prévoir une extraction au bulldozer.

L'engin poussera dans la pente le matériau à employer procédant ainsi à un certain brassage, un loader pourrait charger ensuite sur camion le cordon ainsi formé.

c) Sables limons et argiles: Les sols prélevés classés sables limons (SL) ont donné aux limites d'Atterberg les résultats moyens suivants:

LL	29.2	25	27.5
LP	20.9	20.2	21.
IP	8.3	4.8	6.5

Les sols classés limons argiles (LA) ont donné

LL	39.7	29.6	41.2
LP	16.4	13.6	15.9
IP	23.3	16	25.3

Les sols classés sables ont une plasticité nulle ou faible non mesurable.

CLASSIFICATION DES SOLS:

Pour la sélection des sols pouvant constituer la couche de roulement nous avons comparé nos matériaux aux normes A.A.S.H.O. (American Association of State Highway Officials). Courbes ci-jointes.

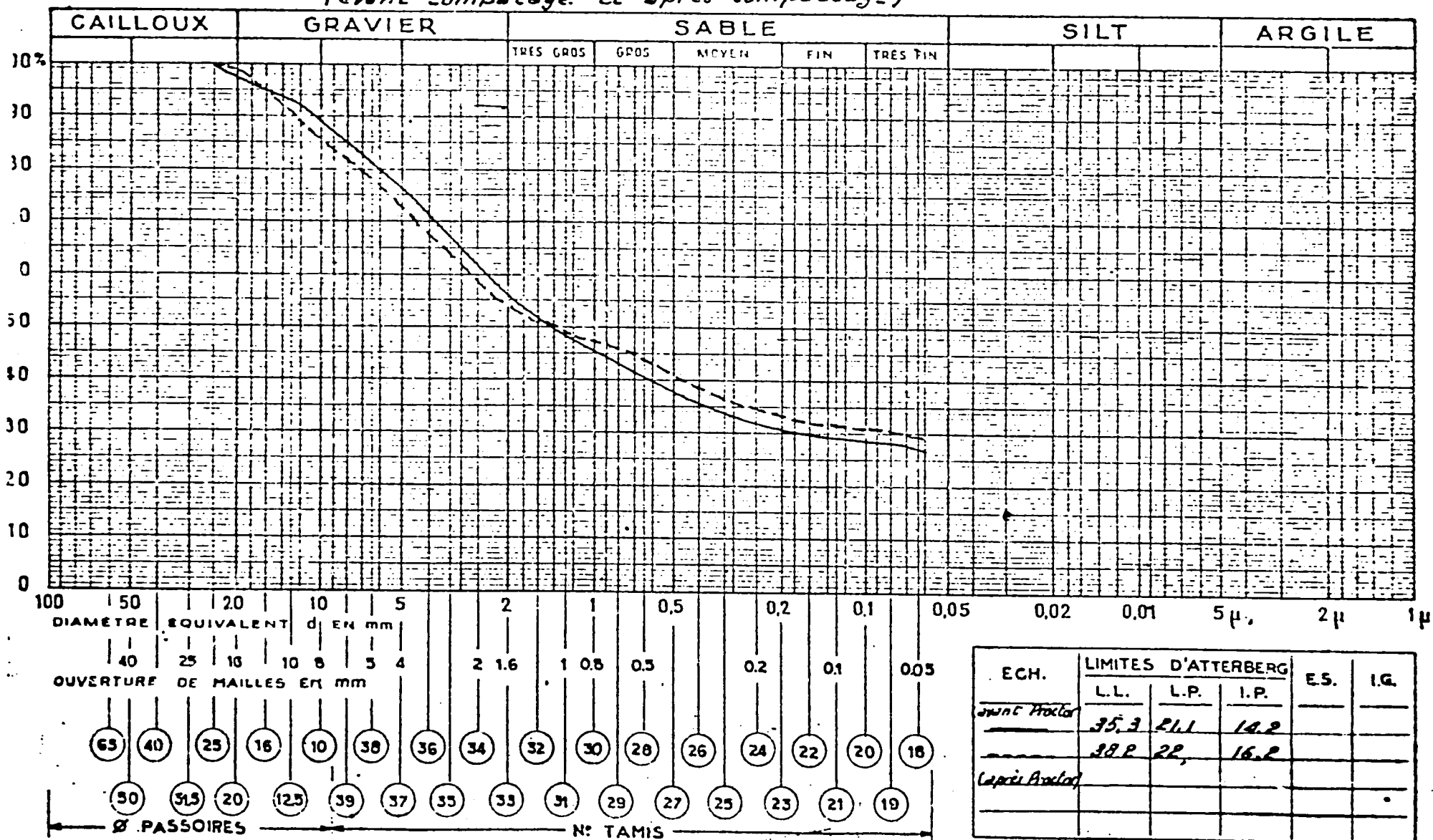
DOSSIER N°

SOUDAN
TRAVAUX PUBLICS
LABORATOIRE

ANALYSES GRANULOMETRIQUES

ECH.

Essais sur matériau shisteux
(avant compactage et après compactage)



ECH.	LIMITES D'ATTERBERG			E.S.	I.G.
	L.L.	L.P.	I.P.		
avant Proctor	35.3	21.1	14.2		
——	38.2	22,	16.2		
(après Proctor)					

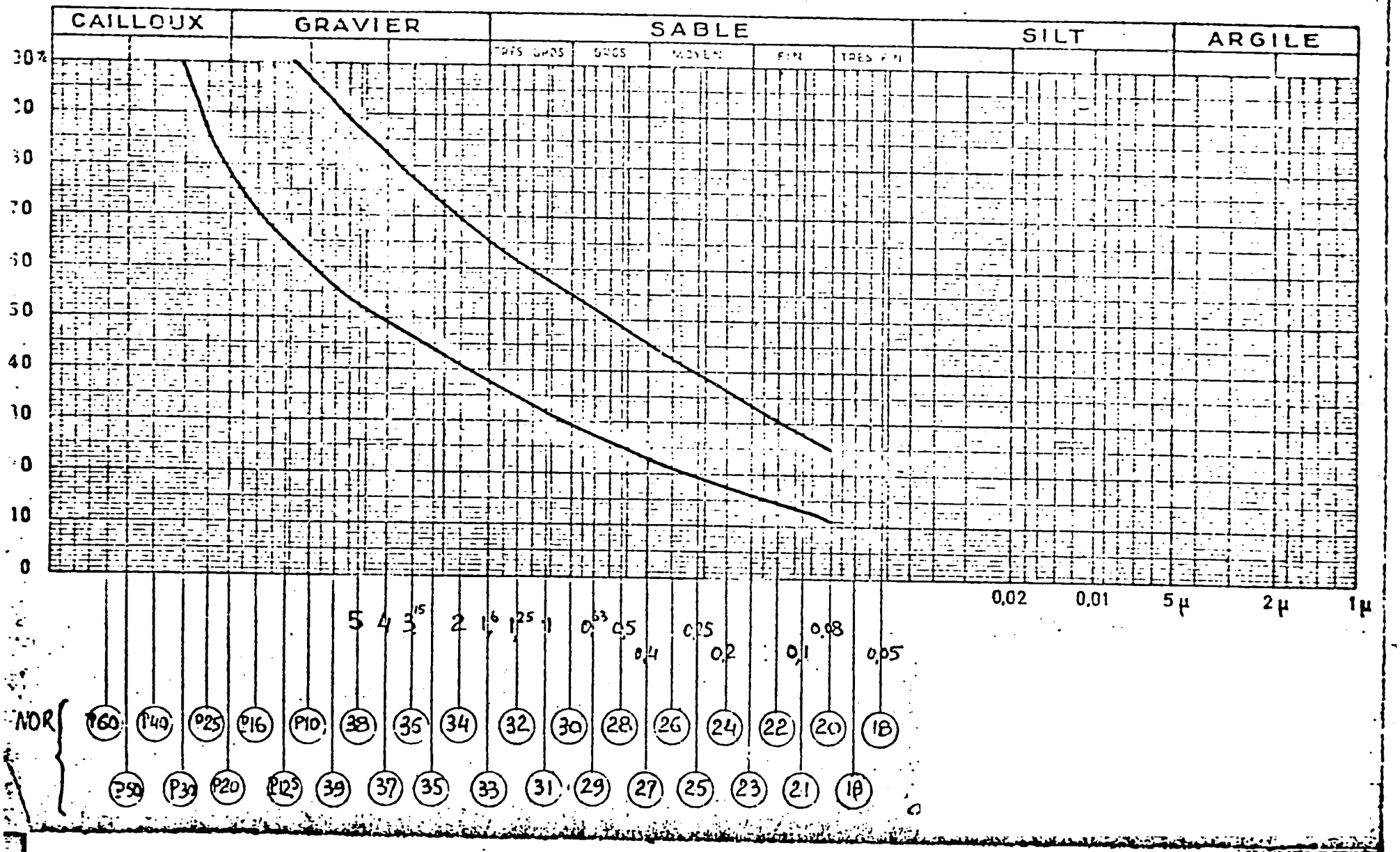
S.F.E.D.T.P.

LABORATOIRE.

Normes américaines A.A.S.H.O

ANALYSES GRANULOMÉTRIQUES

couche d'usure Type B 4 ≤ IP ≤ 9 LL ≤ 35



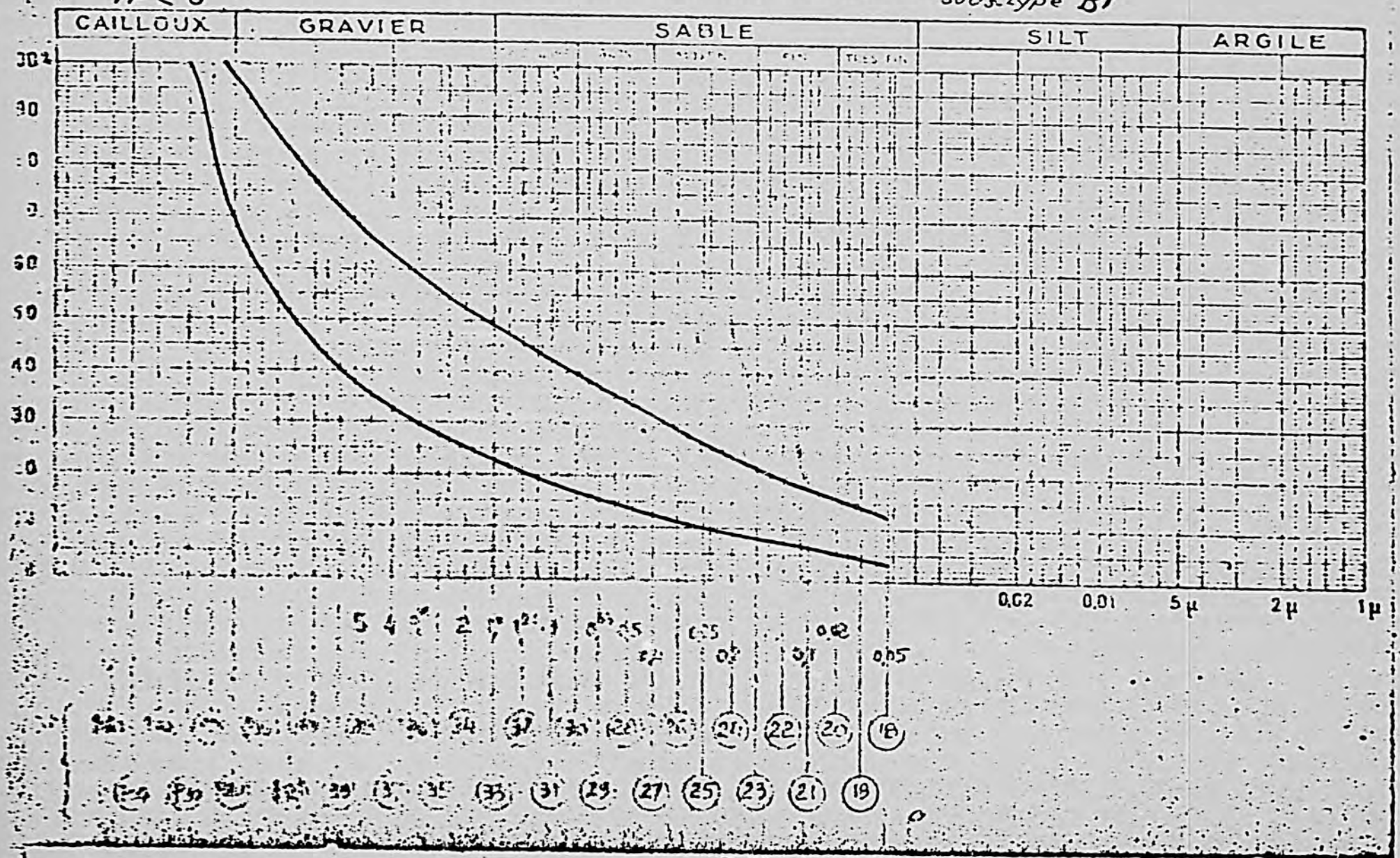
S.F.E.D.T.P. — Normes américaines A.A.S.H.O

LABORATOIRE

ANALYSES GRANULOMÉTRIQUES

Fondation de revêtement bitumineux - Type B sous-type B1

IP < 6

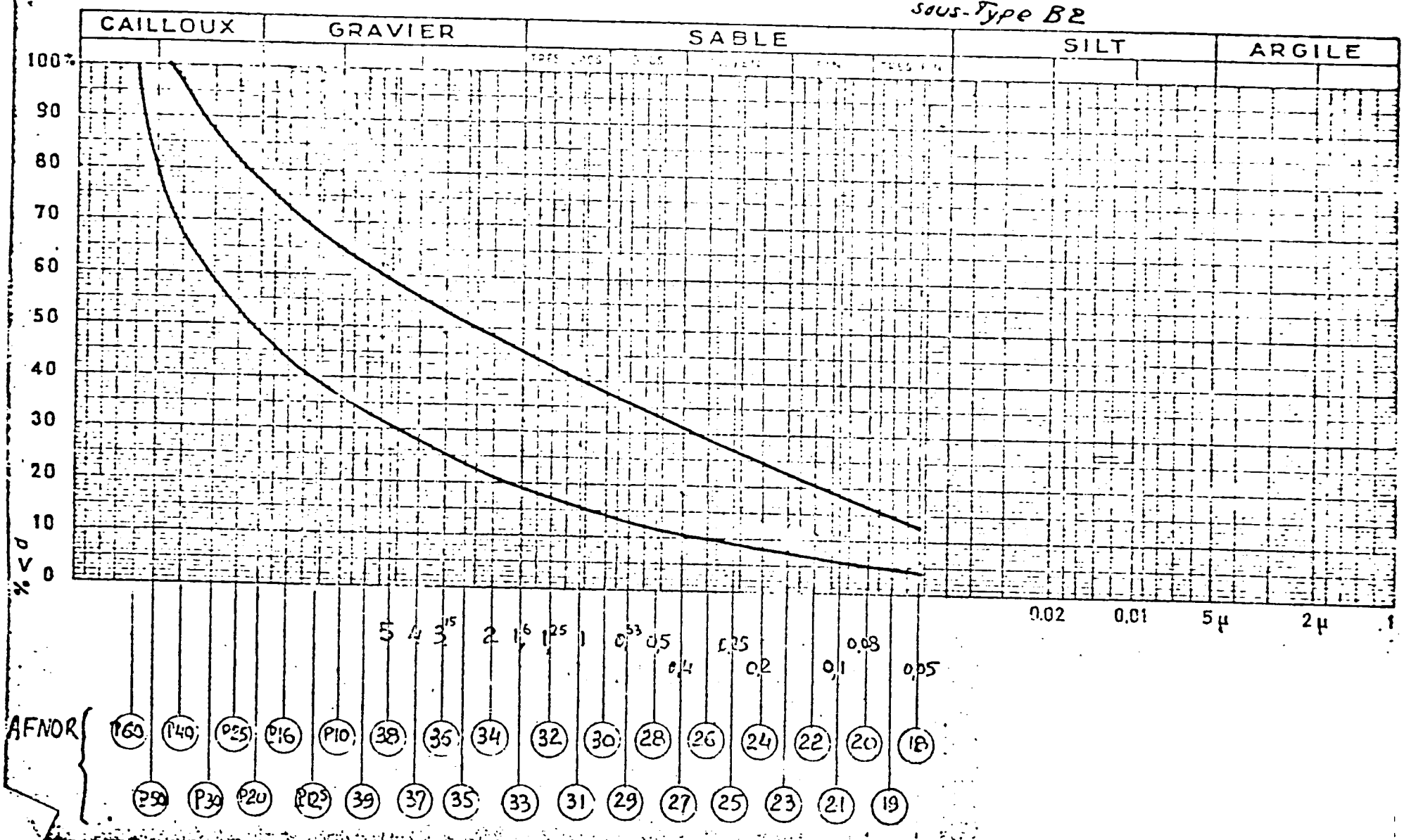


S.F.E.D.T.P. Normes américaines A.A.S.H.O

ANALYSES GRANULOMETRIQUES

LABORATOIRE

IP < 6 Fondation de revêtement bitumineux Type B sous-Type B2



II. CARACTERISTIQUES DES DIVERS GISEMENTS

1°)-753 B -Même type de matériau que le 685 B. Difficilement exploitable en bordure de la route en raison de l'étroitesse du dépôt.

Ce gisement s'étend entre 2 collines en face le 75.500.

Surface exploitable 20.000 m2. Puissance 6.000m3. Découverte nulle.

Allure générale des courbes de type B mais pourcentage de sable et silt légèrement trop élévé.

Acceptable toutefois en couche d'usure 6 L IP L9.

2°)-880 B -Vaste plateau graveleux s'étendant du P.K. 85 au PK 90,5.

Le début du gisement est formé de cailloux et de graviers d'origine shisteuse de bonne qualité mais qu'il est préférable d'utiliser en sous fondation en raison de leur dureté supérieure à celle des graviers d'origine latéritique. Découverte faible ou nulle sur toute la longueur du plateau. Interruption du gisement entre le PK 86,500 et 87.

Allure générale des courbes de type B

5 L IP L 13

Sol convenant parfaitement en couche d'usure.

3°)-918 B -Séparé du précédent par un banc de shistes et de sable limoneux. Exploitation facile entre le PK 92 et le PK 92,500.

Découverte nulle - Gravier d'origine latéritique

Allure générale des courbes de type B. Pourcentage légèrement trop élevé des sables fins et silt. Acceptable en couche d'usure.

5 L IP L 10

4°)-1015 B-Gisement d'origine latéritique s'étendant du PK 100,80 au PK 102,200. Facilement exploitable et découverte nulle à partir du PK 101. Epaisseur moyenne de graviers: 0m,40 Allure générale des courbes de type B. Pourcentage légèrement trop élevé sable moyen, fin et ni silt. Acceptable en couche d'usure.

5 L IP L 10

5°)-1045 B-Butte latéritique en face le PK 104,5 et à 150 m de la route. Exploitable dans sa partie basse sur une largeur de 40 m environ. Epaisseur moyenne de gravier 0m,50
Découverte nulle. Puissance 4.000 m3
Courbes granulométriques de type B

IP moyen 10

Sol parfait en couche d'usure.

6°)-1080 B-Gisement situé à 100 m de la route, à droite, origigine latéritique. Découverte nulle, épaisseur moyenne de gravier 0m,40. Surface exploitable: 50.000 m2. Puissance 20.000 m3
Allure générale de courbes de type B IP moyen 6.

7°)-1087 B-Gisement situé à gauche de la route, à 100 m, origine latéritique. Découverte nulle, épaisseur moyenne de gravier 0m,40. Surface exploitable 30.000 m2. Puissance 12.000 m3
Courbes granulométriques de type B IP moyen 6.

8°)-1105 B-Carrière située au PK 110,600 à droite et à 200m de la route, origine latéritique. Découverte nulle. Epaisseur moyenne de gravier 0m,40. Surface exploitable 50.000 m2. Puissance 20.000 m3.
Courbes granulométriques de type B IP moyen 6.

9°)-1120 B-Gisement important de part et d'autre de la route s'étendant du PK 111,200 au PK 112,500. Origine Latéritique. Découverte nulle, épaisseur moyenne de gravier 0m,40
Courbes granulométriques de type B IP moyen 7.

10°)-1135 B-Faible gisement de part et d'autre de la route en face le PK 113,500. A droite ne s'étend pas au delà de 50m. Découverte nulle. Epaisseur moyenne de gravier 0m,40. Surface exploitable 10,000 m2 environ. Puissance 4.000 m3.
Courbes granulométriques de type B IP moyen 7.
Le matériau de ces gisements convient parfaitement en couche d'usure.

11°)-1174 B-Vaste plateau latéritique s'étendant du PK 115,700 au PK 118,500. Découverte faible ou nulle. Epaisseur moyenne de gravier 0m,40. Allure générale des courbes de type B.
Si les sols prélevés en regard des PK 116,700 et 116,800 sont assez plastique (15) le reste des essais donne une moyenne d'IP égale à 7.

12°)-1195 B-PK 119,5

Gisement situé à droite et à 100 m de la route. Origine latéritique. Découverte nulle. Epaisseur moyenne de gravier 0m,40. Surface exploitable 30.000 m2. Puissance 12.000 m3.
Allure générale des courbes de type B. Toutefois au milieu du gisement, 2 essais ont relevé un excès de pourcentage en sable fin. La mise en cordon au bull de ce gravier donnera lieu à un certain brassage qui atténuerait ce défaut IP moyen 7.

13°)-1206 B-Gisement de gravier latéritique s'étendant du PK 120,400 au PK 121 de part et d'autre de la route. Découverte nulle.
Epaisseur de gravier 0m,40.
Courbes granulométriques de type B IP moyen 10.

III. CARACTERISTIQUES DES DIVERS GISEMENTS

1°)-1226 B-Gisement à droite et à 100 m de la route, s'étendant du PK 122,300 au PK 123,200. Origine latéritique. Découverte nulle. Epaisseur moyenne 0m,40.

Courbes granulométriques en dehors des faisceaux pour les éléments inférieurs à 0,2 m/m. Plasticité élevée 15 L IP L 20. Ce matériau conviendrait plutôt en sous fondation.

2°)-1254 B-Faible gisement à droite et à 100 m de la route, au PK 125,400 origine latéritique, découverte nulle, épaisseur moyenne de gravier 0m,20. Surface exploitable 10.000 m2. Puissance 2,000 m3.

Courbes granulométriques en dehors des faisceaux IP moyen 12.

Vu la proximité des autres gisements celui-ci peut être réservé au remblai ou à la sous fondation.

3°)-1269 B-Gisement latéritique de part et d'autre de la route entre le PK 126,400 et le PK 127,300. Découverte nulle. Epaisseur de gravier 0,40.

Courbes granulométriques de type B. sous-type B I IP moyen 10.

4°)-1281 B-Gisement de gravier latéritique situé à droite de la route entre le PK 127,500 et le PK 128,600. Découverte nulle. Epaisseur moyenne de gravier 0m,40.

Allure générale des courbes de type B et type B sous-type B I - IP moyen II. A partir du PK 128,300 la plasticité atteint 16, cette dermière partie pourrait être utilisée en sous-fondation.

5°)-1301 B -Faible gisement de part et d'autre de la route, épaisseur moyenne 0m,10. Courbes en dehors des faisceaux. Utilisable en remblai IP voisin 16.

6°)-1370 B -Faible gisement latéritique, situé à droite de la route au PK 137. Découverte nulle. Epaisseur moyenne 0m,40. Courbes granulométriques en dehors des faisceaux 60 % de sable fin silt et argile. Utilisable en remblai et en sous-fondation.

IP moyen 128.

7°)-1394 B -Gisement latéritique situé à droite de la route en face du PK 139,500 découverte nulle, épaisseur moyenne 0m,40. Surface exploitable 10.000 m2. Puissance 4.000 m3. Courbes granulométriques de type B sous-type B 1. Sol très plastique IP moyen 19 utilisable en sous-fondation.

8°)-1431 B -Cailloux schisteux et argile, utilisable en remblai faible pourcentage de gravier de schiste: 10 % - IP 17.

9°)-1450 B -Dépôt de cailloux et gravier de schistes, situé à droite de la route et à environ 200m entre le PK 144,500 et le PK 145,300. Surface exploitable 75.000 m2. Découverte nulle, épaisseur de gravier 0m,32. Puissance 22.000 m3 environ. Courbes granulométriques de type B sous-type B I. Quelques courbes rélèvent cependant un excès d'éléments inférieurs à 0,2 m/m, maïs ces sols restent cependant très acceptables en couche d'usure IP moyen 13.

10°)-1466 B -Dépôt de caillous et gravier de schiste entre le PK 146 et PK 147,200. Découverte nulle - Epaisseur moyenne 0m,30. Surface exploitable 40.000 m2. Puissance 12.000 m3. Courbes granulométriques de type B sous-type B I IP moyen 8. Sol convenable en couche d'usure.

11°)-1490 B Cailloux et gravier de schistes à gauche de la route entre le

PK PK 148,800 et 149,600. Découverte nulle, épaisseur moyenne 0m,30. Surface exploitable 16.000 m2. Puissance 5.000 m3. Du PK 148,800 au PK 149,100. Sol acceptable en couche d'usure, le reste du gisement est à utiliser en sous-fondation le pourcentage de sable et silt étant trop élevé.

12°)-1520 B -Du PK 150,400 au PK 153,200 s'étendant plusieurs dépôts de cailloux et graviers de schistes d'une surface exploitable d'en-

vi viron 35.000 m2. La découverte est nulle et l'épaisseur exploitable est de 0m,25 en moyenne; La puissance totale serait de 9.000 m3. environ.

L'allure générale des courbes est de type B. Ce sol est acceptable en couche d'usure malgré sa plasticité assez élevée IP moyen (15).

13°)-1630 B -Gisement à gauche de la route à environ 1500 m de celle-ci en face du PK 163. Accès difficile en raison d'un oued s'étendant parallèlement à la colline au pied de laquelle se trouve le gisement.

Matériau d'origine schisteux.

Courbes granulométriques type B IP moyen 6.

Utilisable en couche d'usure.

14°)-1696 B -Faible gisement de cailloux et gravier de schistes à gauche de la route au PK 169,600. Puissance 1500 m3.

Utilisable en sous-fondation. Exploitation malaisée.

15°)-1720 B -Vaste gisement d'origine latéritique et schisteuse s'étendant de part et d'autre de la route entre le PK 171,400 et le PK 172,700. Découverte nulle. Epaisseur moyenne exploitable 0m,40. Courbes granulométriques de type B IP moyen 9.

16°)-1733 B -Gisement de gravier d'origine latéritique et schisteuse situé en contrebas d'une colline à 300 m à droite de la route en face du PK 173,300. Découverte nulle. Epaisseur moyenne exploitable 0m,40. Puissance 6.000 m3.

Courbes granulométriques de type B IP moyen 8.

17°)-1745 B-Gisement d'origine latéritique situé à droite de la route entre le PK 173,800 et le PK 175, 500. Découverte nulle, épaisseur moyenne, exploitable: 0m,40.

Courbes granulométriques de type B IP moyen 8.

18°)-1771 B-Gravier d'origine latéritique et schisteuse. Découverte nulle. Epaisseur exploitable 0m,30. Puissance 4.500 m3.

En dehors du faisceau de type B pour les éléments inférieurs à 0.50 m/m IP moyen 7. Acceptable en couche d'usure.

19°)-1880 B-Gisement d'origine latéritique situé à 2.000 m à droite de la route chemin de brousse aménagé au départ de Ségala. Surface exploitable 5.000 m2. Epaisseur de gravier 0m,30. Puissance 1.500 m3.

Matériau hétérogène. Difficilement exploitable. Convenant en sous-fondation.

20°)-1977 B-Faible gisement utilisable en sous-fondation. Puisance approximative 800 m3.

21°)-2110 B-Gisement de gravier latéritique à droite de la route. Découverte faible ou nulle. Epaisseur moyenne exploitable 0m,40.

Courbes granulométriques de type B IP moyen 10.

22°)-2027 B-Gisement d'origine latéritique s'étendant du PK 202,100 au PK 203,400. Découverte faible ou nulle. Epaisseur moyenne exploitable 0m,40.

Allure générale des courbes granulométriques de type B IP moyen II.

23°)-2043 B-Gisement d'origine latéritique et shcisteuse situé en contrebas d'une colline en face le PK 204,300. Découverte moyenne 0m,20. Puissance approximative du gisement: 1.500 m3. Exploitation difficile.

Courbes granulométriques en dehors des faisceaux du type B IP moyen 10. Sol à employer en sous-fondation.

24°)-2090 B-Faible gisement situé en contrebas d'une colline en face du PK 209. Puissance 800 m3. Exploitation difficile.
Sol hétérogène IP variant de 4 à 12.
Utilisable en sous-fondation.

25°)-2140 B-Gisement situé à 250 m à gauche de la route sur une colline accessible aux engins. Les sondages effectués au pied de cette colline n'ont donné que des échantillons faibles en gravier. Il conviendra donc d'exploiter le sommet. Découverte nulle. Epaisseur moyenne 0m,30.
Les courbes granulométriques sont en dehors des faisceaux de type B - IP moyen 14. Ce sol conviendra en sous fondation.

26°)-2152 B-Faible gisement à gauche de la route au PK 215,2 Sol hétérogène, exploitation délicate. Puissance 1000 m3.
Courbes en dehors des faisceaux. A employer en remblai 6 IP 15.

27°)-2205 B-Vaste plateau latéritique s'étendant du PK 219,2 au PK 221,6 Découverte nulle. Epaisseur moyenne, exploitable 0m,40.
Courbes granulométriques comprises dans les faisceaux de type B. 7 IP 15.
Sol convenant en couche d'usure.

28°)-2260 B-Colline latéritique à gauche de la route de 150 m à 500 m de celle-ci au PK 226. Découverte nulle - épaisseur moyenne de gravier 0m,40.
Allure générale des courbes du type B 5 IP 13.
Convenant parfaitement en couche d'usure.

29°)-2309 B-Gisement à droite de la route et à 100 m de celle-ci entre le PK 230,3 au PK 231,5. Découverte nulle ou faible. Epaisseur moyenne 0m,40. Allure générale des courbes du type B mais tendance à sortir des faisceaux pour les diamètres inférieurs

à 0,5 m/m 5 IP II. Acceptable en couche d'usure.

30°)-2345 B-Gisement à 100 m de la route à droite au PK 234,5. Le gravier commence derrière des rochers de diorite visible de la route et s'étend en profondeur. Exploitation délicate, carrière hétérogène le matériau se trouvant pas places. Découverte faible ou nulle. Epaisseur moyenne de gravier 0m,40.

Allure générale des courbes du type B sauf pour les éléments inférieurs à 0,5 m/m dont le pourcentage est légèrement trop élevé. Plasticité très variable, allant de 6 à 20. Il conviendrait de mettre en cordon et de pratiquer à un certain brassage pour obtenir une meilleure homogénéité. Acceptable en couche d'usure.

31°)-Route de FOUKI:

Nous avons recherché une carrière dans les environs de Kayes afin de tenter de raccourcir les distances de transport pour les premiers kilomètres de la route, la carrière 2345 B se trouvant à 11 Km,500 de la fin du tronçon. Sur la route de Bamako, au PK 7 à gauche se trouve une carrière dont le matériau convient parfaitement en couche d'usure. Allure générale du type B IP moyen voisin de 8. Cette carrière s'étend route de Fouki de 100m à 1 km de la route fédérale en bordure d'une colline. La distance de cette carrière à l'origine des travaux serait d'environ 9 kms.

APPENDIX D

APPENDIX D

BRIDGE INVENTORY

Herein is a summary of the bridge inventory carried out as part of the feasibility study for the Kayes-Nioro Road in Mali. The inventory is presented in a standardized manner covering the following information:

- Water Crossing Name
- Stationing
- Photograph(s) of the Bridge
- Description
- Evaluation
- Estimate of Quantities
- Estimate of Costs

The results given are based on a field inspection visit during October 1979.

D - 1 / BRIDGES ON KAYES-NIORO ROAD

PHOTO NO. 22
Elevation

BRIDGE ACROSS KOULOU RIVER
Station: 11 + 41

DESCRIPTION: This is a two span bridge. Each span is 4 meters long. Abutments and pier are stone masonry and the superstructure is a reinforced concrete solid slab; the curb-to-curb width is 3 meters.

EVALUATION: Substructure and superstructure elements show only minor deterioration; the Kayes-side abutment shows loss of material around the footing. Approaches have settled slightly, and there is considerable erosion of the embankment at the approaches. The wearing course needs resurfacing and railings need repair for a 10 meter length.

ESTIMATE OF QUANTITIES:

Resurfacing	–	24 sq. m.
Railing Repairs	–	10 m.
Concrete (350 kg.)	–	4 cu. m.
Earthwork	–	60 cu. m.

ESTIMATE OF COSTS:
1,406,000 FM

PHOTO NO. 18
Underside of the deck

PHOTO NO. 19
Elevation

BRIDGE ACROSS OUAHIQUETOU RIVER
Station: 19 + 34

DESCRIPTION: This is a two span bridge. Each span is 9.5 meters long. The abutments and pier are stone masonry. The superstructure consists of reinforced concrete T-girders and a deck slab with diaphragms; the curb-to-curb width is 3 meters.

EVALUATION: The substructure and superstructure show only minor deterioration; erosion due to scour is minimal. The wearing course needs resurfacing and railings need repair along the entire length.

ESTIMATION OF QUANTITIES:

Resurfacing	–	60 sq. m.
Railings	–	40 m.
Concrete (350 kg.)	–	4 cu. m.
Earthwork	–	10 cu. m.

ESTIMATE OF COSTS:
3,028,000 FM

PHOTO NO. 14
Underside of the deck

PHOTO NO. 15
Elevation

BRIDGE ACROSS KEBATE RIVER
Station: 29 + 77

DESCRIPTION: This is a three span bridge. Span lengths are 9.0, 9.0, and 6.0 meters. Abutments and piers are stone masonry. The superstructure consists of reinforced concrete T-beams and a deck slab; the curb-to-curb width is 3 meters.

EVALUATION: Repairs have been made to piers and abutments by plastering the surface with cement mortar. In many places the plaster is spalling. The bridge seat on the Nioro-side abutment requires repairs. The concrete in the T-beams and underside of the deck has heavy spalls and exposed reinforcing bars at several locations.

ESTIMATION OF QUANTITIES:

Railings	–	60 m.
Concrete (350 kg.)	–	11 cu. m.
Earthwork	–	50 cu. m.

ESTIMATE OF COSTS:
5,292,000 FM

PHOTO NO. 13
Elevation

BRIDGE ON KAYES-NIORO ROAD
Station: 31 + 20

DESCRIPTION: This is a one span bridge. The span length is 9.0 meters. Abutments are stone masonry. The superstructure consists of reinforced concrete T-girders and a deck; the curb-to-curb width is 3.0 meters.

EVALUATION: Stone masonry joints on the abutments are in poor condition. The concrete in the deck and curbs has spalls. The railing needs repairs. Approaches have settled by 0.30 meter, and embankments at the approaches have been eroded. The wearing course needs resurfacing. Growth of vegetation in the waterway channel obstructs the flow of water and should be cleaned up.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	–	5 cu. m.
Resurfacing	–	30 sq. m.
Earthwork	–	15 cu. m.

ESTIMATE OF COSTS:
950,000 FM

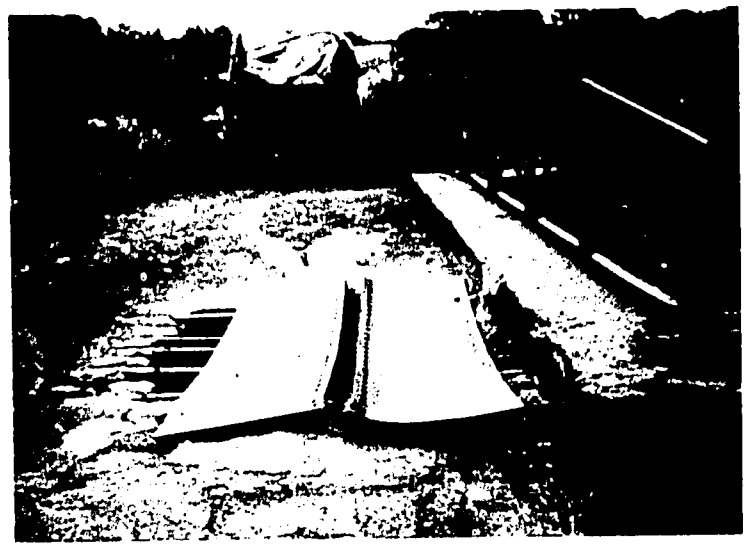


PHOTO NO. 112
A hole in the deck bridge

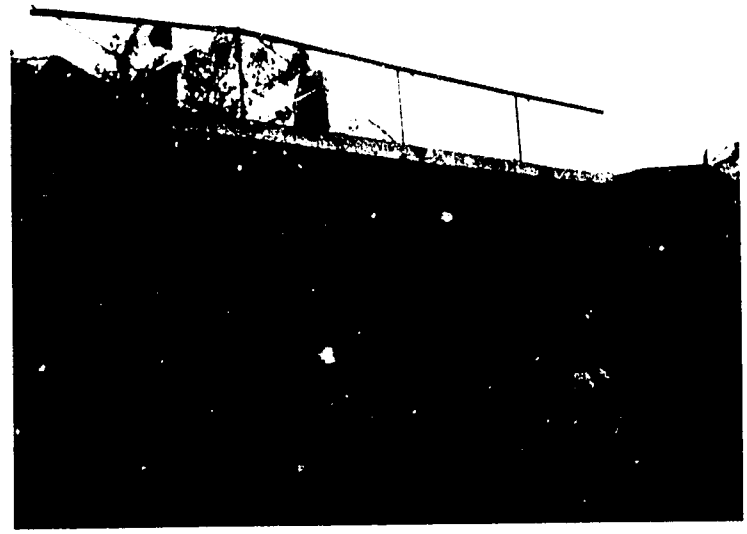


PHOTO NO. 113
Side view of the bridge

BRIDGE ACROSS SANAKE RIVER
Station: 57 + 67

DESCRIPTION: This is a one span bridge. The span length is 5.5 meters. The abutments and splayed wingwalls are stone masonry. The superstructure consists of reinforced concrete T-girders and a deck slab.

EVALUATION: The substructure shows minor deterioration. The desk slab of the superstructure has a 2 x 2 meter hole near the Nioro-side abutment. In addition, the concrete of the deck slab is of very poor quality with cracks and spalls. The existing deck slab and curbs should be replaced by casting in place a new deck slab and curbs. The concrete in the T-girders has few cracks and spalls.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	–	7.0 cu. m.
Reinforcing steel	–	22400 kg.
Railing Repairs	–	11 m.
Earthwork	–	50 cu. m.
Removing existing concrete	–	7.0 cu. m.

ESTIMATE OF COSTS:
16,154,000 FM

PHOTO NO. 110
North elevation

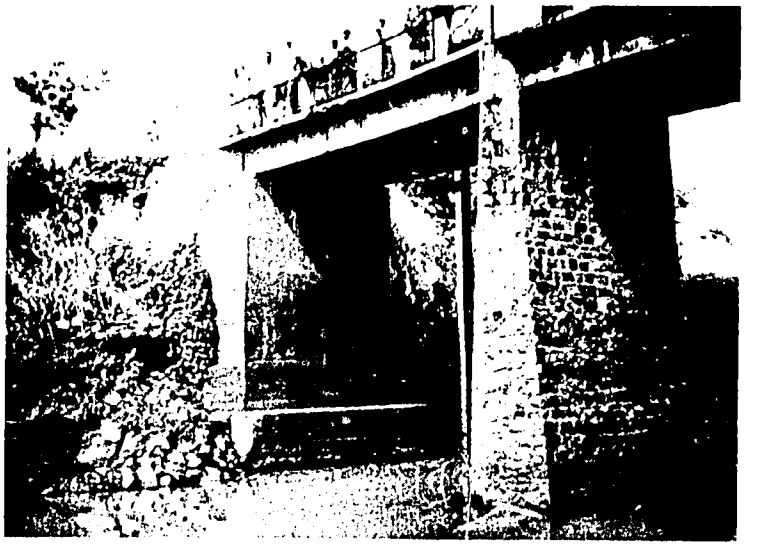


PHOTO NO. 111
Nioro-side abutment and pier

BRIDGE ACROSS KIRGOU RIVER NEAR VILLAGE OF SEGALS
Station: 60 + 11

DESCRIPTION: This is a two span bridge. Each span is 7.5 meters long. The abutments and pier are stone masonry. The superstructure consists of T-girders and a deck slab; the curb-to-curb width is 3.05 meters.

EVALUATION: The stone masonry abutment has been repaired by cement mortar plaster. The Nioro-side abutment shows cracks from the bridge seat extending toward the wing-wall. The masonry joints on the pier are losing mortar and need repointing. The superstructure concrete shows limited deterioration. There is substantial erosion at approach embankments. The wearing course needs resurfacing.

ESTIMATE OF QUANTITIES:

Resurfacing	–	25 sq. m.
Concrete (350 kg.)	–	5 cu. m.
Rip-rap	–	80 cu. m.

ESTIMATE OF COSTS:

1,790,000 FM

PHOTO NO. 104
Top view of the bridge looking towards Kayes

PHOTO NO. 105
Elevation

BRIDGE ACROSS GARI RIVER
Station: 93 + 67

DESCRIPTION: This is a two span bridge. The 6.5 meter span is a T-girder and deck slab type: the 15 meter span is a reinforced concrete floorbeam-girder type. Abutments and pier are stone masonry; the curb-to-curb width is 3.1 meters.

EVALUATION: Abutments and pier show limited deterioration. The concrete in the T-girders of the 6.5 meter span shows some spalling. Scour erosion is very minor. The wearing course needs resurfacing. The approaches are substantially eroded and should be regraded.

ESTIMATE OF QUANTITIES:

Resurfacing – 70 sq. m.
Concrete (350 kg.) – 5 cu. m.

ESTIMATE OF COSTS:

1,000,000 FM

PHOTO NO. 92
Kayes-side Abutment
severe erosion under
footing

PHOTO NO. 93
Scour due to erosion
under footing of Kayes-
side abutment

BRIDGE ACROSS NAHLI RIVER
Station: 103 + 31

DESCRIPTION: This is a two span bridge and each span is 10 meters long. Abutments and pier are stone masonry. The superstructure consists of reinforced concrete T-girders and a deck slab; the curb-to-curb width is 3.0 meters.

EVALUATION: The foundation of the Kayes-side abutment is supported on decomposed rock. Due to scour of this rock, the footing is unsupported over a 2 meter length and a 1.5 meter width. This is a dangerous situation which should be remedied. The void created by scour should be filled with concrete and the remaining rock under the footing should be inspected for any decomposition. The stream is changing its course at the Kayes-side abutment and rip-rap protection is required at the abutment and banks to avoid any future damage. The beams of the superstructure show some diagonal cracking. These cracks can be filled with mortar but further investigation is required to determine the cause of the cracking.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.) -- 10 cu. m.
Rip-rap -- 100 cu. m.

ESTIMATE OF COSTS:

2,820,000 FM

PHOTO No. 88
Top view of the bridge

BRIDGE OUTSIDE VILLAGE OF SANDARE
Station: 144 + 43

DESCRIPTION: This is a one span bridge with a span length of 10.5 meters. Abutments are stone masonry and the superstructure consists of T-girders and a deck slab; the curb-to-curb width is 3.0 meters.

EVALUATION: The joints in the stone masonry of the abutments are in poor condition. The concrete in the fascias is spalling at a few places. The Kayes-side abutment shows erosion of material in the surrounding area. Railings require repairs for about a 5 meter length.

ESTIMATION OF QUANTITIES:

Concrete (350 kg.)	–	6 cu. m.
Railing	–	5 m.
Earthwork	–	10 cu. m.

ESTIMATE OF COSTS:
1,327,000 FM

PHOTO NO. 86
Top view of the bridge

PHOTO NO. 87
Elevation

BRIDGE ON KAYES-NIORO ROAD
Station: 149 + 92

DESCRIPTION: This is a one span bridge. The span length is 10.5 meters. Abutments are stone masonry. The superstructure consists of a reinforced concrete floorbeam-girder-deck; the curb-to-curb width is 3.0 meters.

EVALUATION: The superstructure and substructure show minor deterioration. Erosion and scour are very limited. The steep slopes at the approaches have resulted in erosion of the embankment, and the area behind the abutments needs regrading.

ESTIMATE OF QUANTITIES:

Earthwork – 75 cu. m.
Concrete (350 kg.) – 3 cu. m.

ESTIMATE OF COSTS:

666,000 FM

PHOTO NO. 84
Top view of the bridge

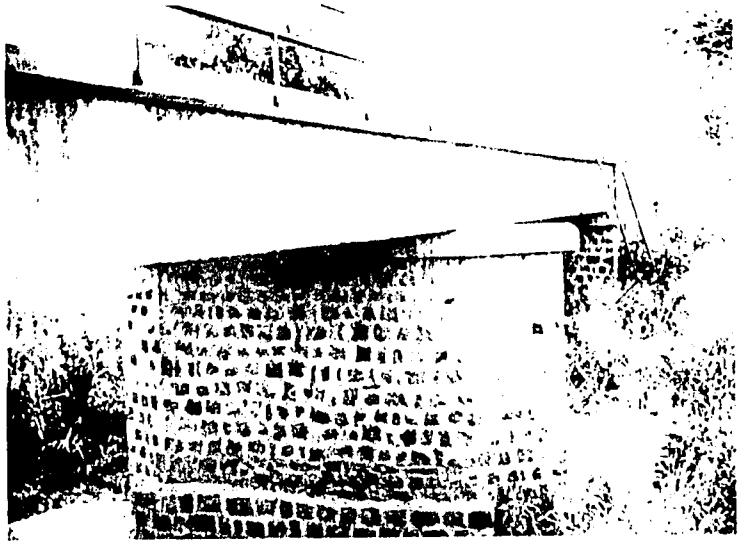


PHOTO NO. 85
Side view of the bridge

BRIDGE NEAR VILLAGE OF SOMONKARA
Station: 156 + 78

DESCRIPTION: This is a two span bridge. Each span is 10.5 meters long. The abutments and pier are stone masonry. The superstructure is a reinforced concrete floorbeam-girder-deck.

EVALUATION: The substructure and superstructure show minor deterioration. There is scour due to erosion around the pier. This requires rip-rap protection against scour. The railings need repair for about 12 meters. The approaches show some settlement and erosion of embankment. Regarding of the area around abutments is required.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	--	3 cu. m.
Rip-rap	--	50 cu. m.
Earthwork	--	50 cu. m.
Railings	--	12 m.

ESTIMATE OF COSTS:
1,826,000 FM

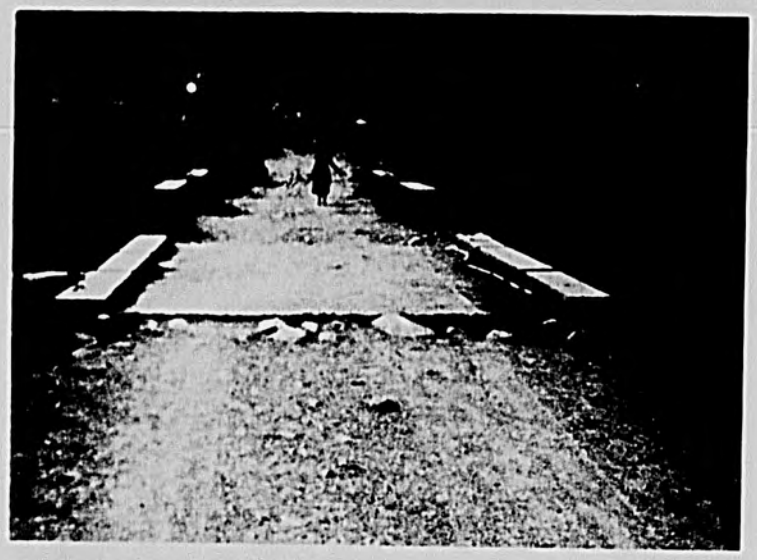


PHOTO NO. 78
Top view of the bridge

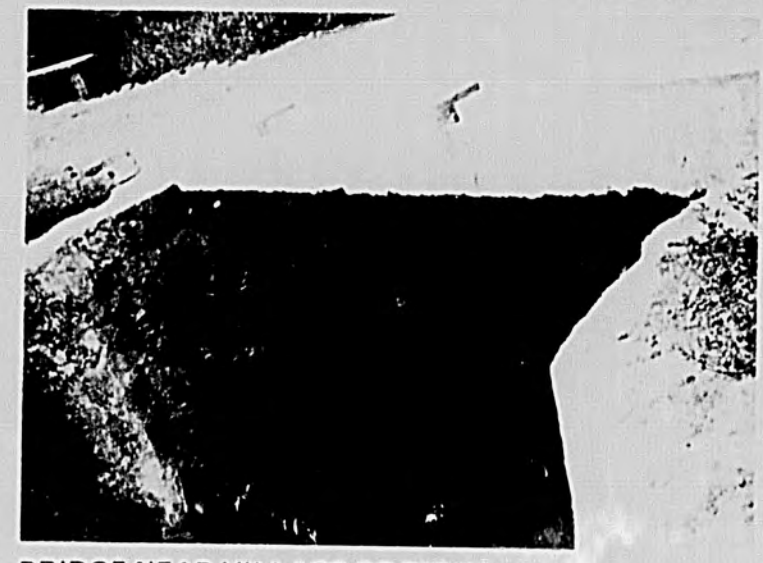


PHOTO NO. 79
Side view of the bridge

BRIDGE NEAR VILLAGE OF DIOKA
Station: 177 + 85

DESCRIPTION: This is a one span bridge. Abutments are stone masonry. The superstructure consists of closely spaced steel beams. Stones rest on the bottom flanges of the steel beams and act as bottom forms for the concrete-filled deck. The span length is 5.0 meters; the curb-to-curb width is 3.20 meters.

EVALUATION: The substructure has only minor deterioration. The steel beams in the superstructure are not corroded and the deck appears to be in fair condition. The embankment at the approaches is eroded and needs regrading. The bridge needs a railing for its entire length.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.) – 3 cu. m.
Railing – 10 m.

ESTIMATE OF COSTS:

1,066,000 FM

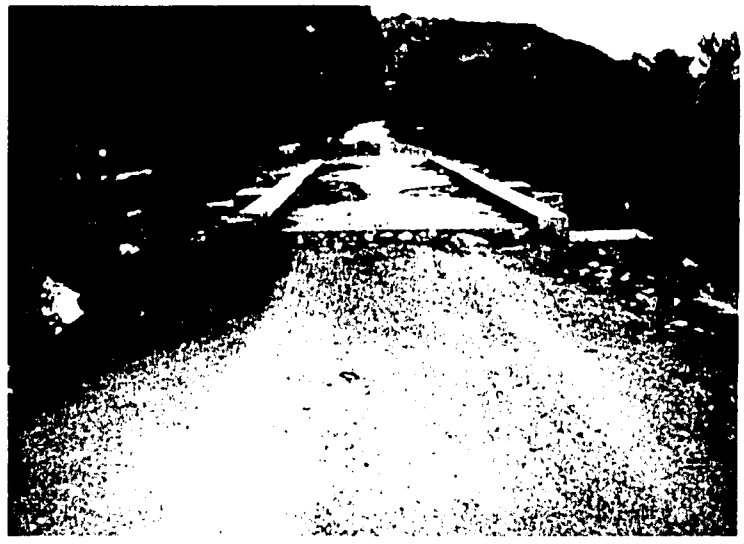


PHOTO NO. 80
Top view of the bridge

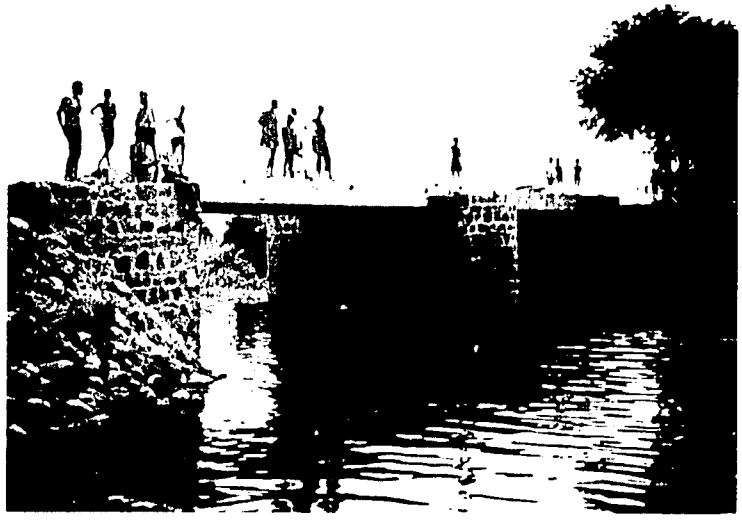


PHOTO NO. 82
Side view of the bridge

BRIDGE NEAR VILLAGE OF DIOKA
Station: 177 + 89

DESCRIPTION: This is a two span bridge. Each span length is 9.0 meters. Abutments and pier are of stone masonry. The superstructure is similar to that of an adjacent bridge at Station 177 + 80.

EVALUATION: The abutments and pier are in good condition with very little erosion or scour problems. Comments concerning the superstructure for the bridge at Station 177 + 80 also apply here. Railings are required for the entire bridge. Water accumulates on the bridge because of the lack of cross-slope.

ESTIMATE OF QUANTITIES:

Resurfacing	–	55 sq. m.
Railing	–	40 m.
Concrete (350 kg.)	–	5 cu. m.

ESTIMATE OF COSTS:

3,170,000 FM

PHOTO NO. 72
North elevation of the bridge

PHOTO NO. 73
Top view of the bridge looking towards Nioro

BRIDGE ON KAYES-NIORO ROAD
Station: 214 + 20

DESCRIPTION: This is a one span bridge. The span length is 10.0 meters. The abutments are of stone masonry. The superstructure is a reinforced concrete floorbeam-grider-deck; the curb-to-curb width is 3.0 meters.

EVALUATION: The substructure and superstructure have only minor deterioration. The waterway opening is adequate; scour due to erosion is insignificant at the bridge. Approaches have settled about a 10 meter length.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	–	5 cu. m.
Railing	–	10 m.
Earthwork	–	50 cu. m.

ESTIMATE OF COSTS:

1,510,000 FM

PHOTO NO. 69
North elevation

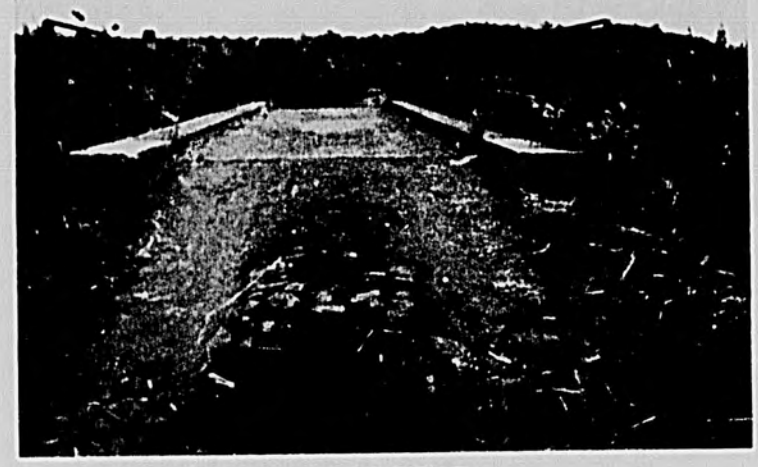


PHOTO NO. 70
Top view of the bridge looking towards Nioro

BRIDGE ON KAYES-NIORO ROAD
Station: 217 + 08

DESCRIPTION: This is a two span bridge. Each span is 10.5 meters in length. The abutments and pier are of stone masonry. The superstructure is a reinforced concrete floorbeam-girder-deck; the curb-to-curb width is 3.0 meters.

EVALUATION: The superstructure and substructure have only minor deterioration. There is considerable vegetation in the waterway channel which may effect the flow. There is some settlement of the approaches, and some erosion of the embankment. The steel railings need repair for about a 10 meter length.

ESTIMATE OF QUANTITIES:

Concrete (350kg.)	–	4 cu. m.
Railing	–	15 m.
Earthwork	–	50 cu. m.

ESTIMATE OF COSTS:
1,613,000 FM

PHOTO NO. 66
Scour at pier footing on the downstream side

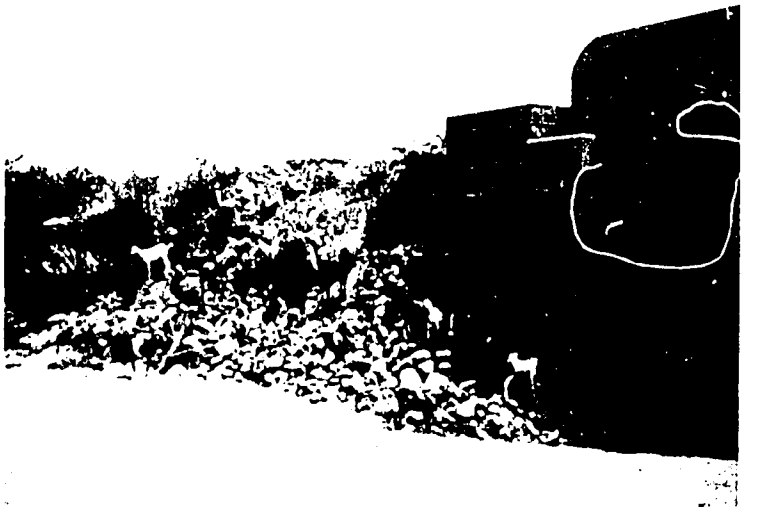


PHOTO NO. 67
Erosion of approach embankment on the Nioro side

BRIDGE ACROSS LAMBA RIVER
Station: 222 + 40

DESCRIPTION: This is a two span bridge. Each span is 13 meters in length. The abutment stems are of stone masonry with a concrete bridge seat and footing. The pier-stem is stone masonry and the pier-cap and footing are concrete. The superstructure is a reinforced concrete deck, with stringers, floorbeams and through-girders. The girders also act as parapets. The curb-to-curb width is 3.0 meters.

EVALUATION: The superstructure and substructure have only minor deterioration. Scour due to erosion has exposed the pier footing. Large portions of the embankment behind the Nioro-side abutment have eroded and the area should be regraded by placing rip-rap on the slope.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	—	3 cu. m.
Earthwork	—	90 cu. m.
Rip-rap	—	25 cu. m.

ESTIMATE OF COSTS:
971,000 FM

PHOTO NO. 56
Elevation

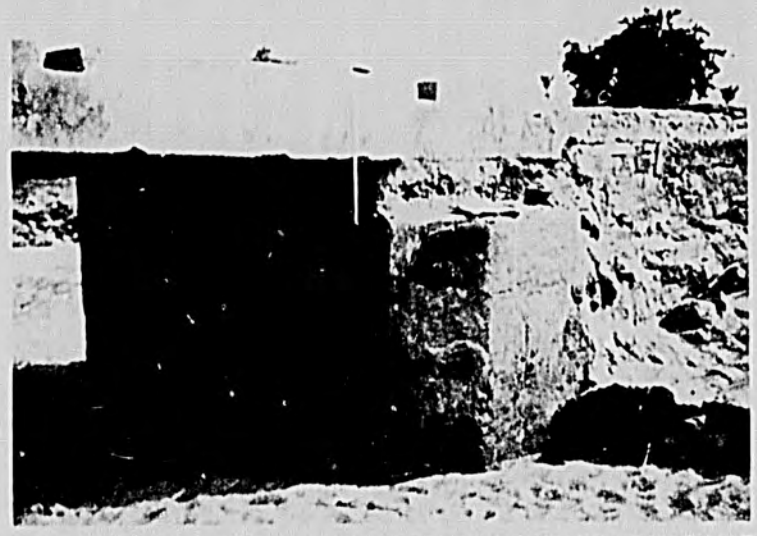


PHOTO NO. 58
Settlement of abutment on Nioro side of the bridge

BRIDGE ACROSS FAKA RIVER NEAR NIORO-DU-SAHEL
Station: 250 + 25

DESCRIPTION: This is an eight span submersible bridge. The span lengths range from 2.5 meters to 6.5 meters. The abutments and piers are concrete. Except for the 6.5 meter span, all of the span has reinforced concrete solid slabs 0.30 meter thick. The superstructure for the 6.5 meter span consists of steel I-beams spaced at 0.75 meter center-to-center, the deck is filled with concrete supported by stones which in turn rest on the bottom flanges of the steel beams. The curb-to-curb width is 3.0 meters.

EVALUATION: The superstructure and substructure have only minor deterioration but the superstructure of 6.5 meter span should be further investigated for its structural condition because of its unusual construction. The embankment of the Nioro-side approach has considerable erosion and will require rip-rap slope protection. The wearing course requires resurfacing.

ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	–	5 cu. m.
Resurfacing	–	125 sq. m.
Rip-rap	–	60 cu. m.
Earthwork	–	100 cu. m.

ESTIMATE OF COSTS:

1,970,000 FM

D · 2 / BRIDGES IN VICINITY OF KAYES

PHOTO NO. 4
South elevation

PHOTO NO. 5
Top of the bridge

BRIDGE NEAR SAME, 14 KM FROM KAYES

DESCRIPTION: This is a three span bridge. Each span is 9 meters in length. Abutments, piers and wingwells are stone masonry. The superstructure is of steel beams, very closely spaced at .30 meter, with a steel plate between them which supports the concrete fill of the deck, the curb-to-curb width is 3.0 meters.

EVALUATION: The stone masonry in the abutments has vertical cracks. These can be filled with cement mortar but should be monitored in the future. The bottom flanges of the steel beams show little corrosion, but the steel bearings are heavily rusted. The wearing course requires resurfacing. Railings require repairs for about 20 meters in length. Growth of vegetation in waterway channel should be cleared up so that it does not obstruct the flow.

ESTIMATE OF QUANTITIES:

Concrete (350kg.)	–	5 cu. m.
Resurfacing	–	85 sq. m.
Railings	–	20 m.

ESTIMATE OF COSTS:

2,130,000 FM

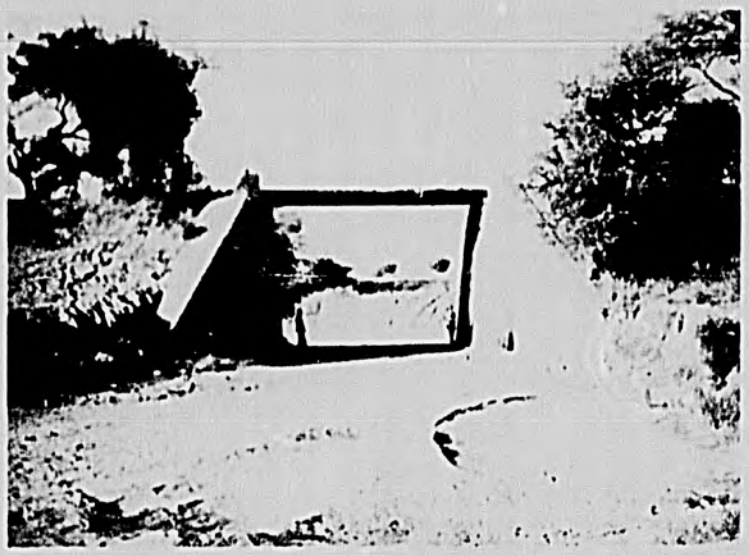


PHOTO NO. 6
West elevation

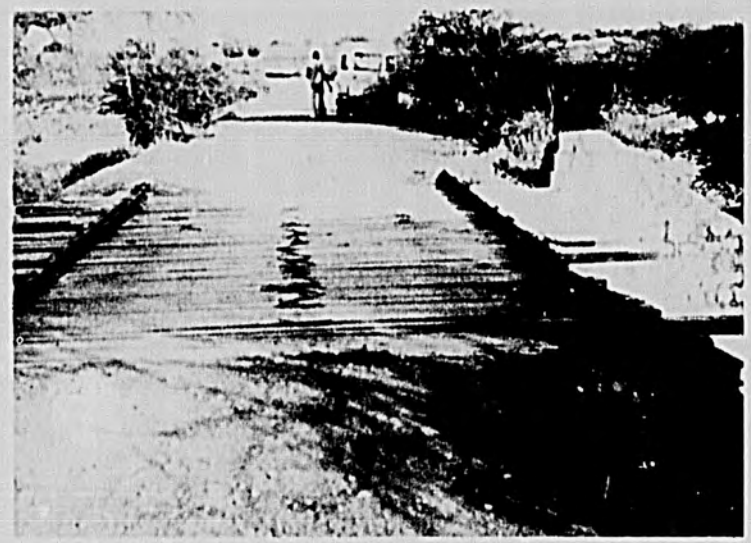


PHOTO NO. 9
Temporarily repaired deck

BRIDGE ACROSS KAMANKOLE RIVER ON KAYES-SAME ROAD

DESCRIPTION: This is a one span bridge. The span length is 8.0 meters. The abutments are stone masonry. The superstructure was of reinforced concrete solid slab, but it collapsed in 1975 and was temporarily replaced by steel beams and wooden planks.

EVALUATION: The bridge is located on a bend in the river and the flow of the river causes severe erosion behind the Kayes-side abutment. This approach embankment will require extensive rip-rap protection. The bridge will require a new reinforced concrete slab. As an alternative, consideration should be given to selecting a new bridge site about 500 meters to the east of the existing bridge where the river has more defined banks.

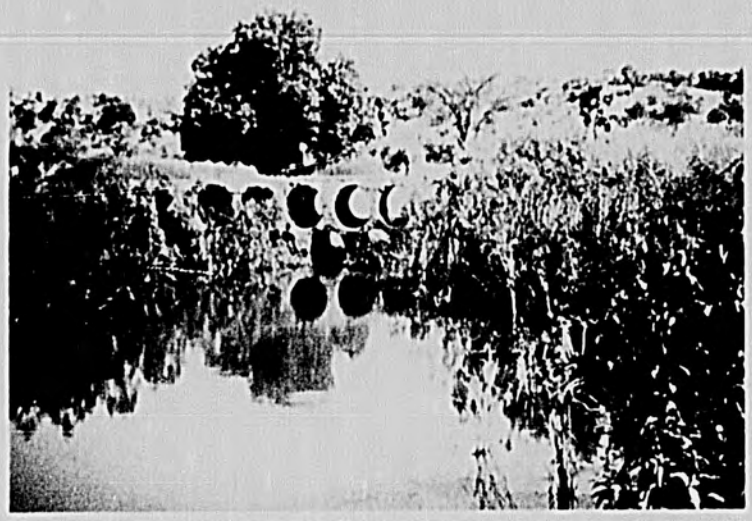
ESTIMATE OF QUANTITIES:

Concrete (350 kg.)	–	20 cu. m.
Reinforcing bars	–	1750 kg.
Rip-rap	–	700 cu. m.
Railings	–	18 m.

ESTIMATE OF COSTS:

13,224,000 FM

PHOTO NO. 2
South elevation



PIPE CULVERT, 17 km FROM KAYES, ON THE KAYES-KENIABA ROAD, ACROSS THE PAPARA RIVER NEAR BINTIGUELE

DESCRIPTION: This long culvert has 20-1 meter Ø pipes in the top row and 6-1 Ø pipes in the bottom row. The pipes are embedded in concrete.

EVALUATION: The pipes are filled with debris and obstruct the flow. As a result, water overflows, eroding the approaches. The west approach has settled as much as 1.5 meters. A new bridge is required at this site. Hydrological and soil data are not available at this time. However, for estimating purposes a three span bridge with a 10 meter span reinforced concrete solid slab is assumed.

ESTIMATE OF QUANTITIES:

Bridge construction — 180 sq. m.

ESTIMATE OF COSTS:

112,000,000 FM

D · 3 / BRIDGES ON YELIMANÉ BRANCH

PHOTO NO. 27
Stone arch bridge

PHOTO NO. 29
Slab bridge next to stone arch bridge

BRIDGE ACROSS TEREKOLE RIVER NEAR YELIMANÉ
Station: 65 + 70

DESCRIPTION: This structure consists of a series of spans that include ten stone arch spans, each 2.7 meters long, with varying heights and a slab span 33 meters long. The bridge is founded on rock outcrops. Next to that bridge there are slab bridges with spans 3 meters long. The abutments are stone masonry.

EVALUATION: The substructure and superstructure show some deterioration. However, the structure does not require immediate repairs.

ESTIMATE OF QUANTITIES:

—

ESTIMATE OF COSTS:

—

APPENDIX E

APPENDIX E

EXISTING TRAFFIC

TIPPETTS-ABBETT-McCARTHY-STRATTON

MINISTRY OF PUBLIC WORKS AND TOURISM

KAYES-NIORO DU SAHEL ROAD
FEASIBILITY STUDY

ORIGIN-DESTINATION SURVEY FORM

1. Vehicle category _____
(passenger car, pick-up, bus, light truck, heavy truck)

2. Make of vehicle _____

3. Country of registration _____

Day:

Date:

Location:

Hour:

Data collector:

4. Origin of trip _____

5. Final destination of trip _____

6. Intermediate stops _____

7. Trip purpose _____
(official, private business, tourism, other)

8. Passenger occupancy (driver included) _____

9. Vehicle carrying capacity _____

10.

Goods category	Number of metric tons
a.	
b.	
c.	
d.	

Table E-1

Origin-Destination Trip Table - The KAYES Station
(% of Total Traffic Moving Between Zones)

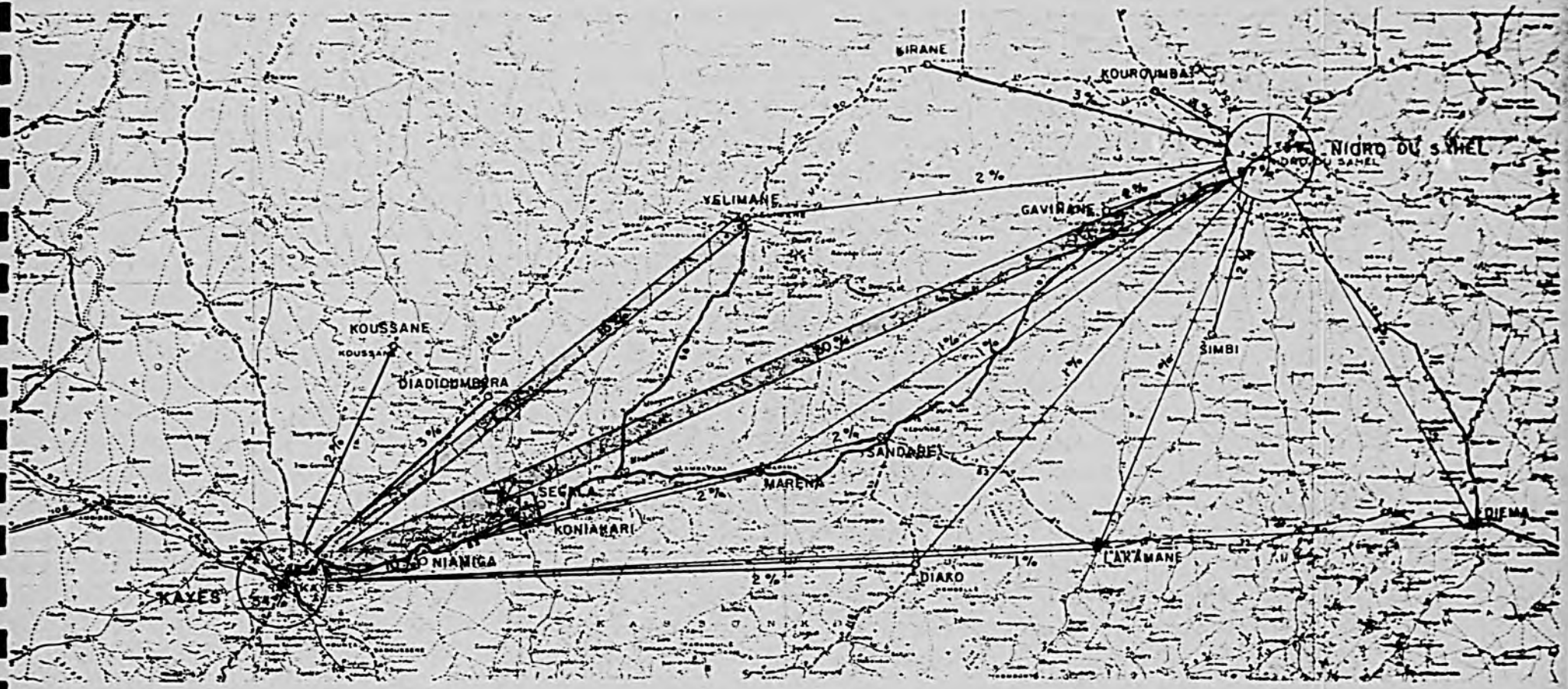
From \ To	1. Kayes	2. Niamaga*	3. Ségala	4. Koniakari	5. Yelimané	6. Sandaré	7. Nioro	OTHER	TOTALS
1. Kayes	--	10	16	4	14	2	7	5	58
2. Niamaga*	9	--	--	--	--	--	--	--	9
3. Ségala	10	--	--	--	--	--	--	--	10
4. Koniakari	3	--	--	--	--	--	--	--	3
5. Yelimané	8	--	--	--	--	--	--	--	8
6. Sandaré	--	--	--	--	--	--	--	--	--
7. Nioro	6	--	--	--	--	--	--	--	6
8. Other	6	--	--	--	--	--	--	--	6
TOTALS	42	10	16	4	14	2	7	5	100%

* Including Koussane, Goumera, Sero, Sirimoulou, Diadiaumbera, Oourou

Table E-2

Origin-Destination Trip Table - The NIORO Station
(% of Total Traffic Moving Between Stations)

From \ To	1. Kayes	2. Yelimané	3. Sandaré, Diema	4. Simby, Gavinane	5. Nioro	6. OTHER	TOTALS
1. Kayes	--	--	--	--	15	--	15
2. Yelimané	--	--	--	--	7	--	7
3. Sandaré, Diema	--	--	--	--	2	--	2
4. Simby, Gavinane	--	--	--	--	7	--	7
5. Nioro	21	--	--	5	--	14	40
6. Other	--	--	--	--	29	--	29
TOTALS	21	--	--	5	60	14	100%



LEGEND/*LEGENDE*

LIGHT VEHICLES/*CAMIONETTES*

HEAVY VEHICLES/*CAMIONS*

20% 10% 1% TRAFFIC VOLUME/*TRAFFIC*

2.5% = 1 VPD/*VEHICULE PAR JOUR*

TAMS

FIGURE E – 1
1979 VEHICULAR ORIGIN – DESTINATION/
ORIGINE – DESTINATION DES VEHICULES EN 1979

APPENDIX F

APPENDIX F
EXISTING ENVIRONMENTAL, ECONOMIC AND SOCIAL CONDITIONS

F.1 THE ZONE OF INFLUENCE

Administratively, the route is located within the westernmost region of Mali, the First Region. The terminus at Kayes is the last major city in Mali along the Dakar-Bamako railroad and the center of the Kayes Cercle. The terminus at Nioro du Sahel, located 250 kilometers to the northeast, is the major center of the Nioro Cercle. The Yelimané branch connects Yelimané, principal center of the Yelimané Cercle, to Dialaka, located approximately 82 kilometers east of Kayes. The Kayes-Nioro segment passes through six arrondissements (administrative subdivisions of a cercle). These are Kayes and Segala within the Kayes Cercle, Marena within the Yelimané Cercle, and Sandaré, Gavinané and Nioro in the Nioro Cercle. The Yelimané branch traverses the two arrondissements of Marena and Yelimané in the Yelimané Cercle.

The road's zone of influence has been defined as a day's donkey journey, a 25 kilometer band to either side of the road, adjusted for the presence and location of feeder roads. This zone of influence has guided, to the extent possible according to available data, the portrayal of the affected environmental, economic and social conditions.

F.2 CLIMATE AND AIR QUALITY

Climate within the southern portion of the route is generally described as the southern Sahel (Church 1968), also referred to as the Sahelian Savannah or Sahelo-Sudanian, with more than 600 mm of rainfall per year. Nioro lies approximately at the dividing line between this climatic classification and the Sudanian Sahel with 450-600 mm of rain per year. The rainy season extends from May through October with the bulk of precipitation occurring in July and August. Rainfall data available for selected stations in the region of the route is given below.

Location	Average Annual Rainfall (in mm)	Source
Kayes	760 (5 year average)	Church, 1968
Sandare	721.6 (1954-1976)	ITC, 1977
Nioro du Sahel	616.2 (1923-1976)	ITC, 1977
Yelimané	680 (20 year average)	Kayes Weather Station

Rainfall varies extremely from year to year: in 1971, 1972 and 1973, for example, rainfall at Nioro reached only 341 mm, 439 mm and 360 mm, respectively. In 1968 and 1970, Kayes received only 480 mm and 556 mm of rain. Rains can also be exceedingly intense within a short time. At Kayes, the 24-hour recorded maximum was 122 mm in 1936; in August 1936, 516 mm fell in one month. At Nioro, the maximum monthly record of 463 mm was achieved in August 1958.

During many months of the year, potential evapo-transpiration exceeds rainfall. In the Nioro vicinity, only July and August rainfall exceeds potential evapo-transpiration. For one out of two years, rainfall is higher or lower than the median (620 mm), but the water table is recharged only during wet years when rainfall is greater than 620 mm (ITC 1977).

Temperature shows variation from month to month. In Nioro, the 1941-1960 average monthly temperature rose from a low of 22°C in January to a high of 34°C in May with a general decrease in temperature to 23°C in December. At Kayes a similar annual variation has been recorded: the monthly averages of daily maxima and minima can range between 43°C and 28°C in May and 24°C and 18°C in December.

Three distinct seasons, according to patterns of temperature, rainfall and wind, can be differentiated. From March to May, the weather is hot and dry with Harmattan winds (hot, desiccating winds from the east). From June to October, monsoon winds from the south bring in the rainy season. Between November and February, the weather is dry but relatively

cooler with cool winds from the northeast (Church 1968, GRM 1976).

No air quality data for the region is available. Significant sources of industrial or urban pollution are absent in the area and the number of vehicles is extremely small. Dust-haze, particularly during the dry season, and brush fires are the principal sources of air pollution.

F.3 PHYSIOGRAPHY, GEOLOGY AND SOILS

Starting from Kayes, the southwestern portion of the route lies initially within the Sénégal River Basin; thereafter it traverses the southern portion of the Lake Magui basin, a complex system of flood plains and intermittent lakes of the Kolombiné-Terekolé and Krigou Rivers.

Near Dialaka, the escarpments of the dolerite plateau rise to the north and south of the road, as the route passes through the valley of the Krigou and its tributaries. After Lambatara the route rises to cross the escarpments (elevations of approximately 250 to 400 meters). The rocky plateau (sedimentary schists with dolorite dike intrusions) give way to a sandy, weakly duned region. Subsequently, the route crosses the schist plateau (composed principally of slate) as it nears Nioro (elevation 260).

The branch to Yelimané lies to the west of the escarpments and follows an elevated terrace of an ancient river basin.

The soils in the vicinity of the western portion of the route are generally lateritic with schist and dolerite outcrops. Soils within the influence of the Kolombiné-Terekolé-Krigou and Lake Magui system are more fertile than the shallow leached, lateritic soils typical of the region generally. These flood plain soils are enriched by the weathering of surrounding geologic formations as rainfall washes material into the plains and by the alternate pattern of flood and recession which aids in the accumulation of organic matter.

Soils in the Kaarta region, extending north and east from Marana and surrounding Nioro have been mapped, based on interpretation of aerial photography and satellite imagery. In the valleys of the dolerite plateau, the soils are loam and clayey loam, changing to sand and loamy sand in the dunes area; in the schist plateau, soils are characterized by various associations of shallow sandy loams. The valley soils have generally good agricultural capability; the dune soils have little water holding capacity and are extremely susceptible to erosion. The soils on the schist plateau have marginal or little capability because of their shallow nature and thin hard surface which makes them difficult to work. Soils are generally considered rich in mineral elements, but water is a limiting factor for agricultural capability. Pockets of soils with good and fair agricultural capability do exist in the Kaarta region. Those within the road's zone of influence are located in the areas of Bema, Tourougoumbé and south of Nioro du Sahel near Guetma and Mandala. Complete soil descriptions, including profiles, can be found in ITC (1977).

F.4 HYDROLOGY AND WATER RESOURCES

Limited hydrolological data is currently available. A three-year study of the Terekolé-Kolombiné-Lake Magui region, by the Federal Republic of Germany, will provide more accurate information on streamflow and other water resources and will develop plans for three small dams and an irrigation project. Pending results of the German study and of interest to Operation Vallée Senegal-Terekolé-Lake Magui (OVSTM), is a dam at Doro, near Niamiga. The OVSTM project,initially focused on irrigated perimeters along the Senegal River, now includes dryland sectors of the Yelimané Cercle and of Kayes Cercle. In addition to agricultural development, a long-range objective of the OVSTM is adequate preparation and organization for the impact of the proposed Manantali Dam, on the Bafing River, a tributary of the Senegal upstream and south of Kayes. This project would regulate the height and flow of the Senegal to permit inland navigation as

far as Kayes, irrigated agriculture and hydroelectric power. While this project can be considered a future possibility whose impact would change the Kayes region, the timing of the project is ambiguous. If developed, the area of irrigation potential is outside the road's zone of influence. Availability of hydroelectric power, however, could alter the economies of development in a larger zone.

The Senegal is the only permanent water source in the road's service area. The rivers and lakes of the Terekolé-Kolombiné-Krigou-Lake Magui system dry up over most of their course a few months after the last rains, but leave behind numerous swamps and ponds which dry more slowly, some lasting until May. After the rainy season, water in this flood plain area (characteristic of the western segment of the route) is obtained from sinks placed in the alluvial deposits of lowlying backwater areas (OMBEVI 1976). When these dry up, dug wells are used by villages.

In the Kaarta region, because of the conditions of topography and the torrential nature of the rains, infiltration to recharge the aquifer is deemed weak, except in the river and streambeds (ITC 1977). The number of wells in rock is minor in the area and most are placed in alluvium and colluvium.

Groundwater reserves could not be accurately defined by the map reconnaissance made for the Kaarta project. Indications were, however, that no continuous aquifers exist in the region and that aquifers are a very localized geologic phenomenon. Those dikes and fracture systems, where significant groundwater reserves would be likely, were not considered large reserves, but could be sufficient for small villages and small herds (ITC 1977).

F.5 TERRESTRIAL RESOURCES

F.5.1 VEGETATION

The overall vegetational pattern is largely a function of water (principally rainfall, but also water-holding capacity of the soil, and closeness of water table to the surface). In and near the route, vegetational differences occur due to topography, soil type, and the degree to which human influences are present. In certain classification schemes (Church 1968), the southern and south-central portion of the route, north of Kayes, is termed the Sudan Savannah, while the Nioro vicinity lies at or within the southern extreme of the zone called the Sahel Savannah. The Sudan Savannah is characterized by singly occurring trees of which the tallest are the large-trunked baobab (Adansonia digitata). Smaller acacia trees and brushy shrub, such as Combretum micranthrum are present along with seasonal grasses. Grass sprouts just before the rainy season and remains green during it, but does not last through the dry season. The Sahel Savannah is thought to derive from thorn woodland; the presence of acacia trees is considered characteristic. Acacia seyal, common on clay soils, Acacia senegal and acacia nilotica (both sources of gum) are present. Acacia nilotica is particularly prevalent in the flood plains of rivers and streams. Shrubs such as Balanites and short, discontinuous tussocky grasses are associated with this zone. These broad classifications are generally indicative of the vegetation in the area, but local edaphic conditions make the two-zone distinction somewhat arbitrary over such a relatively small area.

The Savannah vegetation has an increasing density of trees as rainfall increases toward the south and is bushier in natural depressions and places where the water table is closer to the surface. During field reconnaissance for the route, baobab trees, particularly in the southern portion, and acacias were noted. In and near towns, particularly in the Nioro vicinity, various types of palms were evident. Evidence of past

tree-cutting, dead or dying trees, burned over areas and burning fires were visible along the sides of the route.

Acacia albida and Acacia senegal are protected species in Mali (Code Forestier) and their cutting or mutilation without authorization is forbidden. The Ronier palm is also protected and although not noted near the route could potentially be found in selected areas.

For the Kaarta area, detailed vegetational maps are available (ITC 1977). These indicate, within the road's influence, these vegetational units.

- Tree savannah* with local pockets of shrub savannah, on sandy soils, north of Nioro du Sahel. Density of trees is about 10 trees per hectare attaining a maximum height of 8 meters. Dominant species include Combretrum ghasalense and various types of Eragrostis. In areas with more than 600 mm of rainfall, species of Bombax become more important. The association of Bombax and Eragrostis was mapped in the sandy area north of Dioka.
- Tree savannah with species of Acacia. Particularly developed on loamy soils or clay loams, in eroded clay soils and abandoned fields. Mapped in the central Nioro arrondissement and characterized by species requiring less than 700 mm of annual rainfall. Pockets of this vegetation with species requiring more than 700 mm of rainfall mapped on the loamy or loamy clay soils on the slopes of valleys between Marana and Samantara.
- Tree and shrub savannah with species of Pterocarpus and Adansonia. Particularly on rocky soils and dolerite escarpments. Mapped in the plateau area from Marana to north of Samantara.
- Woodland savannah (savane boisées) and thin forest (forêts claires) with stages of structural degradation. Characterized by species of Bombax and Cordyla, this vegetation was mapped in the area north of Samantara to north of Dioka, on sandy soils.
- Pond, marsh and riverbank vegetation. Where the water table crops out and on the banks of low-lying spots forming pools and marshes, vegetation characterized by Acacia nilotica and Mitragyna or Philiostygma and Mitragyna is found.
- Cultivated, rotating and fallow fields. On sandy soils, in the vicinity of permanently cultivated fields, Acacia albida and else-

* called savanes arborees by ITC (1977) and savanes arborescentes by ODIK (1979)

where Bauhenia and Eragrostis were found. In fallow fields the characteristic vegetation was Combretum and Eragrostis. Acacia albida is thought to be a remaining example of the natural vegetation which would have been characteristic of the area.

In 1977, in the course of vegetation mapping for the Kaarta project, the grouping of vegetation with Blepharis and other typically Sahelian species were advancing toward the south.

F.5.2 FORESTRY

The route passes through Forêt Classée de Nioro, just west of Nioro; Foret Lorak Bané lies about 18 kilometers north of Nioro. Other locations along the route can be categorized as classified forest or protected forest domain because of steep slopes or proximity to watercourses, as defined below.

The classified forest domain (le domaine forestier classé) comprises classified forests (les forêts classées), protected perimeters (les perimètres de protection) and reforested zones. Protected perimeters, for instance, include mountain slopes greater than 35°, moving sand dunes, and areas such as the Sahel, insufficiently wooded or too bare to permit regeneration of the forest cover. The protected forest domain (le domaine forestier protégé) includes mountain slopes, hills and plateaus with risks of erosion and slope instability; the banks of watercourses; headwaters and their watershed. Clearing is restricted in both zones.

Rights of use within the forest domain are permitted to individuals or groups; commercial use rights are more strictly limited. Such rights include circulation by foot or in vehicles, pasturing of domestic animals and the gathering of forest products (honey, fruit, medicinal plants, dead wood), but not including clear-cutting or mutilation of trees. Cutting permits are officially required for commercial exploitation. The lack of administrative personnel and the expanse of territory make enforcement of the forest laws difficult. Unauthorized commercial exploitation, particularly for firewood, occurs. It is also likely that clearing for cultivation and individual

exploitation for firewood occur in ways that are not compatible with the law's intentions.

The practice of ébranchage, uprooting or stripping and tearing the branches and limbs of trees and woody shrubs in order to feed livestock, is forbidden in the Sahel, since it causes death and injury to trees. (The official southern limit of the Sahel in the First Region, defined by the Code Forestier, is the River Senegal, Segala, Marena, Lakamane, Kainera and Djema and thus includes the route.) The sanction is impossible to enforce. For herders, nourishment provided by foliage is a means to keep cattle alive at the end of the dry season when grass is in short supply. The Kayes-Nioro livestock development project has suggested introduction of a cutting tool to snip ends of branches as one way of combatting the problem (CMBEVI 1976).

In this same zone, special fire restrictions also apply to control brushfires (feux précoces). Brushfires, however, particularly accidental ones and also those set to improve the range, are common. Traditionally, fire has been used to discourage shrub, favor palatable grasses and keep down pests and diseases; fire can help fertilize the surface of the soil and some have argued that fire increases the available supply of protein (Dasmann et al 1973 and Horowitz 1979). Fires can also destroy rangeland and recovery is slow in arid zones; if set at the wrong time of year, fires can encourage the invasion of shrubs. Fires in this region, however, are thought to be more often due to carelessness than to traditional practices of range utilization.

A number of reforestation efforts exist in the region. The Kayes-Nord livestock development project aims to plant 100,000 trees per year in their village reforestation program. In addition, the project plans both primary and secondary fire-breaks to reduce fire hazard. The Kaarta project, likewise, has a forestry strategy the objectives of which are to plant trees around wells where overgrazing has occurred, to encourage a safer way

of practicing ébranchage and to promote tree planting around cultivated fields and villages. Among the negative constraints to the implementation of these goals are the legalistic and policing thrust of the current regulations which do not ensure the collaboration of the local population (ODIK 1979). Forestry resources are traditionally viewed as free and unlimited rather than as a resource which requires protection.

Under sponsorship of the Federal Republic of Germany, a reforestation project will create a greenbelt around Kayes, establish nurseries, and develop plantations for the harvesting of firewood. Executed by the Operation Amenagement de Production Forestière, this project is expected to move north from Kayes and to plant nimes (a type of quickly growing tree well adapted to dry conditions).

Forest protection and reforestation are important environmental goals in Mali. Control of deforestation will require sensitivity to the role of trees as nourishment for cattle and as an energy source.

F.5.3 WILDLIFE

Wildlife information is extremely limited. During field reconnaissance, wild boar (phacochères), small mammals, lizards and numerous varieties of birds (including wildfowl) were observed. The First Region's Water and Forest Service (Service des Eaux et Forets) states that hunting has been forbidden in the last two years because game numbers have diminished, partly because of drought and partly because of past hunting pressure. Lack of personnel prevents effective enforcement of this regulation. Hunting is not generally for sport, but for food supply and hunted game are mostly birds, fowl (plumiers), doe (biches) and wild boar (phacochères). Some protected wildlife species are believed to inhabit areas in the vicinity of the route. The protected bird species are vultures (les vautours), herons (spatules herons) and calalos (les calalos). Protected mammals are gazelles (gazelle n'dama or biche Robert) and oryx (a type of

gazelle).

Birds (quelea-quelea in particular) just as crickets and grasshoppers, are field pests and threaten crop production. Spraying programs exist in the region to combat these. It is believed that the populations of birds and crickets have increased as the areas of cultivation have increased.

F.6 POPULATION

F.6.1 COMPOSITION AND DISTRIBUTION

The 1980 population within the road's zone of influence, including the Yelimané branch, numbers approximately 246,000. (Estimated proportion of each arrondissement's 1976 population lying within the zone of influence, projected from 1976 to 1980.) Table 13-1 shows the distribution of this population among administrative districts (cercles each composed of arrondissements). The "population de droit" includes legal residents who were absent at the time of enumeration; the population de fait excludes these but includes visitors. According to the district, the absent population represents between 2.5% and 5% of the population present and visitors constitute from 1.5% to 2%. Table F-1 shows estimated size of largest villages on the route.

Among resident absents, males outnumber females; they do so by as much as 3 to 1 in Sandaré and 2 to 1 in Marena and Ségala, but in northern arrondissements, the disparity is less striking. In part, these statistics reflect the outmigration of young men seeking work; the variability among arrondissements appears to reflect ethnic group distribution (see F.6.2).

The active population, men and women from 14 to 60 years of age, generally hovers around 50%, but data varies significantly by arrondissement (ITC 1977). No region-specific vital statistics were located but averages pertaining to Mali (ranges derived from U.N. 1978 and U.S. Dept.

Table F-1

Estimated Size of Largest Villages
Along Kayes-Nioro Route

	Approximate Population	Distance Between (km)
Kayes-Nioro		
Niamiga	2,700*	23
Ségala	2400*	7
Koniakary	5200*	15
Dialaka	2700*	6
Marena	1300*	7
Lambatara	1500*	45
Sandaré	1700	10
Samantara	1500	50
Birou	1400	10
Gavinane (off road)		
Youri	4600	10
Nioro[1/]	13,000-18,000	
Dialaka-Yelimané		
Yelimané	2,000*	18
Yaguine-Banda	1600*	23
Mongoro	1600*	

Average Village Sizes by Administrative District:

Kayes Cercle	675 persons per village
Nioro Cercle	650 persons per village
Yelimané Cercle	850 persons per village

[1/] Low number from 1976 census; high number from ITC (1977).

Sources: ITC (1977), OMBEVI (1976) and USAID (n.d. circa 1977). ITC based on 1976 Census; others (*figures) are more approximate.

of Commerce 1977) give a crude indication of the components of demographic change.

Birth Rate Per 1,000 Pop.	49-55
Death Rate Per 1,000 Pop.	26-30
Infant Mortality Per 1,000 Live Births	120-210
Life Expectancy	36.5 (Males) and 39.6 (Females)

The average population density within the zone of influence is 16 persons per square kilometer. The rural population density (Kayes excluded) is 12 persons per square kilometer. Population is unevenly distributed and largely influenced by the availability of water. Detailed mapping of village populations for the Kaarta project (whose area includes the eastern half of the road's zone of influence) reveals that population is concentrated in the north, i.e., in Nioro du Sahel and surrounding arrondissements. In the remainder of the project area, population clusters along principal roads which follow river valleys (ITC 1977). The arrondissement of Nioro Central (including the urban area of Nioro du Sahel) had a 1976 density of 35 persons per square kilometer; the adjacent arrondissements of Bema, Gogui, Tourougoumbé and Gavinané averaged respectively 12, 14, 19 and 17 persons per square kilometer. Lakamané, Simbi, Sandaré and Oussoubidiana in the southern and western portion of the Kaarta project had much lower densities; respectively these were 6, 7, 6 and 4 persons per square kilometer. Population in the Kayes-Nord livestock project (whose area includes the western half of the road's zone of influence) also clusters along the river valleys, particularly near the Sénégal and around Lake Magui, to the west of road's zone of influence (OMBEVI 1976). The 1976 density in Yelimané Cercle, 13 persons per square kilometer, represents approximate density in the northern area of the road's zone of influence. Population density in the southwestern zone near Kayes is somewhat higher.

F.6.2 ETHNIC GROUPS

Four principal ethnic groups inhabit the area: Peul, Sarakolé, Bambara and Khassonké. Mauré and Malinké are also present. The predominant ethnic group in the First Region as a whole is the Sarakolé (also called Soninké). Field reconnaissance and interpretation of data prepared for the three principal development projects (Kaarta, Kayes-Nord and O.V. - S.T.M.) indicate that Sarakolé are probably in the majority. Sources, however, do disagree about the relative proportion of Peul which may number almost as much or slightly more. A brief summary of ethnic groups is given below; extended treatment can be found in N'Diayé (1970).

Sarakolé

The Sarakolé are typified as "extraordinary travelers" (N'Diaye 1970). Their young men emigrate from villages to France and to other West African countries and support families back home by sending postal mandats. The Sarakolé are also renowned as entrepreneurs and merchants.

Generally inhabitants of villages, the Sarakolé are sedentary agriculturalists. They do keep livestock which are often entrusted to a Peul herder. Family sizes are large -- approximately 12 to 15 members where a family is defined as an extended family grouping responsible for a farm production unit. In the Kaarta region, the average area cultivated in grain and peanuts was 4.4 hectares with an estimated total size of 5 hectares if other crops were included (ITC 1977). Women typically have their own vegetable and spice plots while men cultivate the grain crops (sorghum and millet), but women also participate in grain crop production. Women are engaged in trade and in the dyeing of cloth.

The society is divided into three classes: nobles who control land distribution; a casted class of blacksmiths, weavers, leather-workers and griots (storyteller-historians) and other artisans; and slaves who are less esteemed members of the group with patron-client relationships to noble families. The Sarakolé practice Islam.

Peuls (Peulhs)

The Peuls are primarily known as raisers of livestock and in many parts of West Africa are nomadic. When nomadic, the Peul are still not isolated from sedentary agricultural communities; it is customary to pasture cattle on fallow land and to exchange dairy products for grain. Semi-sedentary groups have farms in addition to raising cattle and move their cattle in a more restricted cycle of transhumance. The farm location becomes a point of attachment where household heads remain year-round with a small herd. Sons or paid herdsmen move the larger herds to graze, but return to the home base to help clear land or harvest crops. Sedentary Peul communities are also common in the Western Sudan near Kayes. An additional type of sedentary community is formed by descendants of serfs and former slaves of the Peul (Stenning 1964).

Within the route's zone of influence, the Peul are semi-sedentary and sedentary. They are cultivators, although to a lesser degree than other groups, and raise livestock. Transhumance is practiced in the area by Peuls and Maures who trek cattle south in the dry season and north toward Mauritania in the rainy season. Peul herders also work for other ethnic groups and take their livestock on transhumance.

The family size and cultivated area of the Peul is generally smaller than that of the Sarakolé. The farm production unit averaged 6 persons within the Kaarta region. The size of a cultivated production unit for Peul was approximately 1.8-2.5 hectares in contrast to the larger size for the Sarakolé. Productivity on these smaller units, however, was found to be higher, possibly because of more intense cultivation or greater use of dung as fertilizer.

The majority of Peul practice Islam. Their society is composed of three classes, often distinguished by dissimilar physical characteristics: nobles; casted class (blacksmiths, woodworkers, musicians) and slaves.

Khassonké

The Khassonké of Mali are principally centered in the region near Kayes and are not spread throughout the country. Generally thought to be of Peul origin, the Khassonké speak a language of Manding origin. They are spread along the rivers of the Krigou and traditionally have inhabited areas close to the hills such as Mont Tapa near Koniakary.

The Khassonké are predominantly agriculturalists, but also raise some livestock. Statistics developed for the Kaarta project indicate

that the number of hectares per production unit was approximately 4 and the number of persons per family production unit was approximately 8.

The group is Islamic, but with a tradition of animism (N'Diayé) and has a three part division of social classes.

Bambara

Bambara, the largest ethnic group in Mali, are a minority in this area. Agriculture is the major occupation of this group and livestock raising is generally limited. One set of statistics for the Kaarta region (ITC 1977) indicate the same number of persons and hectares cultivated per family production unit as for the Khassonké. Others (ODIK 1979) indicate 10 persons per exploitation averaging 5 hectares in size.

Bambara villages encountered during field reconnaissance along the road practice Islam. The three part class division of society is also characteristic.

F.6.3 POPULATION MOVEMENT

Like many parts of rural Mali, the rural portion of the First Region, and therefore most of the road's zone of influence, is subject to outmigration and other population movements. Outmigration takes a number of forms, but is not typically entered into as a permanent move; migrants assume that they will return to their native villages.

Some migrations, particularly toward urban areas, have become permanent in the process of modernization and transition from an agricultural society. Population growth rates, for example, are significantly higher in urban areas. Kayes urban area shows an estimated growth rate of 6.05% per year over a nine year period by comparison to an average rural growth rate of 1.4% for the entire Kayes First Region. In recent years a higher rate of migration toward cities has been experienced as a result of drought conditions in the Sahelian zone.

Within the entire route's zone of influence, the estimated growth rate has averaged 2.07% per year. (Estimate was based on available growth rates for

the four cercles included in the zone of influence and rates were weighted according to the proportion of rural and urban population each contributed to the zone.) With urban Kayes excluded, the rural portion of the zone of influence experienced a growth rate of 0.90% per year.

The types and directions of temporary migrations are summarized in Table F-2. Seasonal migrations generally occur during the dry season in the road's zone of influence and provide a means to supplement marginal family incomes. Longer term migrations also represent a response to economic needs and have evolved over a long period as a traditional way of coping with limited resources. The directions of these migrations change in response to available labor market opportunities, but the phenomenon has become a cultural expectation. Every village where interviews were conducted confirmed the presence of these types of migration.

The migrations of the Sarakolé to France are nearly legendary and are believed to date from the time of World War I or prior. A young unmarried man between 20 and 24 years of age, leaves his village for a stay away from home for four or five years, but sometimes as long as ten. Upon return home, the young man marries and he stays a few years until he makes a second shorter migration abroad, usually lasting two to four years. Earnings, transferred by postal mandat, are sent by the migrant to trusted friends who transmit them to the families concerned; the funds are usually accompanied by instructions regarding their intended use. The implications of this migration are many. The funds represent a relatively large capital inflow to the region. The money is used to pay taxes and to buy clothes, jewelry, cattle and household commodities. Although migrants return with conspicuous consumer goods (cassette players, for example), the migration abroad does not fundamentally alter the structure of society and young men return to assume their traditional agricultural roles (Dussauze 1974). Because of the absence of these young men, seasonal laborers usually of a different ethnic group and from other villages and districts, are hired to

Table F-2

Types And Directions of Temporary Migrations

TYPE	DIRECTION	CHARACTERISTICS
1. Seasonal		
	Sénégal	Principal migratory current. In exchange for food, lodging and land to cultivate peanuts for three days a week, migrant cultivates for four days a week.
		Harvest and assistance in commercialization of peanuts from November through February.
	Large towns of neighboring arrondissements	By artisans; in Kaarta region toward Bema, Tourougoumbe and toward Sefeto in Kita.
	Le Fouladougou	Traditionally, by Maures (Moors) to Fouladougou in cercle of Kita. Massive migration to assist in grain transport, clearing of new fields and forest work. Newer migration is related to peanut production in the cercle of Kita. From the beginning of the rainy season to end of commercial production. Like migration to Senegal but without length of transport and customs.
	Cities of Mali	Predominantly to Bamako and Kayes to work as laborers in building, as porters and woodcutters.
	Ivory Coast	Migrants leave at the end of the cultivating season, generally in a group to work as forestry laborers and agricultural workers in commercial production of coffee, cacao and kola nuts.
2. Long-term Temporary		
	Sénégal	A migration lasting several years. During the rainy season migrants work in peanut cultivation and after as laborers, porters and woodcutters. Help ready fields for sowing. Some commercial occupations.

TYPE	DIRECTION	CHARACTERISTICS
	African countries	Sierra Leone, Zaire, Gabon and Liberia to work in mining, metals and precious stone industries.
	Cities of Mali	Particularly Sarakolés. Above all to be merchants, but also butchers and shoe shiners.
	Ivory Coast	A significant migration. Similar occupations to seasonal migration to Ivory Coast, but particularly commerce.
	France	France, especially Paris. Migrants work in factories and as street cleaners. Duration of first stay varies; often followed by a second voyage of shorter duration.

Sources: ITC (1977)

replace them. According to villagers interviewed as part of this study, an important use of the road is travel to and from the post office location by the villager or a trusted friend who has received the postal mandat.

In addition to the seasonal, the long-term external and the rural-urban migrations, some population movement associated with transhumance occurs within the road's zone of influence. The pattern of movement is toward Mauritania in the rainy season and back to Mali in the dry season in order that cattle can take advantage of water sources. (Movement north in the wet season among Peul has also evolved as a way of protecting zebu cattle from the tsetse fly; since the road's zone of influence lies above the fly's northern limit, movement for this purpose would originate further south.) The extent to which population groups originating in the route's zone of influence accompany herds could not be accurately determined. The impression gained from project documents for Kayes-Nord and Kaarta and from village interviews is that mostly the Peul maintain home points and that herders, rather than groups of families, travel. Nomadic groups of Peul and Mauré do, however, travel within the route's zone of influence. If estimates derived for the Kaarta project are applied to this zone, then nomads would increase the resident population by about 15%.

Another more localized population movement also exists within the route's zone of influence. Hameaux de culture (hamlets for use during the cultivating season) are established when fields are located at a distance from villages. These may grow into permanent satellite villages.

Migration numbers are difficult to estimate, particularly by category. Based upon analysis of census statistics examined in conjunction with average birth and death rates, migration out of the rural portion of the zone of influence is estimated at 2 to 3% per year.

F.7 LAND USE

F.7.1 AGRICULTURAL USE

Agriculture is localized around settlements. The village chief, typically the descendant of an original settler or the first who came to clear the land, distributes land for cultivation with rights of perpetual use. Land nearest the village tends to be cultivated each year and fertilized with animal manure; as one moves progressively farther away from the village, outlying areas farmed without fertilizer and allowed to go fallow are found. Cultivatable land, according to villages where interviews were conducted, is not in short supply in relationship to the size of each village; the settlement of a new family can be accommodated by the distribution of new lands, albeit often at a distance from the village. When lands are too distant for easy access during the cultivating season, hameaux de culture (hamlets for cultivation) are established. These hamlets, whose locations can shift easily,also allow sedentary villages to practice an itinerant agriculture; when soils in one area are exhausted, new fields are cleared.

Staple crops cultivated are varieties of millet and sorghum, with some maize and rice. Rice is cultivated less in the drier northern area,as is corn which requires a high soil moisture content. Vegetables (okra, onions, bitter tomatoes, sweet potatoes, squash, potatoes), fruit (watermelon, limes, mangos), cotton, peanuts, beans, earth peas, calabash, ladle gourds, sauce ingredients, dyes and tobacco are also grown. The types of crops now grown, according to most of the villagers interviewed, do not differ greatly from the kinds their ancestors grew, but one Peul village (Dioka) noted that fruits and vegetables had not been grown by their grandfathers. Another Peul village (Fassoudebé in the north) stated that whereas their fathers had only hoes to use, some villagers now had plows and they had turned to shorter growing season varieties. Villagers named the varieties of sorghum and millet rather than distinguishing between the two categories of sorghum and millet and specified the soil type best suited to each. Niebé, a nitrogen-fixing leguminous

plant (beans), is often associated with the cultivation of other cereals. Because of these characteristics and its protein content, the Kaarta development project hopes to emphasize its production (ODIK 1979). Statistics used in the feasibility analysis regarding current and projected area under cultivation are analyzed in Chapters 10 and 11.

Data available for the Segala area (extrapolated from regional statistics by USAID reports) indicate that a typical exploitation or family production unit encompasses three to five hectares of which about half is devoted to millet and sorghum, nearly a third to corn and about fifteen percent to peanuts. Yields in the Segala area are thought to fall below the Kayes First Region average of 840 kilos of millet per hectare and nearly 1300 kilos of corn and peanuts per hectare (USAID n.d. circa 1978). Cultivated land was estimated to be 25 to 40% of the area amenable to cultivation. Land in the flood plains of rivers, between Kayes and Segala and similarly near Yelimané and Diounkoulane, is considered quite rich and permits decru (flood recession) cultivation and double cropping. Plows, and steers for animal traction are in use. The estimated number of multiculteurs, seeders and charettes, however, is extremely small; the shorthandled hoe is the traditional tool of cultivators and weeding and harvesting are done by hand.

Land use maps are available for the Kaarta project area of 35,000 square kilometers. These maps reveal a pattern of more intensive cultivation near villages. Approximately 3% of the project's total area is cultivated intensively (above all in river valleys of the south and west of the region) and 10% is moderately or non-intensively cultivated (these latter categories include fallow fields). Approximately 9% is not utilized and the remainder (78%) is pastured. A high proportion of non-utilized land (neither pastured nor cultivated) exists in the plateau area north and south of Marana and Sandaré. Based upon the distribution of cultivated crops for the entire Kaarta project, the typical production unit devotes 80% of its land to sorghum and millet and the remainder to peanuts, corn and rice in descending order of land cultivated.

Although permanent cultivation is sustained in the richer river valleys the more common system in the Kaarta region is cultivation of fields for two to five years, followed by a fallow period of two to fifteen years. The shorter period applies to land nearest villages. Hand cultivation is the dominant mode of exploitation; most farmers utilize the hoe (un sarcloir). Those who can afford it employ a plow (une charrue) pulled by a steer, donkey or horse. Crop losses due to grasshoppers, birds and mice in the fields and infestations during storage are estimated at 30%. Differences in the size of production units among ethnic groups have been noted (see 3.6.2); the Sarakolé not only cultivate the largest plots, but are most inclined to use animal drawn plows.

Potential for agricultural development in the zone of influence is greater than existing use. Lands in the river valleys (Kayes-Segala-Yelimané axis) were noted by O.V.S.T.M. as particularly suited to more intense exploitation. Analyses made for the Kaarta project area show that 16% of the project area has agricultural suitability (Classes 2 and 3) although none of it is prime or Class 1 land, but only 3% (more or less) is used for production each year.

F.7.2. PASTURE USE

Approximately 78% of the Kaarta project area is utilized as rangeland and this magnitude of grazing use can be considered applicable to the entire service area of the road. Although only 2% of the Kaarta area is considered intensively pastured or overpastured, this statistic is probably an underestimate and the points of overpasturing are not distributed uniformly. Watering points (wells and swampy areas) are notably subject to trampling and to soil compaction which leads to increased runoff and erosion. Heavy grazing also diminishes the ability of vegetation to resist drought by reducing the stored nutrients in plants (Dasmann et al, 1973). This problem is particularly marked in the Lake Magui sector of the Kayes-Nord project

area (OMBEVI 1976) in areas east and south of Dioka and northwest of Nioro and along the routes of transhumance (ITC 1977). The Lake Magui sector has its own concentration of sedentary herds and attracts nomadic herds during the dry season.

The distribution of cattle and the use of rangeland is not easily determined, since at least three principal types of pasturing systems exist. In sedentary stocking, livestock graze beyond the tilled lands of villages during the cultivating season and return each night; after the cultivating season they graze the stubble of the fields. Nomadic grazing implies the movement of livestock north and south along defined paths in order to take advantage of watering points and the seasonal availability of pasture. Semi-nomadic or seasonal livestock movement involves the displacement of herds from villages toward Mauritania during the rainy season and their return to villages after the harvest season to glean stalks of harvested fields. This practice has the advantage of keeping livestock away from cultivated fields during the growing season and like the others,eliminates the need to raise fodder. Dry season pasture near villages. however, is often inadequate, water supplies run low and cattle do not fare well. Storage of feed for cattle does not typically exist.

Generally speaking, dry season livestock movement promotes a dispersal of cattle, while the wet season promotes a concentration near watering points in the north. For example, the north-south paths of transhumance mapped for the Kaarta project area are distributed from east to west across the project area but converge either to the west of Nioro du Sahel,going to the ponds of Amake, or in the arrondissement of Gogui. This pattern leads to overgrazing and erosion and can precipitate desertification.This general phenomenon is modified in the region since sedentary stocking practices also lead to overgrazing and erosion around villages and movement of nomadic cattle from north to south can lead to overconcentration near watering points

in the dry season. For example, a major axis of transhumance parallels the Dialaka-Yelimané route and is used to move nomadic herds from Nioro-du Sahel to watering areas near Lake Magui.

A semi-sedentary pattern of grazing, characterized by the transhumance of livestock north toward Mauritania in the rainy season and back to the village in the dry season, existed in seven of the nine villages where inquiries were made. Only small milk herds were maintained near the villages during the rainy season. (In Niamiga near Kayes and in Diandioumé north of Nioro, livestock grazed on lands near the village all year round.) In all of those villages where this type of transhumance was practiced, the villagers themselves stayed put to practice agriculture and sent Peul herders (hired Peul if the village was not Peul) to care for the livestock. Livestock are raised by all ethnic groups in the area, but is a more important occupation for the Peul and Mauré and the number of cattle, sheep and goats per production unit is higher.

The number and density of livestock can not be stated accurately. The 1976 census of livestock is known to be a gross underestimate, since villagers are reluctant to reveal their wealth (see F.8). Analyses of the livestock service suggest an increase in the census number of cattle by a multiple of 2.5 and in the census number of sheep and goats by plus or minus 4. Within the zone of influence, the 1980 estimated number of cattle is 195,000 and the number of sheep and goats is 319,000.(This estimate is based upon apportionment of each arrondissement's censused livestock in 1976, inflated by the multipliers noted above and adjusted for a 3% growth in the cattle population and a 2% growth in sheep and goat populations). Density of cattle is therefore approximately 21 per hectare for the entire zone of influence, while density of sheep and goats averages 13 per hectare. Translated into animal units (UBT), this is equivalent to 12 animal units per hectare. The carrying capacity for parts of the range is greater than existing use, if livestock are redistributed over it and if improved livestock management practices are utilized.

The use of land for pasturing is not entirely free or common, despite the lack of legally defined land ownership. Differential claims on range use are established by different ethnic groups and by specific clans, lineages and families (Horowitz 1979). The control of wells and watering areas also establishes rights to use the rangeland. Although the absence of owned property is frequently cited as an example of the "tragedy of the commons" and as the major cause of overgrazing, this conclusion is an oversimplification of a more complex system of social arrangements.

F.8 ECONOMIC CONDITIONS, EMPLOYMENT PATTERNS AND MARKETING

F.8.1 GENERAL ECONOMIC CONDITIONS AND EMPLOYMENT PATTERNS

The rural economy of the road's service area is based upon agricultural and livestock production. Estimated annual per capita income in the region is $45 to $50 per year.[1/]

Employment is largely in the agricultural and livestock sector and directed to production for family consumption. Nearly every member of the rural population participates in this work. Women and men each cultivate specific crops and share in the production of others; okra, tomatoes, onions and ladle gourds are predominantly women's crops while calabash, grains and beans are men's. Peanuts and fruits can be grown by either and women frequently assist in grain production. The specific division of labor varies among ethnic groups and from village to village. Available labor, given the amount of time agriculture requires, is a principal constraint to the amount of area in production. Wage labor from outside the area is employed during the cultivating season in some villages. These laborers receive food and lodging to supplement their daily wage (1000MF for morning work and 500MF for afternoon work in villages interviewed). During the dry season, males seek work in other parts of Mali or in other African countries; young males are also employed abroad for longer duration and are

1/ OMBEVI (1976) used estimates of 17,600 FM per person in rural areas of the Sahel zone.

absent (See F.6.3, Population Movements). This occurrence is believed to necessitate the use of wage labor during the cultivating season. Postal mandats sent by workers abroad contribute a significant amount to the average income. Using the figure of 3 billion FM per year in the First Region (OMBEVI 1976), the mandat money accounts for approximately 3500 FM per capita or 15-20% of per capita income.

Statistics available for non-agricultural employment cover the entire Kayes Region. In 1973, there were 178 establishments employing 3,675 salaried workers. Assuming an active population equal to half or less the total population, this employment represents no more than one percent of the active working or workseeking population. Most of this employment is centered in and around Kayes. Statistics for public sector employment in 1973 show 1,366 public sector employees of which 77 were employed in Nioro, 101 in Yelimané and 848 in Kayes. In addition to this salaried public and private sector employment, the rural population engages in non-agricultural work in order to supply basic necessities other than food. These home industries include leather working, wood working, pottery making, blacksmithing, spinning, dyeing and weaving, but do not appear to be organized into any system of cottage industries. These artisanal industries are by and large performed by members of the casted classes, but with some variation among ethnic groups. Women typically are the pottery makers and the cloth-dyers while men are weavers and tailors.

F.8.2 MARKETING PATTERNS

Both the products of home industry and of agricultural and livestock production, in excess of consumption needs, are sold in local and regional markets. Markets held every day exist in larger towns like Nioro and in Kayes; smaller villages have weekly markets. Villagers stated that they sold potatoes, onions, okra, mangoes, ladle gourds, calabash, cotton, tomatoes and cloth and,sometimes,millet and sorghum. They also sold cattle, sheep and goats. Villagers buy products such as Shea butter, peanut oil, soap, spices, tea, sugar, and similar articles not made or grown

locally. Women, in particular, practice commerce; they may be outsiders coming to sell at the local market or villagers who travel to other markets to sell their local produce. In some villages (Ségala and Batema), certain women have become specialized as merchants; they bring goods to Kayes for sale and return with goods bought for resale in the village market. Men appear to be the calabash merchants and to handle sales of grain and livestock, whereas women sell vegetables and cloth and are responsible for buying household items. The dominant organization of commerce, whether by local villagers mostly going out to sell and to buy for resale and home consumption or by outsiders coming to sell and to purchase for resale in other markets, could not be accurately determined by the survey, but both types exist in each village. Kayes appears to be the principal source for purchase of non-local products and the principal market for locally grown or produced items. Nioro is a secondary center and particularly oriented to livestock sales. Bamako is also a principal point of orientation for villagers who want to buy extensively. Although almost all locally produced items are commercialized to some extent, calabash bowls and the making of straw mats or fans are examples of two products which are produced for commercial purposes. The marketing of grain and livestock each merit separate discussions, which follow.

F.8.3 GRAIN MARKETING

Grain sales are officially controlled by the Mali Government through OPAM, the government marketing and storage agent. Villages supply quota amounts of grain to the state agency at the end of the harvest season and sell at a guaranteed price. A parallel market in grain also exists; it handles a greater proportion of marketed grain volume than the official market and with clandestine exports this market is estimated between nearly double the official market (CILSS Club du Sahel 1977) and 80% of the total market (local estimates). The region, including the road's service area, is frequently deficient in grain and depends upon imports from other parts of Mali.

The government grain price policy has as its goal the provision of grain to urban centers and deficit zones. The mechanics of the process, however, can work to the detriment of the individual farmer. A CILSS/Club du Sahel (1977) study on grain marketing concluded that the goals of the cereal policy have not been achieved because transportation and storage difficulties and other administrative problems have affected the redistribution of grain. Official prices are therefore not followed and those in need of buying grain often pay a much higher price than the official one. Although the prices of consumer goods are also controlled, in effect, only a minority can buy at the authorized prices. Thus, "the farmer who is supposed to be protected by having prices kept artificially low ends up paying the costs and losing the most by it" (CILSS/Club du Sahel, 1977). In zones that are isolated, prices fall in a normal or good year and the supply is not absorbed by the parallel market because of the costs involved in shipping and marketing, and the risks posed by economic legislation which hinder medium and long distance shipment. The farmer in the isolated zone must market his grain for less than he otherwise might and is willing to sell cheap just to get something. In a deficit situation, if the farmer is obliged to purchase grain, he can end up paying high parallel market prices for it.

Villagers interviewed as part of this study noted the fluctuating grain prices and viewed the quota system as a disincentive to the production of greater quantities of grain. They do buy and sell on the parallel market and do try to keep grain in their storage facilities to allow the price to rise when they have excess. Locally constructed storage facilities, mud-brick granaries, are considered relatively insect-proof and adequate by some sources.

F.8.4 LIVESTOCK MARKETING

The northern area of Kayes, and the circles of Nioro and Yelimane are considered the most important cattle producing areas in the entire Kayes region. Cattle raising, rather than agriculture, provides the greatest amount of income (OMBEVI 1976). Marketing of cattle and of sheep and goats is a complex affair which is not totally governed by market economics and which is influenced by social custom and by herding practices which have evolved over centuries. The village producers have a low offtake rate for

cattle and keep male stock for a long period of time. Producers are prompted to sell "when they need money", for taxes, a marriage, to buy grain, or to buy consumer goods (salt, sugar, tea, shoes). Cattle prices, for example, tend to go down when grain prices are up (Livestock Merchants Cooperative and Dr. So, Personal Communications, 1979). Cattle represent a form of investment, a capital stock, which the owner seeks to maintain, but parts with when necessary. Like any investment they represent social prestige. Conversion of animals to cash has also not been sound when the value of cash is diminshed by inflation and when a large number of animals are needed for survival, i.e., the need to keep enough cows lactating throughout the year and to maintain healthy breeding stock (Horowitz 1979). A high proportion of older (more knowledgeable) steers in a herd is also believed to help in management of the herds (Horowitz 1979). The drought experience, which causes loss of cattle and forced sale to buy grain, helps to convince herdsmen of their vulnerability and encourages them to maintain higher stocks as a cushion. Villagers in Sandare, for example, noted that they were not currently selling cattle, since the drought had diminished their supply. These practices, along with the mobility of transhumance, are sometimes viewed as economically irrational. They can, however, be seen as appropriate ecological responses to a difficult environment. Mobility keeps livestock away from fields during the growing season and provides an adaptation to unpredictable variation in the quantity and distribution of rain. In one village near Nioro, villagers were selling an increased proportion of three to five year old steers and seemed receptive to development objectives for the region which would increase the offtake rate and encourage management of herds for commercial meat and milk production.

The marketing of livestock, more sheep and goats than cattle, is typically done by specialized merchants who come to villages to buy, who seek out Peul herds or who purchase at collecting markets where villagers take livestock. These bush collectors or rabatteurs then take livestock to markets of regroupement for sale to larger merchants. (Tourougoumbé and Nioro are two important collection and regroupement markets.) Animals are

subsequently driven to terminal markets at Kayes or Kati (near Bamako) where livestock are slaughtered or exported to Sénégal or the Ivory Coast. Cattle are almost exclusively walked to market. Sheep and goats are sometimes trucked and would be trucked more according to villagers if the roads were better, but walking is the more common practice. According to the Nioro Livestock Merchants Cooperative, about 75% of the herds are taken to Bamako and 25% to Kayes. Bamako is favored because of higher demand. A typical loss is 5 out of 50 cattle or 10% due to disease and weight loss. No comparable data is available for the Yelimané area.

The Kayes-Nord livestock project is oriented to production in the northern zones with transport to the Kayes and the vicinity of the Senegal River for fattening and slaughter. This direction for future livestock development is based upon a strategy of zonal stratification advocated by the Club du Sahel. The strategy aims to make the Sahel a "zone de naissance" and to concentrate fattening activities further south in the "zone engraisseur" in order to prevent future overgrazing in the Sahelian zone. An abbatoir has been built at Kayes, but will not be used to daily capacity at current offtake rates. The future economic significance of slaughtering, commercialized feedlots, industrial ranches and spin-off livestock employment will depend upon the success of such programs as Kayes-Nord which include this type of intervention.

F.9 SOCIAL SERVICES

F.9.1 HEALTH

Health conditions are poor in the region. The average life expectancy at birth is less than 40 years and the infant mortality rate is high. Some analysts believe that the mortality rate of the population under five reaches 50%. Specific baseline data regarding health conditions is extremely limited. To the extent that mortality data for all of Mali is representative of the area, the three leading causes of death are enteritis and diarrhea (principally in children), measles and malaria. These diseases,

along with malnutrition, upper respiratory infections, eye infections, diarrhea and dysentery, intestinal worms, guinea worm and water borne diseases such as schistosomiasis, were identified by local authorities as threats to life and productivity.

Health facilities in the area are inadequate, understaffed and under-supplied due to shortages of money, personnel and supplies. The condition of roads was cited by health officials and villagers alike as the major impediment to providing access to the health care facilities that do exist. Emergency medical assistance cannot reach patients in time. Sick people and pregnant women are transported at risk over the roads and vehicle maintenance and repair absorbs a large portion of the regional health director's administrative budget.

The major point of orientation for serious medical problems is the regional hospital in Kayes (215 beds, five doctors). A secondary hospital at Nioro (44 beds, 1 doctor) can provide medical services, but can only perform limited surgical procedures. Yelimane has a health center including a dispensary with beds and a maternity. The health care system is organized so as to provide regional hospitals, health centers in the administrative seat of each cercle and dispensaries in the chief place of each arrondissement. The cities have neighborhood dispensaries and in some arrondissements large towns, in addition to the administrative center, have dispensaries. The locations of those health care facilities within the road's zone of influence are depicted in Figure 13-1. Villages also take the initiative to construct their own health care facilities. At Batema, for example, a cement block maternity was built with money sent by young men in France. Segala, through the Federation des Groupements Ruraux, has opened a popular pharmacy and stocked it with medicine which villages can purchase. Koniakari and Sandaré also have such popular pharmacies to supplement their public dispensaries which villagers felt were undersupplied. These pharmacies use the profits of their sales to build rural maternity clinics. Although some

villages have traditional healers and practice traditional healing in the household, villagers were receptive to and interested in access to modern health care services in every village where inquiries were made.

The Yelimané Rural Health Development Service Project (financed by USAID) is pilot venture oriented to developing low-cost health care service at the village level. The project includes training of health workers and the introduction of health and health education services. This demonstration project has as its goal the testing of a scheme which could be adopted for a national rural health services system. This new national strategy for health care, primary health care (soins de santé primaires) at the village level is now in its beginning phase of planning and implementation (G.R.M. Direction Nationale de Sante, 1979). This program will place health teams composed of a hygenist, mid-wife and community organizer (animateur) in villages. The team will work to introduce public health measures in collaboration with villagers who will select the health care team. Waste disposal, condition of wells, vaccination, maternal and child care and general public health measures will be emphasized. Village teams will be assisted by sector teams serving several villages and by the health system of the arrondissement where a nurse is typically available. In creating this fundamental level (niveau de base), new transportation needs will be generated.

F.9.2 EDUCATION

Schools within the zone of influence of the route are depicted in Figure 13-1.Except for the lycée at Kayes, these are all schools of the first cycle (first six years) and second cycle (next three years). The service radius for primary first cycle education is generally no more than 10 kilometers and these rural schools draw the bulk of their students from the immediate village and nearby villages. Attendance statistics for three schools in the Segala arrondissement, contained in Table 13-2, illustrate this point.

Although education is mandatory and the rate of school attendance (taux de scolarite) can reach 90% in towns, such high rates are not characteristic of smaller villages. For all of Mali, the 1972-1973 rate of school attendance for children up to 14 years old was around 24% (G.R.M. Ministere du Plan, 1977). Members of the Sarakolé ethnic group, according to the inspection report on education in Kayes for 1978-9, are more reluctant to send their children to school than other ethnic groups. Inquires made at villages near the Kayes-Nioro road indicated that proximity to a school is the principal limiting factor. Villagers, however, seemed receptive to education and in some cases villages take the initiative to build schools. In two towns, villagers noted that they were supposed to send children to particular schools but sent to others where they had relatives with whom children could stay. This phenomenon is particularly common for children who attend school beyond the first cycle. Entrance to high school is based upon competitive examinations. Successful students receive government scholarships; their placement in high schools is made according to available space and bears no necessary relationship to a student's place of residence. These students board away from home and only visit home during school vacation.

In addition to a formal educational system for children, literacy programs have been incorporated into the activities of development operations such as Kaarta. Youth programs, oriented to sports and cultural events, occur annually in the region; transportation for these events was noted by the Governor of the First Region as particularly difficult.

F.9.3 EXTENSION SERVICES

The three existing development projects within the road's zone of influence emphasize extension services for agricultural and livestock improvement. The Kayes-Nord project includes a program for animal health (the establishment of veterinary and vaccination centers) and the use of extension agents to provide education and training to livestock associations

whose formation is contemplated. The O.V.S.T.M. project sends agents out of Segala to surrounding villages and is the center of the O.V.S.T.M.'s dryland farming development project. Operation Mil-Kaarta has plans for increased agricultural and livestock production that require extensive training and extension activities in the area's sub-sectors. Similarly, a First Regional Pilot Development Project under consideration by USAID and the Government of Mali would depend heavily on extension services.

F.10 DESERTIFICATION

Desertification is a phenomenon whose causes and effects are complex and not easily unraveled. Within the road's zone of influence, no statistical data is available to indicate how much desertification exists. Overgrazing, frequent fires and deforestation, often precursors to desertification, do occur. Loss of vegetation, which can result from any one of these factors or a combination, leads to further vegetational changes (for example, perennials to annuals), soil compaction, decreased water storage capacity, increased runoff, greater risks of water and wind erosion, and eventually to soil crusting and sterilization. Loss of trees, in particular, intensifies the effects of soil movement.

Some analysts view herding methods and the role of livestock in the society as the causes of overgrazing, deforestation and fires. The absence of private land ownership, for example, is thought to lead to the tragedy of the commons -- the resource is free and common and it is in the interest of no one user to restrict voluntarily his exploitation of it. Since livestock in the Sahel is a form of capital accumulation with prestige value, offtake rates are low. Large numbers of cattle are also insurance against drought and disease and are maintained in the expectation of such loss. These practices are linked to overgrazing and thus to desertification. The mobility of livestock, i.e., making the transhumance or nomadic grazing, is also viewed as a compounding problem which concentrates animals at watering points. Policy recommendations, reflected in plans for livestock improvements,

follow from this line of reasoning. The objectives of the Kayes-Nord project include regulation of pasture rights, formation of livestock associations with responsibility for particular territories, creation of new watering points to avoid concentration around existing ones, changes in management of herds to increase offtake, emphasis upon fattening (embouchement) south of the Sahel, reforestation and firebreaks. The Kaarta project aims to discourage transhumance, to increase herd off-take and to dig new wells in areas with good vegetation cover.

While the picture of desertification presented above places the onus of change upon herdsmen, not all analysts agree that herding practices are the causes. Some climatologists, for example, view desertification as part of a long-term climatic change. Desertification can also be related to increased reflectivity of the earth's surface (higher albedo) caused not only by the denuding of vegetation associated with overgrazing, but by the increasing proportion of cultivated lands which leave the ground without vegetative cover for a portion of the year (Ormerod 1976). A change in albedo can affect rainfall patterns by altering the thermal dynamics of the atmosphere in a way that suppresses rainfall.

Policies which compress available rangeland such as sedentarization of nomads and expansion of areas under cultivation can also contribute to overgrazing and desertification (Horowitz 1979; Swift 1977). Changes made in the effort to develop, such as the financing of wells in the Sahel and the control of animal disease, have removed some traditional constraints to herd size, led to confinement of herds near watering points and intensified the problems of overgrazing. Livestock mobility of the traditional fashion, it is argued, is an adaptive mechanism which has prevented prolonged grazing in any one place and has conveyed survival value in an unpredictable environment (Horowitz 1979; Dasman et al 1973). Traditional herding practices have long limited herd size (through the constraints of management capacity and through gifts, loans and sale of livestock). Efforts

to legalize pasture rights to avoid the tragedy of the commons fail to recognize the restriction of range rights by social custom. Thus efforts to change the social organization of livestock raising and the values of those engaged in it, in this interpretation, may be ineffective in combating desertification. At the very least they may require more sensitivity to the relationship which has evolved between the resource users and the range resource.

Change, however, has already affected the system and a return to the traditional balance between grazers and grazing land and their relationship to sedentary cultivation is not likely. The key is to find socially as well as ecologically appropriate ways of preserving rangeland and arresting desertification, but the definition of these appropriate ways is not clear-cut.

APPENDIX G

APPENDIX G

SOCIO-ENVIRONMENTAL SURVEY

The questionnaire utilized in interviews of nine villages is reproduced on the following pages. The interview team included four persons (Sociologist, Environmental Planner and two Anthropologists, one of whom is the USAID anthropologist for the Mali mission). Villages were selected, prior to field investigation, to represent a variety of ethnic groups, different population sizes, and villages both on and off the road. Travel conditions and speed along the road limited the team to an average of one interview per day and did not permit interviews in all pre-selected villages.

The approach typically involved interviewing the chief and his counsel. Although separate interviews of women or women only in every other village were planned, village protocol prevented interviewing only women or women first and time constraints prevented interviewing two separate groups in any one village. The anthropologist members of the team translated the questions into Bambara for the villagers. Where Bambara was not spoken generally in the village, a member of the Chief's counsel or advisors retranslated the questions. The questionnaire could not be followed strictly in all cases and clarifying questions to permit dialogue among members of the team were inserted.

Answers to portions of the questionnaire summarized in this appendix should not be considered statistically representative. They are, however, qualitatively and conceptually indicative and can be cross-validated by reference to literature and technical reports. Information about prices was sufficiently consistent among villages to conclude that for this particular year they are generally valid.

The location of villages surveyed is shown in Figure G-1.

I. INTRODUCTION: Explanation of Visit

II. BACKGROUND QUESTIONS: First we would like to ask some questions about the village.

Who settled the village? When?
Where did they come from?
What ethnic group?
What crops did your fathers grow?
Is the village growing?
    Why? Birth rate or migration?
    If migration, from where?
Are the young men in the village accustomed to living in France, Ivory Coast, elsewhere?
Do young women go elsewhere to seek work?
Do they (men/women) send back money (mandats)?
Where is the nearest post office?
Where is the nearest infirmary?
    Is there medicine there?
    Where do you go to get medicine?
    Is there a traditional healer?
Where is the nearest school?
    Do children from the village go there?
Where is the nearest market?

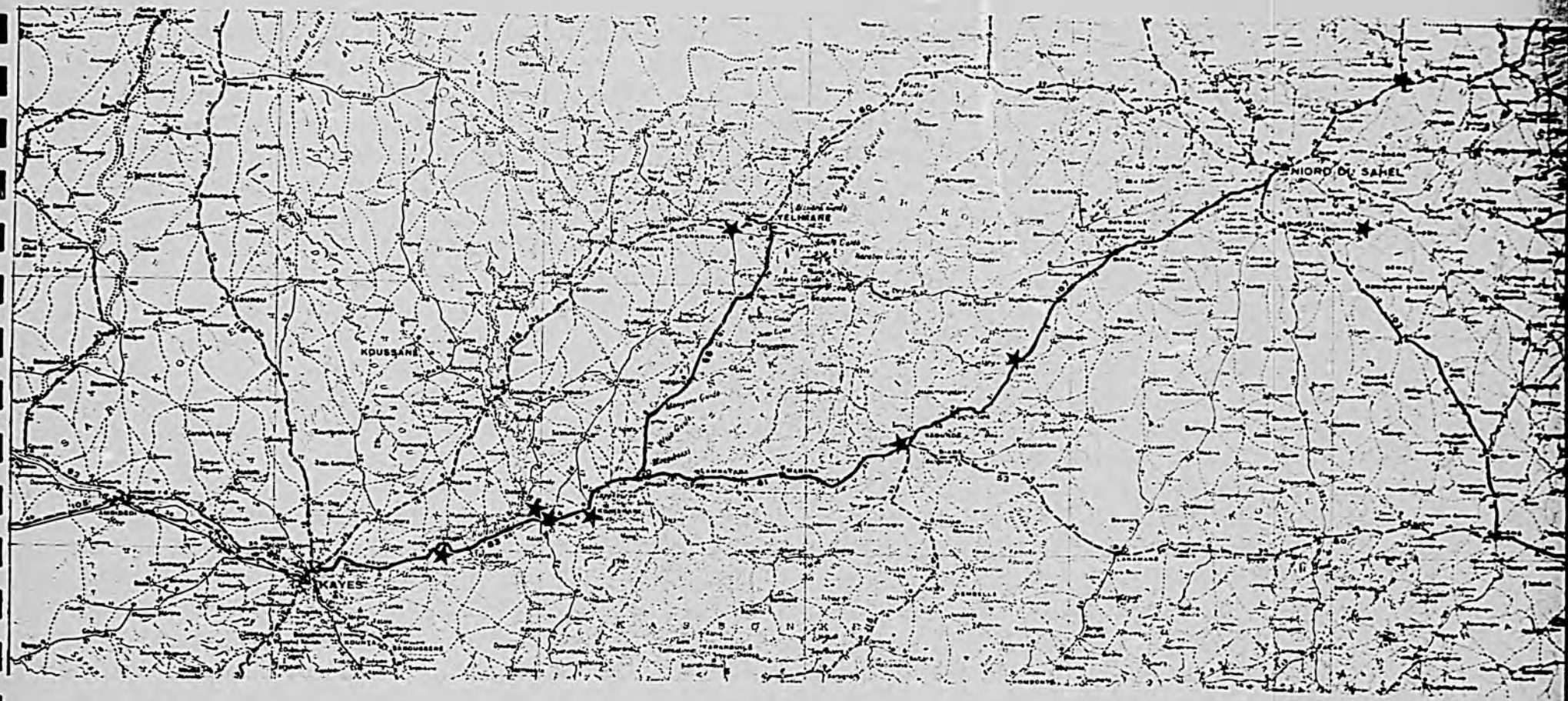
III. CROPS

If the harvest is good, what do you normally sell from this village?
    For example: onions, peanuts, cotton, da, calabash, okra, tomatoes, Baobab fruits, honey.
What crops are grown by men? by women?
What is the price of transport for a passenger to go to market for selling?
What is the price of transport for goods?
If the road is improved, how does it increase your profit?
How do you travel?

IV. GRAIN

We realize you are asked to sell a certain amount of your grain to the authorities:

During a good harvest, might you have grain to sell other than to the government?
Where do you sell it?
How much do you get for a bag?
How much does it cost to transport a bag?
Before the new crop is in, food is scarce and people can't feed themselves, grain prices rise. How high do they go?



LEGEND/ LEGENDE
★ VILLAGES WHERE INTERVIEWS WERE CONDUCTED
VILLAGES OU LES ENQUETES ONT ETE MENEES

TAMS

FIGURE G – 1
LOCATION MAP OF VILLAGES INTERVIEWED
CARTE DE SITUATION DES VILLAGES OU LES ENQUETES ONE ETE MENEES

V. LIVESTOCK

Do you ever sell cattle, sheep, goats?
Why do you sell?
Where do you sell?
Are there people who only raise livestock?
Do you do this for a living?
Who takes care of the livestock?
How much can you sell a good cow for?

VI. WAGE LABOR

Do you have work seekers in this village?
What is the daily wage?
Is there available labor to build the road?
Do you repair your own roads?

VII. ROAD LOCATION

Is there anything you want to specify about the location of the road?
Are there sacred places near the road?

VIII. BENEFIT PERCEPTION

What would you want us to tell USAID about how this road will help you or not?

SUMMARY OF BENEFIT PERCEPTION

The following quotes from the village interviews directly and colorfully summarize villagers' perceptions of benefits. Generally these answers were responses to the open-ended question regarding how the improved road would help the village.

Niamiga (Khassonké)

The road will make it easier to travel in the rainy season.

We had to cut off a child's leg after he fell out of a tree (because we couldn't get to the hospital).

Ségala (Peul)

The road will help women have a baby at Kayes.

Women can go to buy fruit, sauce ingredients and indigo to dye cloth at Kayes. Women can sell their cloth (and other goods) in Kayes.

Women could go from here to Kayes and be back home in time to cook dinner.

To have this road is our greatest dream. (Chief of the arrondissement)

Batema (Soninké dominant, but many Peul)

It will be easier to market produce.

Fifteen women here do "real" commerce. (Buy fruit, spices, cloth, soap, peanut oil, Shea butter and flour to resell in Batema.) More want to do commerce, but they fear the road.

If we're really sick, we need to go to Kayes.

With more trucks in commerce, transport costs could be lower. A better road would mean less repair costs and less fuel.

Our fields are no good this year. We'll need to go buy food.

Koniakari (Peul)

The "ambulance" can't get here. The road will help sick people.

We could sell more watermelons and sweet potatoes.

It will take less time to do commerce.

Women can go to sell cloth at Kayes.

Water is really our biggest concern; we really need a well.

Dionkoulané (Soninké)

The villagers in Dionkoulané preferred a road linking Yelimané directly with Kayes: There have been a lot of surveys over 30 years, but so far we haven't seen any road.

A road alone will not solve our problems. We plant our crops like this year, and there is no rain, there is no crop to harvest and no crop to sell. This year we need a road to go to market to buy grain. Or, we plant a crop and grasshoppers and locusts eat it up.

We would prefer the road Yelimané to Kayes, but wherever you build the road, it will be a good thing. We are completely cut off in this region.

There will be more commerce.

Pregnant women can't go to Kayes now, so you pray; it's in God's hands.

You know that when you are well and you go over that road, you can get sick. If you are sick, you die.

Sandaré (Bambara)

We could sell produce ourselves.

Just the fact of being able to travel for yourself, more easily and more comfortably.

We could transport sheep and goats by truck . The sheep and goat commerce would increase.

If you wanted to buy things in Kayes or Nioro, the cost of getting them would go down. That would lead also to more consumer goods being available here.

If you're sick, you could go to the hospital in Kayes or Nioro more quickly and immediately.

If there were a road, travel would increase. Some of us have money, we could buy a truck and market our produce. With the road as it is, it isn't worth it to us. A vehicle will be torn up in one year.

More people would buy vehicles for transport and commerce. There is now one Land Rover and one 404 Peugeot in town. Individuals can buy vehicles with their own money or get a backer.

If you need something, roofing, wood for rafters, farming tools, or if a plow or cart is broken, you can go quickly to town and bring back what is needed. We could build better houses here.

If there were a better road, there would be passenger vehicles; you would not have to ride in the back of a truck. In other places, they do not transport people like cattle. That would be a big benefit.

In years of bad harvest, like this year, the road will bring grain merchants so that we won't have to go to Kayes or Nioro to buy grain.

There are women in the town who do commerce. Transport cost will be cut in half. These women will make more money. They could take fresh okra to market,not just dried okra. They could sell fresh produce in general. Also,they could buy fresh produce. As it is now, all of it spoils. They could even buy fresh fish.

Dioka (Peul)

We could visit relatives in Nioro. As it is, I (Chief) haven't been there in 12 years because I'm old and the trip hurts me.

We could get whatever we need from Nioro and Kayes.

We could take our produce elsewhere to sell because the transport prices are sure to go down, if the road is made better.

We could put cattle, sheep and goats in trucks and transport them to market. We can't do that now because they die in trucks.

We have wild produce here which is not found in Senegal, we could sell it using trucks.

Potatoes, tomatoes and watermelons could be sold. Now they are in trucks so long that they spoil or are broken up.

Sick women and pregnant women could go to the hospital in Kayes or Nioro. Then we would be less likely to lose them.

If we could sell produce, it would be possible to make money and we would not lose our young men.

There is a rice area near here. This could be farmed using a tractor which we could buy. It can't be done now because no one will come this distance to buy it, the merchants have to pay too much to get here to make a profit at all. Nonetheless we have rice to sell now.

We could sell milk and butter in big cities.

Young men might find work building the road and they would stay here.

Fassoudebé (Peul)

We'd rather go to Bamako, but we would use the [Kayes-Nioro] road in the rainy season. We really don't care about the Kayes-Nioro road. From Makena east, everbody goes to Bamako.

Commerçants would come from Kayes to Nioro and their goods would circulate in the area.

We want our list of needs known to USAID. They are (in order):

- Improvement of Bamako-Nioro road
- Plows
- Plow oxen
- Carts
- Medicines
- Wells
- Improved road from village to Nioro
- Insecticides against grasshoppers

Diandioumé (Soninké dominant and some Peul and Mauré)

If a person is really sick, we put them in a plane for Kayes or Bamako.

Even though its shorter to go to Kayes, people will go to Bamako because they have relatives there. We could take the train from Kayes to Bamako and the better road from here to Kayes.

If the road is built, the price of transport will come down, if you want to come here from Kayes.

Women here make Soninké cloth. They could go to Kayes and sell it.

Now if you want to sell a lot of sheep and goats they'd die on a road in a truck. [Could avoid this]

Grain merchants could go to Kayes, buy 10 tons and come back the next day.

Now if you have a sick relative in Kayes, it could take 3-4 days to get there and the relative could die. [Could avoid this]

When the price of rice in Nioro is too high, a bad crop year, you could go to Kayes to get it.

If a herder is stealing head from your herd and tries to sell them in Kayes, you could go there and be waiting for the thief.

The salt merchants who travel on foot with donkeys could travel in a truck.

Commerce will increase. We could get products at Kayes and bring them here. We could get goods from Sénégal off the train.

We could get agricultural tools and do more agriculture. Road could help supply more tractors to the Nioro area. There is one for rent in Nioro, but it costs 7500 francs an hour. (Maybe price would be cheaper with road.)

CROPS & PRODUCTS OF WOMEN

Niamiga	no information
Ségala	Grow okra, onions, tomatoes; dye and sell cloth, make mats and fans; participate in commerce - some exclusively
Batema	Grow peanuts; participate in commerce (15 do so heavily)
Koniakari	No cultivation; little commerce; dye cloth and sell it
Dionkoulané	Grow okra, onions, cotton, peanuts, indigo, rice and some millet; some commerce
Sandaré	Grow okra, onions, ladle gourds, bitter tomatoes, pepper, and rice; with men, grow sorghum, millet, papaya and peanuts; participate in commerce (okra and onions)
Dioka	Grow okra, onions, ladle gourds, bitter tomatoes; with men, grow sorghum, millet, corn, cotton, peanuts, beans and earth peas
Fassoudebé	Grow okra and cotton
Diandioumé	Grow okra, onions, ladle gourds, bitter and regular tomatoes, rice, squash, calabash, sweet potatoes; with men, grow cotton, peanuts, earth peas, beans, cassava, watermelons, dakumu and datu; have their own grain fields; participate in commerce

TRANSPORT PRICES QUOTED BY VILLAGERS

From		To	Passenger	Freight Transport
Niamiga	-	Kayes	2,000	20 F/kilo
	-	Nioro	5,000	30 F/kilo
Batéma	-	Kayes	2,000 F	20 F/kilo
Koniakari	-	Kayes	2,000 F	20 F/kilo
	-	Nioro	6,000 F	
Dionkoulané	-	Kayes	7,500 (rainy season)	50 F/kilo
	-	Kayes (via Yelimané Road)	5,000 (dry season)	30 F/kilo
Sandaré	-	Kayes	4,000	20 F/kilo
	-	Nioro	3,000	20 F/kilo
Dioka	-	Nioro	2,500	15 F/kilo
	-	Kayes	4,000	20 F/kilo
Kayes	-	Dioka	5,000	40 F/kilo
Fassoudebé	-	Nioro	1,500 (Landrover)	20 F/kilo
			1,000 (truck)	
	-	Bamako	10,000 (Landrover)	50 F/kilo
	-	Bamako (dry season)	7,000 (truck)	
Diandioumé	-	Nioro	1,500 Landrover	15 F/kilo
			1,000 Big truck	
Nioro-Kayes			5,000	30 F/kilo

GRAIN AND LIVESTOCK PRICES QUOTED

Village	GRAIN Parallel Market Prices (per 100 kilos in FM) Millet/Sorghum 1/	Rice
Niamiga	6-15,000	-
Ségala	-	-
Batema	7,500-15,000	25,000
Koniakari	6,000-8,000	20,000-30,000
Dionkoulané	8,000-16,000	-
Sandaré	-	-
Dioka	Up to 15,000	-
Fassoudebé	-	-
Diandioumé	-	-
Other Sources 2/	10-11,000	25,000-30,000

LIVESTOCK (IN FM)

Village	Steer (10-12 years)	Steer (3-4 years)	Cow 3/	Calf
Niamiga	-	-	-	-
Ségala	-	-	-	-
Batema	90-125,000			
Koniakari	110-115,000			
Dionkoulané	125,000			50,000
Sandaré	120-125,000	45-50,000	80-100,000	
Dioka	125-150,000	50-65,000		
Fassoudebé	-	-	-	-
Diandioumé	100-125,000	40-50,000	80-100,000	
Other Sources 2/	125-130,000			

1/ OPAM price quoted by villagers as 4,000 MF (1978) and 5,000 MF (1979)

2/ Includes merchants and officials

3/ Varies according to size and state of pregnancy.

APPENDIX H

APPENDIX H

INPUT FOR MODEL OF REGIONAL PRODUCTION SYSTEM

(all costs, prices and tariffs are based on 1979 values)

H.1 BASE CASE: NO AGRICULTURAL INVESTMENT

Table H.1

Area Under Cultivation (hectares)

Alternatives	Year 1	5	10	25
* 1. Status Quo (without)	60,000	65,000	[illegible]000	72,000
** 2. With Improvements				
Alt. 1	↓	↓	71,325	77,000
2			71,500	77,250
3			72,500	78,750
4			74,500	81,750
5			75,000	82,500
6			76,000	84,000
7			76,250	84,400

* Values are based on ODIK projections which were cut by about in half, and then only applied to that portion of zone of influence inside the ODIK jurisdiction.

** Projections are made in proportion to level of road improvements on basis that maximum spread effects of road investment are equal to effect of ongoing development projects (ODIK and Kayes Nord), over half the zone of influence.

Table H.2

Crop Area Breakdown (Percent)

Alternative/ Crops	Year 1	5	10	25
1. Status Quo				
Beans	22.0 (1.1)*	18.0 (2.7)	16.5 (3.3)	16.5 (3.3)
Sorghum	33.0	30.1	28.4	28.4
Millet	24.0	24.0	24.0	24.0
Maize	7.5	7.1	6.8	6.8
Peanuts	21.2	22.5	23.5	23.5
Miscellaneous	13.2	13.6	14.0	14.0
2. With Improvements (all alternatives)				
Beans	22.0 (1.1)	18.0 (2.7)	12.0 (4.2)	12.0 (4.2)
Sorghum	33.0	30.1	26.0	26.0
Millet	24.0	24.0	22.8	22.8
Maize	7.5	7.1	6.0	6.0
Peanuts	21.2	22.5	26.0	26.0
Miscellaneous	13.2	13.6	15.0	15.0

* Numbers in parenthesis are the percent of beans under cultivation, separate from other crops.

Crop pattern changes, projected by ODIK, were cut by about in half.

Crop pattern changes are projected to account for movement towards cash crops without reduction in present levels of deficits in staple cereals.

Table H.3

Percent of Area in Improved Cultivation *

Crops/ Alternatives	Year 1	5	10	25
1. Beans				
Status Quo	5	15	20	20
Alt. 1 & 2	↓	↓	35	35
3	↓	↓	↓	↓
4	↓	↓	↓	↓
5	↓	↓	↓	↓
6 & 7	↓	↓	↓	↓
2. Sorghum				
Status Quo	0	12	18	18
Alt. 1 & 2	↓	↓	23	23
3	↓	↓	26	26
4	↓	↓	30	30
5	↓	↓	32	32
6 & 7	↓	↓	35	35
3. Millet				
Status Quo	0	15	23	23
Alt. 1 & 2	↓	↓	28	28
3	↓	↓	31	31
4	↓	↓	35	35
5	↓	↓	37	37
6 & 7	↓	↓	40	40
4. Maize				
Status Quo	0	25	33	33
Alt. 1 & 2	↓	↓	35	35
3	↓	↓	36	36
4	↓	↓	38	38
5	↓	↓	39	39
6 & 7	↓	↓	40	40
5. Peanuts				
Status Quo	0	18	28	28
Alt. 1 & 2	↓	↓	32	32
3	↓	↓	34	34
4	↓	↓	36	36
5	↓	↓	38	38
6 & 7	↓	↓	40	40
6. Miscellaneous				
Status Quo	0	12	20	20
Alt. 1 & 2	↓	↓	26	26
3	↓	↓	30	30
4	↓	↓	34	34
5	↓	↓	37	37
6 & 7	↓	↓	40	40

* Projections are half the ODIK estimates for the status quo alternative. Projected increases in area under improved technology cultivation are [illegible]ortional to levels of road improvements, with the maximum increase [illegible]g equal to double that of status quo case but not more than 40 per[illegible] of total area.

Table H.4

Net Yield* for Stabilized Traditional Cultivation (kg/ha)**

Alternative	Years	Crop: Beans	Sorghum	Millet	Maize	Peanuts	Miscellaneous
1. Status Quo	1 to 25	220	485	375	575	495	750
2. With Improvements	1 to 5						
3. With Improvements	6 to 25						
Alt. 1		230	500	390	595	510	790
2		230	505	390	600	515	800
3		230	510	390	605	520	810
4		235	515	395	610	525	820
5,6 & 7		235	520	400	615	530	825

* Net yields are the gross yields less seeds and losses; also accounts indirectly for reduction in costs of inputs due to road improvements.

** Projections are those provided by the average from ODIK studies and GOM statistics.

Table H.5

Net Yields* for Improved Cultivation (kg/ha) **

Alternative	Year	Crop: Beans	Sorghum	Millet	Maize	Peanuts	Miscellaneous
1. Status Quo	1 - 25	2,020	800	620	1,250	1,070	1,650
2. With Improvements	1 - 5						
3. With Improvements	6 - 25						
Alt. 1		2,080	825	640	1,290	1,100	1,700
2		2,090	830	645	1,300	1,105	1,710
3		2,110	840	650	1,310	1,115	1,725
4		2,130	850	655	1,320	1,125	1,740
5,6 & 7		2,140	850	660	1,325	1,135	1,750

* Net yields are the gross yields less seeds and losses; also accounts indirectly for reduction in costs of inputs due to road improvements.

** Projections are those provided by the average from ODIK studies and GOM statistics.

Table H.6

Rural Population Increase (percent/annum) *

1. Population in year 0 (1980) = 190,000

2.

Alternative	Increase
Status Quo	0.90
Alt. 1	1.15
Alt. 2 through 7	1.20

* Based on GOM projections with assumed road impact of improved accessibility to health services.

Table H.7

Per Capita Consumption (kg/person/year) *

Crop	Year 0 - 10	Years (11 - 25)	
	All alternatives	Status Quo & Alt. 1	Alt. 2 - 7
Beans	20	20	22
Sorghum	75	75	80
Millet	40	40	42
Maize	15	15	17
Peanuts	5	5	5
Miscellaneous	20	20	22
Total	175	175	188

* Projections are based on an average of ODIK studies and GOM statistics.

Table H.8

Domestic Outbound Quota (kg/ha) *

Crop	Year 1 - 10	Year 11 - 25
Beans	0	0
Sorghum	25	35
Millet	25	35
Maize	25	35
Peanuts	0	0
Miscellaneous	0	0
Total	75	105

* On basis of GOM statistics and interviews in Bamako and First Region.

Table H. 9

Traffic Distribution of Agricultural Exports (percent)

Alternative/ Crop	Domestic Exports	Foreign Exports	Exports not on Road
1. Status Quo			
Beans	95	0	5
Sorghum	95	0	5
Millet	95	0	5
Maize	95	0	5
Peanuts	80	10	10
Miscellaneous	95	0	5
2. All Alternative improvements			
Beans	85	10	5
Sorghum	90	5	5
Millet	80	15	5
Maize	80	15	5
Peanuts	50	40	10
Miscellaneous	85	10	5

* On basis of analysis of likely markets and transportation network.

Table H. 10

Economic Prices of Agricultural Produce (MF/kg) *

Alternatives	Years	Crop: Beans	Sorghum	Millet	Maize	Peanuts	Miscellaneous
1. Status Quo & All Alternative Improvements	1 - 25 / 1 - 5						
Domestic export		137.4	85.4	85.4	85.4	107.4	144.4
Local Consumption		134.4	83.4	83.4	83.4	104.9	141.4
Domestic import		155.0	103.0	103.0	103.0	125.0	162.0
Foreign Export		155.0	100.0	100.0	100.0	135.0	175.0
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
2. Alt. 1	6 - 25						
Domestic export		141.6	89.6	89.6	89.6	111.6	148.6
Local Consumption		138.6	87.6	87.6	87.6	109.1	145.6
Domestic import		150.8	98.8	98.8	98.8	120.8	157.8
Foreign Export		159.2	104.2	104.2	104.2	139.2	179.2
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
3. Alt. 2	6 - 25						
Domestic Export		142.0	90.0	90.0	90.0	112.0	149.0
Local Consumption		139.0	88.0	88.0	88.0	109.5	146.0
Domestic Import		150.4	98.4	98.4	98.4	120.4	157.4
Foreign Export		159.6	104.6	104.6	104.6	139.6	179.6
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
4. Alt. 3	6 - 25						
Domestic Export		142.3	90.3	90.3	90.3	112.3	149.3
Local Consumption		139.3	88.3	88.3	88.3	109.8	146.3
Domestic Import		150.1	98.1	98.1	98.1	120.1	157.1
Foreign Export		159.9	104.9	104.9	104.9	139.9	179.9
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0

Table H. 10 (Continued)

Economic Prices of Agricultural Produce (MF/kg) *

Alternatives	Years	Crop					
		Beans	Sorghum	Millet	Maize	Peanuts	Miscellaneous
5. Alt. 4	6 - 25						
Domestic Export		142.5	90.5	90.5	90.5	112.5	149.5
Local Consumption		139.5	88.5	88.5	88.5	110.0	146.5
Domestic Import		149.9	97.9	97.9	97.9	119.9	156.9
Foreign Export		160.1	105.1	105.1	105.1	140.1	180.1
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
6. Alt. 5	6 - 25						
Domestic Export		143.4	91.4	91.4	91.4	113.4	150.4
Local Consumption		140.4	89.4	89.4	89.4	110.9	147.4
Domestic Import		149.0	97.0	97.0	97.0	119.0	156.0
Foreign Export		161.0	106.0	106.0	106.0	141.0	181.0
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
7. Alt. 6	6 - 25						
Domestic Export		144.2	92.2	92.2	92.2	114.2	151.2
Local Consumption		141.2	90.2	90.2	90.2	111.7	148.2
Domestic Import		148.2	96.2	96.2	96.2	118.2	155.2
Foreign Export		161.8	106.8	106.8	106.8	141.8	181.8
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0
8. Alt. 7	6 - 25						
Domestic Export		144.4	92.4	92.4	92.4	114.4	151.4
Local Consumption		141.4	90.4	90.4	90.4	111.9	148.4
Domestic Import		148.0	96.0	96.0	96.0	118.0	155.0
Foreign Export		162.0	107.0	107.0	107.0	142.0	182.0
Export not on Road		145.0	92.0	92.0	92.0	120.0	160.0

* Derived from analysis of market prices in Bamako, Kayes, Senegal and Mauritania, and taking into account transportation costs by likely modes of transportation.

Table H.11

Agricultural Production Costs (1,000 MF/ha/year) *

Crop	Type of Cultivation: Stabilized Traditional	Improved	Clearing of new land
Beans	29	63	7
Sorghum	29	51	↓
Millet	29	51	↓
Maize	29	51	↓
Peanuts	52	65	↓
Miscellaneous	40	72	↓

* Although production costs are kept the same for all road improvement alternatives, the production costs are not assumed to be constant. Reduction in transport costs have been accounted for by increasing the net yields (See Tables H.4 and H.5). Largest portion of production costs is that of labor time at 500 MF/day (GOM and World Bank studies).

Table H.12

Transport Costs and tariffs (MF/veh-km) *

Alternative	Year	Kayes-Dialaka Cost	Kayes-Dialaka Tariff	Dialaka-Nioro Cost	Dialaka-Nioro Tariff	Dialaka-Yelimané Cost	Dialaka-Yelimané Tariff
1. Status Quo and all Improvements	1-25, 1-5	461.2	645.7	480.6	672.8	459.9	643.9
2. All Improvements							
Alt. 1	6-25	260.3	484.7	265.1	498.9	459.9	643.9
2	↓	↓	↓	↓	↓	254.4	478.2
3	↓	239.7	464.1	↓	↓	↓	↓
4	↓	↓	↓	243.9	477.7	↓	↓
5	↓	175.9	400.3	↓	↓	↓	↓
6	↓	↓	↓	175.9	409.7	↓	↓
7	↓	↓	↓	↓	↓	234.5	458.3

* See Chapter 9 for basis of projections.

Table H.13

Percent of zone of influence attributable to Each Road Section

Year	Kayes-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1 - 5	21	67	12
6 - 15	20	68	12
16 - 25	16	71	13

Table H.14

Transport Cost for non-Agri Vehicles (MF/veh-km)*

Alternative	Year	Kayes-Ségala	Ségala-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1. Status Quo & all Improvements	1-25	251.8	296.7	286.7	261.2
	1-5				
2. All Improvements					
Alt. 1	6-25	152.3	152.3	152.3	261.2
2					152.3
3		140.1	140.7		
4				140.6	
5		92.2	96.9		
6				96.9	
7					141.0

* See Chapter 9 for basis of projections.

Table H.15

Normal Non-Agri Traffic (Vpd) *

Year	Kayes-Segala	Ségala-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1 (1981)	18	11.5	8	4.5
2		12		
3				
4	19		9	
5				
6		13.5		5.5
7				
8	20.5			
9			10	
10	21.5			
11		14.5		7
12				
13	22.5			
14		16		
15	23.5		11.5	
16				
17		17		
18	25			
19				
20	26	18	12.5	8
21				
22	27			
23				
24	28	19	13.5	
25 (2005)	29.5			

* See Chapter 9 for basis of projections.

Table H.16

Road Sections Length (km) *

Alternative	Years	Kayes-Ségala	Ségala-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1. Status Quo & all Improvements	1-25 / 1-5	60.0	22.0	168.0	68.0
2. All Improvements	6-25				
Alt. 1		60.0	22.0	168.0	68.0
2					
3		59.4	21.8		
4				166.3	
5					
6					
7					67.3

* Road section lengths are reduced by 1% for standards BB and AA.

Table H.17

Road Construction Costs (Million MF) *

Year	Status Quo	Alternative Improvements **						
		Alt. 1	2	3	4	5	6	7
1 (1981)	0	27	103	156	156	184	184	255
2		419	418	1,021	1,137	1,476	1,557	1,557
3		2,098	2,902	3,876	6.043	6,583	7,740	7,964
4		835	1,638	1,882	2,536	2,677	3,308	3,532
5		295	295	295	568	572	834	1,861
6 - 24		0	0	0	0	0	0	0
25 (2005)		-735	-1,071	-1,446	-2,096	-2,299	-2,725	-3,034

* See Chapters 4 and 5 for basis of projections. Cash flow of costs is based on implementation program A. Although cash flow for implementation program B would be different, the net present value of costs, at 10% cost of capital, is nearly equal (± 1/1,000).

** Construction costs of the modified alternative road improvements (Kayes-Nioro Road only) can be derived by subtracting the difference between alternates 2 and 1 (See Chapter 11).

Table H.18

Road Maintenance Costs (Million MF)*

		Alternative Improvements **						
Year	Status Quo	Alt. 1	2	3	4	5	6	7
1 (1985)	63.60	63.60	63.60	63.60	63.60	63.60	63.60	63.60
2	↓	↓	↓	↓	↓	↓	↓	↓
3	↓	↓	↓	↓	↓	↓	↓	↓
4	↓	↓	↓	↓	↓	↓	↓	↓
5	↓	106.64	106.64	79.69	59.64	65.65	70.12	70.12
6	↓	138.85	159.32	132.37	77.13	83.14	95.45	73.09
7	↓	302.59	323.05	212.36	94.83	90.69	95.45	73.09
8	↓	261.37	359.69	332.74	168.23	174.24	173.31	81.50
9	↓	138.85	159.32	136.91	85.06	102.77	123.77	101.41
10	↓	302.59	323.05	411.30	447.68	244.60	116.63	98.04
11	↓	261.37	359.69	332.74	427.69	433.70	173.31	246.39
12	↓	138.85	159.32	132.37	77.13	651.54	1086.65	1064.29
13	↓	302.59	323.05	212.36	94.83	90.69	836.75	814.39
14	↓	261.37	359.69	337.29	176.16	193.86	201.63	109.82
15	↓	138.85	159.32	132.37	83.06	89.07	116.63	98.04
16	↓	302.59	323.05	411.30	441.75	238.67	95.45	73.09
17	↓	261.37	359.69	332.74	427.69	433.70	173.31	246.39
18	↓	138.85	159.32	132.37	77.13	83.14	95.45	73.09
19	↓	302.59	323.05	216.91	102.76	110.32	123.77	101.41
20	↓	261.37	359.69	332.74	174.16	748.57	1185.69	1097.65
21	↓	138.85	159.32	132.37	77.13	83.14	836.75	814.39
22	↓	302.59	323.05	411.30	441.75	238.67	95.45	73.09
23	↓	261.37	359.69	332.74	427.69	433.70	173.31	246.39
24	↓	138.85	159.32	136.91	85.06	102.77	123.77	101.41
25	↓	302.59	323.05	212.36	100.76	96.62	116.63	98.04

* See Chapter 6 for basis of projections.

** Maintenance costs of the modified alternative road improvements (Kayes-Nioro Road only) can be derived by subtracting the difference between alternatives 2 and 1 (See chapter 11).

H.2 CASE OF VERY LIMITED MAINTENANCE BEYOND 1990: NO AGRICULTURAL INVESTMENT

Note: Only those Input items which vary from Case H. 1 are given

Table H. 19

Area Under Cultivation (Hectares) *

Alternatives	Year 1	5	10	25
1. Status Quo (without)	60,000	65,000	68,000	72,000
2. With Improvements				
Alt. 1	60,000	65,000	71,350	72,000
2	↓	↓	71,500	↓
3	↓	↓	72,500	↓
4	↓	↓	74,500	↓
5	↓	↓	75,000	↓
6	↓	↓	76,000	↓
7	↓	↓	76,250	↓

* See footnotes on page H.2. Furthermore, area under cultivation is projected to level off in year 25 at that for the status quo condition due to deterioration of road from lack of adequate maintenance.

Table H. 20

Crop Area Breakdown (Percent) +

Alternatives/ Crops	Year			
With Improvements (all alternatives)	1	5	10	25
Beans	22.0 (1.1)*	18.0 (2.7)	12.0 (4.2)	16.5 (4.2)
Sorghum	33.0	30.1	26.0	28.4
Millet	24.0	24.0	22.8	24.0
Maize	7.5	7.1	6.0	6.8
Peanuts	21.2	22.5	26.0	23.5
Misc.	13.2	13.6	15.0	14.0

* Numbers in parenthesis are the percent of beans under cultivation, separate from other crops.

\+ See footnotes on page H. 3. Furthermore, changes in crop patterns are less, due to deterioration of road from lack of adequate maintenance (See page H.3).

Table H. 21

Percent of Area in Improved Cultivation *

Crops/ Alternatives	Year 1	5	10	25
1. Beans				
Status Quo	5	15	20	20
Alt. 1 & 2	↓	↓	35	↓
3	↓	↓	↓	↓
4	↓	↓	↓	↓
5	↓	↓	↓	↓
6 & 7	↓	↓	↓	↓
2. Sorghum				
Status Quo	0	12	18	18
Alt. 1 & 2	↓	↓	23	18
3	↓	↓	26	20
4	↓	↓	30	23
5	↓	↓	32	25
6 & 7	↓	↓	35	26
3. Millet				
Status Quo	0	15	23	23
Alt. 1 & 2	↓	↓	28	23
3	↓	↓	31	25
4	↓	↓	35	28
5	↓	↓	37	30
6 & 7	↓	↓	40	31
4. Maize				
Status Quo	0	25	33	33
Alt. 1 & 2	↓	↓	35	33
3	↓	↓	36	34
4	↓	↓	38	35
5	↓	↓	39	36
6 & 7	↓	↓	40	36
5. Peanuts				
Status Quo	0	18	28	28
Alt. 1 & 2	↓	↓	32	28
3	↓	↓	34	30
4	↓	↓	36	32
5	↓	↓	38	33
6 & 7	↓	↓	40	34
6. Miscellaneous				
Status Quo	0	12	20	20
Alt. 1 & 2	↓	↓	26	20
3	↓	↓	30	22
4	↓	↓	34	25
5	↓	↓	37	28
6 & 7	↓	↓	40	30

* See footnotes on page H.4. Furthermore, percent of area under improved cultivation recedes beyond year 10 due to deterioration of road from lack of adequate road maintenance.

Table H. 22

Transport Costs and Tariffs (MF/veh-km) *

Alternative	Year	Kayes-Dialaka Cost	Kayes-Dialaka Tariff	Dialaka-Nioro Cost	Dialaka-Nioro Tariff	Dialaka-Yelimané Cost	Dialaka-Yelimané Tariff
1. Status Quo &	1 - 25	461.2	645.7	480.6	672.8	459.9	643.9
all Improvements	1 - 5						
2. Alt. Improvements							
Alt. 1	6 - 25	341.0	544.0	351.0	562.0	459.9	643.9
2		341.0	544.0	351.0	562.0	337.0	539.0
3		328.0	531.0	351.0	562.0	337.0	539.0
4		328.0	531.0	339.0	550.0	337.0	539.0
5		290.0	493.0	339.0	550.0	337.0	539.0
6		290.0	493.0	298.0	509.0	337.0	539.0
7		290.0	493.0	298.0	509.0	325.0	527.0

* See footnote of Table H.12. Projections assume a reduced maintenance level beyond year 5 and hence a lower reduction in transport costs and tariffs than previously (See Table H.12).

Table H. 23

Transport Cost for Non-Agri Vehicles (MF/veh- km) *

Alternative	Year	Kayes-Ségala	Ségala-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1. Status Quo & all Improvements	1-25 / 1-5	251.8	296.7	286.7	261.2
2. Alt. Improvements					
Alt. 1	6-25	192	210	206	261.2
2		192	210	206	196
3		185	203	206	196
4		185	203	199	196
5		156	177	199	196
6		156	177	173	196
7		156	177	173	189

* See footnotes of Tables H.12, H.14 and H.22.

Table H. 24

Road Construction Costs (Million MF)

		Alternative Improvements						
Year	Status Quo	Alt. 1	2	3	4	5	6	7
1 (1981)	0	27	103	156	156	184	184	255
2		419	418	1021	1137	1476	1557	1557
3		2098	2902	3876	6043	6583	7740	7964
4		835	1638	1882	2536	2677	3308	3532
5		295	295	295	568	572	834	1861
6 - 24		0	0	0	0	0	0	0
25 (2005) *		-367	-535	-723	-1048	-1150	-1363	-1517

* Assumes a lower salvage value due to reduced maintenance. Compare with Table H.17.

Table H. 25 *

Road Maintenance Costs (Million MF)

Year	Status Quo	Alternative Improvements						
		Alt. 1	2	3	4	5	6	7
1 (1985)	63.60	63.60	63.60	63.60	63.60	63.60	63.60	63.60
2	↓	↓		↓	↓	↓	↓	
3								
4		↓	↓	↓	↓	↓	↓	↓
5		106.64	106.64	79.69	59.64	65.65	70.12	70.12
6		138.85	159.32	132.37	77.13	83.14	95.45	73.09
7		302.59	323.05	212.36	94.83	90.69	95.45	73.09
8		261.37	359.69	332.74	168.23	174.24	173.31	81.50
9		138.85	159.32	136.91	85.06	102.77	123.77	101.41
10		302.59	323.05	411.30	447.68	244.60	116.63	98.04
11 - 25	↓	130.00	130.00	130.00	130.00	130.00	130.00	130.00

* Above projection of maintenance costs is the definition of "limited maintenance" (See Chapter 11). This consists of: same maintenance levels for years 5 through 10 as in Table H.18; and double the present 1979 maintenance level beyond year 10.

H.3 BASE CASE: WITH AGRICULTURAL INVESTMENT

Note: Only those Input Items which vary from Case H.1 are given

Table H.26

Area Under Cultivation (Hectares)*

Alternatives	Year 1	5	10	25
1. Status Quo (without)	60,000	65,000	68,000	72,000
2. With Improvements				
Alt. 1	60,000	65,000	71,325	77,000
2			74,000	81,000
3			75,500	83,000
4			77,500	86,000
5			78,250	87,500
6			79,250	88,500
7			79,600	89,250

* See footnotes on page H.2. Furthermore, areas under cultivation are higher due to added agricultural investment.

Table H.27

Crop Area Breakdown (percent) +

Alternatives/ Crops	Year 1	5	10	25
With Improvements (All Alternatives)				
Beans	22.0 (1.1)*	18.0 (2.7)*	10.0 (5.0)*	10.0 (5.0)*
Sorghum	33.0	30.1	26.0	26.0
Millet	24.0	24.0	22.0	22.0
Maize	7.5	7.1	6.0	6.0
Peanuts	21.2	22.5	26.0	26.0
Miscellaneous	13.2	13.6	15.0	15.0

* Numbers in parenthesis are the percent of beans under cultivation, separate from other crops.

\+ See footnotes on page H.3. Projections assume a larger change towards cultivation of beans, due to expected targeting of added Agricultural investment.

Table H.28

Percent of Area in Improved Cultivation*

Crops/ Alternatives	Year 1	5	10	25
1. Beans				
Status Quo	5	15	20	20
Alt. 1	↓	↓	35	35
2	↓	↓	50	50
3	↓	↓	↓	↓
4	↓	↓	↓	↓
5	↓	↓	↓	↓
6	↓	↓	↓	↓
7	↓	↓	↓	↓
2. Sorghum				
Status Quo	0	12	18	18
Alt. 1	↓	↓	23	23
2	↓	↓	33	33
3	↓	↓	44	44
4	↓	↓	48	48
5	↓	↓	57	57
6	↓	↓	60	60
7	↓	↓	62	62
3. Millet				
Status Quo	0	15	23	23
Alt. 1	↓	↓	28	28
2	↓	↓	42	42
3	↓	↓	56	56
4	↓	↓	60	60
5	↓	↓	72	72
6	↓	↓	75	75
7	↓	↓	78	78
4. Maize				
Status Quo	0	25	33	33
Alt. 1	↓	↓	35	35
2	↓	↓	67	67
3	↓	↓	72	72
4	↓	↓	74	74
5	↓	↓	78	78
6	↓	↓	79	79
7	↓	↓	80	80

Table H.28 continued *

Crops/ Alternatives	Year 1	5	10	25
5. Peanuts				
Status Quo	0	18	28	28
Alt. 1			32	32
2			58	58
3			67	67
4			69	69
5			76	76
6			78	78
7			80	80
6. Miscellaneous				
Status Quo	0	12	20	20
Alt. 1			26	26
2			42	42
3			49	49
4			53	53
5			63	63
6			66	66
7			68	68

* See footnotes on page H.4. Assumes a greater increased in adoption of improved cultivation due to targeting of added agricultural investment.

Table H. 29 *

Percent of Zone of Influence Attributable to Each Road Section

Year	Kayes-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
0 - 5	0.21	0.67	0.12
6 - 15	0.22	0.65	0.13
16 - 25	0.23	0.63	0.14

* The percents of zone of influence attributable to Kayes-Dialaka and Dialaka-Yélimané sections are increased, due to targeting of added agricultural investment (See Table H.13).

Table H. 30

Total Capital Investment Costs (Million MF) *

Year	Status Quo	Alt. 1	2	3	4	5	6	7
1 (1981)	0	27	103	156	156	184	184	255
2	↓	419	728	1331	1447	1786	1867	1867
3	↓	2098	3532	4506	6673	7213	8370	8594
4	↓	835	1948	2192	2846	2987	3618	3842
5	↓	295	295	295	568	572	834	1861
6-24	↓	0	0	0	0	0	0	0
25 (2005)	↓	-735	-1196	-1571	-2221	-2424	-2850	-3159

* Includes added agricultural investment (See Table H.17).

H.4 CASE OF VERY LIMITED MAINTENANCE BEYOND 1990: WITH AGRICULTURAL INVESTMENT

Note: Only those Input Items which vary from Case H.3 are given

Table H.31

Area Under Cultivation (Hectares) *

Alternatives	Year 1	Year 5	Year 10	Year 25
1. Status Quo (without)	60,000	65,000	68,000	72,000
2. With Improvements				
Alt. 1	60,000	65,000	71,325	72,000
2	↓	↓	74,000	75,000
3			75,500	↓
4			77,500	
5			78,250	
6			79,250	
7			79,600	

* See footnotes on pages H.2, H.18 and H.26.

Table H.32

Crop Area Breakdown (Percent)

Alternatives/ Crops	Years 1	5	10	25
With Improvements				
Alternative 1				
Beans	22.0	18.0	12.0	16.5
Sorghum	33.0	30.1	26.0	28.4
Millet	24.0	24.0	22.8	24.0
Maize	7.5	7.1	6.0	6.8
Peanuts	21.2	22.5	26.0	23.5
Misc	13.2	13.6	15.0	14.0
Alternative 2 through 7				
Beans	22.0	18.0	10.0	16.5
Sorghum	33.0	30.1	26.0	28.4
Millet	24.0	24.0	22.0	24.0
Maize	7.5	7.1	6.0	6.8
Peanuts	21.2	22.5	26.0	23.5
Misc.	13.2	13.6	15.0	14.0

* See footnotes on pages H.3, H.19 and H.27.

Table II.33

Percent of Area in Improved Cultivation *

Crops/ Alternatives	Year 1	5	10	25
1. Beans				
Status Quo	5	15	20	20
Alt. 1			35	20
2			50	
3				
4				
5				
6				
7				
2. Sorghum				
Status Quo	0	12	18	18
Alt. 1			23	18
2			33	30
3			44	37
4			48	40
5			57	44
6			60	45
7			62	46
3. Millet				
Status Quo	0	15	23	23
Alt. 1			28	28
2			42	40
3			56	47
4			60	50
5			72	56
6			75	57
7			78	59
4. Maize				
Status Quo	0	25	33	33
Alt. 1			35	35
2			67	64
3			72	68
4			74	69
5			78	71
6			79	71
7			80	72

Table II.33 Continued *

Crops/ Alternatives	Year 1	5	10	25
5. Peanuts	0	18	28	28
Alt. 1			32	32
2			58	56
3			67	61
4			69	63
5			76	66
6			78	67
7			80	68
6. Miscellaneous				
Status Quo	0	12	20	20
Alt. 1			26	26
2			42	40
3			49	44
4			53	47
5			63	51
6			66	53
7			68	54

* See footnotes on pages H.4, H.20 and H.29.

Table H.34

Transport Costs and Tariffs (MF/veh-km) *

Alternative	Year	Kayes-Dialaka Cost	Kayes-Dialaka Tariff	Dialaka-Niore Cost	Dialaka-Niore Tariff	Dialaka-Yelimané Cost	Dialaka-Yelimané Tariff
1. Status Quo & all Improvements	1-25	461.2	645.7	480.6	672.8	459.9	643.9
	1-5						
2. Alt. Improvements							
Alt. 1	6-25	341	544	351	562	459.9	643.9
2		341	544	351	562	337	539
3		328	531	351	562	337	539
4		328	531	339	550	337	539
5		290	493	339	550	337	539
6		290	493	298	509	337	539
7		290	493	298	509	325	527

* See footnotes on pages H.11 and H.21.

Table H.35

Transport Cost for Non-Agri Vehicles (MF/veh-km)

Alternative	Year	Kayes-Segala	Segala-Dialaka	Dialaka-Nioro	Dialaka-Yelimané
1. Status Quo & all Improvements	1-25	251.8	296.7	286.7	261.2
	1-5				
2. Alt. Improvements					
Alt. 1	6-25	192	210	206	261.2
2		192	210	206	196
3		185	203	206	196
4		185	203	199	196
5		156	177	199	196
6		156	177	173	196
7		156	177	173	189

* See footnotes of Tables H.12, H.14, H.22 and H.23.

Table H.36

Capital Investment Costs (Million MF) *

Year	Status Quo	Alternative Improvements						
		Alt. 1	2	3	4	5	6	7
1 (1981)	0	27	103	156	156	184	184	255
2	↓	419	728	1,331	1,447	1,786	1,867	1,867
3	↓	2,098	3,532	4,506	6,673	7,213	8,370	8,594
4	↓	835	1,948	2,192	2,846	2,987	3,618	3,842
5	↓	295	295	295	568	572	834	1,861
6-24	↓	0	0	0	0	0	0	0
25 (2005)	↓	-492	-660	-848	-1,173	-1,275	-1,488	-1,642

* See footnotes on pages H.15 and H.23.

Table H. 37

Road Maintenance Costs (Million MF)*

		Alternative Improvements						
Year	Status Quo	Alt. 1	2	3	4	5	6	7
1 (1985)	63.60	63.60	63.60	63.60	63.60	63.60	63.60	63.60
2								
3								
4								
5		106.64	106.64	79.69	59.64	65.65	70.12	70.12
6		138.85	159.32	132.37	77.13	83.14	95.45	73.09
7		302.59	323.05	212.36	94.83	90.69	95.45	73.09
8		261.37	359.69	332.74	168.23	174.24	173.31	81.50
9		138.85	159.32	136.91	85.06	102.77	123.77	101.41
10		302.59	323.05	411.30	447.68	244.60	116.63	98.04
11-25		130.00	130.00	130.00	130.00	130.00	130.00	130.00

* See footnotes on pages H.16 and H.24.

APPENDIX I

APPENDIX I

SUMMARY TABLES FOR VALUE ADDED ANALYSIS

I.1 PROJECT OPTION A (Kayes-Nioro Road, Yélimané branch and Agricultural Development

I.1.1 REGIONAL SUMMARY TABLES (Pages I.2 to I.9)

I.1.2 VALUE ADDED TABLES (Pages I.10 to I.22)

I.2 PROJECT OPTION B (Kayes-Nioro Road only)

I.2.1 REGIONAL SUMMARY TABLES (Pages I.24 to I.31)

I.2.2 VALUE ADDED TABLES (Pages I.32 to I.44)

I.1 PROJECT OPTION A

Kayes-Nioro Road,
Yélimané branch and
Agricultural Development

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE WO - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.2728	.2728	.2722	.2729	.2725	.2724
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	330888	330888	339006	356666	362153	374351
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	2913215	2960023	3002547	3050129	3096579	3105982
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	262222	271477	279124	288612	297162	308053
6	ROAD CONSTRUCTION COST	106F	0	0	0	0	0	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	3964879	4075350	4179337	4290455	4403392	4369222
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	366984	379936	390636	403918	415884	431124
10	TOT NET AG VALUE (8+9-4-5)	103F	283396	470039	658006	835482	1007008	1156426	1223786	1288302	1355632	1425535	1386311
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75374	75800	76152	76567	76976	77278
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	43125	44117	45039	46043	47033	47218

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.2724	.2720	.2723	.2728	.2728	.2730	.2725	.2725	.2727	.2727	.2724	.2724	.2728	.2724
3	374351	379800	383379	415114	415114	417636	426044	426044	458009	458009	463196	463196	488891	497027
4	3116086	3130200	3142394	3154488	3166639	3179068	3191396	3203531	3215653	3227783	3239977	3252062	3264181	3276314
5	310135	312167	314273	316330	314127	316168	318319	320396	322585	324711	326898	329060	331285	333508
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360
8	4371973	4374841	4377376	4379531	4381671	4383644	4385012	4386027	4387813	4388432	4389007	4388826	4389005	4388899
9	434038	436881	439829	442708	439830	442686	445699	448609	451670	454647	457710	460738	463853	466967
10	1377790	1369355	1360538	1351421	1340735	1331094	1320996	1310709	1301245	1290585	1279842	1268442	1257392	1246044
11	77579	77881	78184	78486	78787	79089	79391	79693	79994	80296	80599	80901	81202	81504
12	47402	47587	47774	47956	48141	48326	48510	48692	48881	49065	49250	49431	49617	49802

7743765 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
75716 YEARLY AVERAGE OF HECTARES IN CULTIVATION
42428 YEARLY AVERAGE OF TOTAL TONS PRODUCED
102.27 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
182.52 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W1 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1646	.1646	.1642	.1637	.1635	.1661
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	199649	199649	204500	213947	217292	228266
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	2958708	3041395	3117383	3197309	3278592	3287895
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241039	257376	159366	170870	181320	192205	202592	209174
6	ROAD CONSTRUCTION COST	103F	27	419	2098	835	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	103F	6360	6360	6360	6360	10664	13885	30259	26137	13885	30259	26137
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4539800	4796334	5024038	5256618	5482106	5461995
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	293818	315024	334291	354360	373510	385644
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	1715544	1899093	2059626	2221464	2374432	2350570
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75476	75905	76155	76506	76890	77295
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	45745	47741	49536	51382	53180	53461

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1661	.1659	.1657	.1647	.1647	.1647	.1644	.1644	.1652	.1652	.1650	.1650	.1644	.1641
3	228266	231650	233294	250620	250620	251958	257033	257033	277459	277459	280570	280570	294625	299420
4	3305322	3322703	3340017	3357329	3374695	3392000	3409409	3426765	3444034	3461541	3478884	3496265	3514277	3531584
5	210842	212475	214179	215868	215114	216820	218540	220225	221952	223685	225434	227223	229273	231406
6	0	0	0	0	0	0	0	0	0	0	0	0	0	735-
7	13865	30259	26137	13885	30259	26137	13885	30259	26137	13885	30259	26137	13885	30259
8	5475716	5488599	5501001	5513043	5525182	5536982	5548031	5559012	5569196	5579187	5588803	5597782	5605447	5611618
9	388720	391731	39487	397988	396215	399356	402525	405628	408808	412002	415222	418519	422294	426226
10	2348272	2345152	23416.8	2337834	2331588	2327518	2322607	2317650	2312018	2305963	2299707	2292813	2284191	2274854
11	77704	78113	78520	78927	79336	79743	80152	80560	80966	81375	81783	82189	82599	83006
12	53745	54026	54309	54589	54872	55156	55438	55720	55999	56282	56565	56844	57129	57411

11433404 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
75875 YEARLY AVERAGE OF HECTARES IN CULTIVATION
45417 YEARLY AVERAGE OF TOTAL TONS PRODUCED
150.69 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
251.74 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W2 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1523	.1523	.1523	.1523	.1523	.1523
3	TOT NON AGRI VHCL COST	103F	296463	297277	297837	320638	320638	184729	184729	189679	199048	202407	209301
4	TOT AGRI PRODUCTION COST	103F	2505280	2602189	2692985	2781876	2870612	3025967	3176640	3314072	3462050	3604504	3618254
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	164411	183663	201676	219544	236658	245514
6	ROAD CONSTRUCTION COST	106F	103	728	7532	1948	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	15664	15932	32305	35969	15932	32305	35969
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4903963	5434395	5920797	5406646	6866899	6707236
9	AGRI TRANSF PRICE REVENUE	103F	286993	302147	318532	338908	360531	307679	343707	377414	410852	442877	459453
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2021264	2417799	2780463	3135904	3468614	3302921
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75684	76351	76736	77254	77700	78190
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	48035	51988	55637	59310	62819	63214

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523
3	209301	212660	214428	231752	231752	232989	238115	238115	255793	255793	258975	258975	272940	277890
4	3640927	3663722	3686456	3709457	3732558	3755286	3777943	3800630	3823247	3845939	3868591	3891252	3913932	3936552
5	247570	249639	251707	253792	252533	254643	256746	258837	260968	263099	265229	267422	269580	271780
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1196-
7	15932	32305	35969	15932	32305	35969	15932	32305	35969	15932	32305	35969	15932	32305
8	6733793	6760684	6786874	6812542	6837353	6862275	6886513	6910780	6935085	6957793	6980434	7003108	7024860	7046628
9	463298	467172	471045	474941	472157	476103	480037	483945	487929	491913	495896	499997	504032	508143
10	3306594	3314495	3319756	3324234	3324419	3328449	3331861	3335258	3338799	3340668	3342510	3344431	3345380	3346439
11	78680	79170	79660	80150	80640	81130	81620	82110	82600	83090	83580	84070	84560	85050
12	63611	64006	64402	64802	65194	65591	65987	66383	66783	67175	67571	67970	68365	68762

14974946 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
76776 YEARLY AVERAGE OF HECTARES IN CULTIVATION
49770 YEARLY AVERAGE OF TOTAL TONS PRODUCED
196.07 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
300.88 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W3 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.35	9.42	9.42	10.13	10.13	10.43	10.43	10.71	11.24	11.43	11.82
2	AVRGE VEHICLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1471	.1471	.1469	.1472	.1471	.1472
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320639	320639	177633	177633	182153	191559	194664	201443
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781976	2870612	3049008	3263168	3447394	3640071	3830697	3846034
5	TOT AGRI TRANSPORT COST	103F	204579	215698	227393	241939	257376	157809	177147	195572	214252	232714	241058
6	ROAD CONSTRUCTION COST	103F	156	1331	4506	2192	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	103F	4360	6360	6360	6360	7969	13237	21236	33274	13691	41130	33274
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5102555	5772203	6403040	7042290	7659268	7509999
9	AGRI TRANSP PRICE REVENUE	103F	284993	302147	318532	338908	360531	301707	339679	373904	409618	444916	460868
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2177445	2670567	3133978	3597585	4040773	3883775
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76024	77019	77717	78538	79275	79800
12	TOT AGRI PRODUCTION	TON	33919	35999	38049	40110	42156	49238	54089	58680	63356	67914	68365

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.92	12.01	12.11	13.09	13.09	13.16	13.44	13.44	14.44	14.44	14.63	14.63	15.41	15.70
2	.1472	.1471	.1470	.1472	.1472	.1472	.1470	.1470	.1472	.1472	.1471	.1471	.1472	.1470
3	204443	204542	204185	223087	223087	224280	228740	228740	244094	244094	249163	249163	262625	267204
4	3871993	3897536	3922824	3948131	3973394	3998723	4023954	4049261	4074568	4099831	4125128	4150391	4175711	4201018
5	243105	245157	247217	249297	247932	250039	252097	254200	256316	258465	260567	262722	264909	267070
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1571-
7	13237	21236	33729	13237	41130	33274	13237	21691	33274	13237	41130	33274	13691	21236
8	7545199	7580198	7613865	7647814	7681392	7714788	7746680	7779134	7811658	7842579	7873673	7904224	7935097	7963969
9	464761	468705	472643	476619	474087	478120	482055	486076	490120	494228	498249	502370	506551	510683
10	3894882	3906210	3916467	3927005	3934153	3944146	3952604	3961749	3970894	3978511	3986227	3993481	4001028	4006564
11	80325	80850	81375	81900	82425	82950	83475	84000	84525	85050	85575	86100	86625	87150
12	68615	69267	69714	70166	70614	71066	71512	71962	72416	72864	73313	73763	74215	74664

16997476 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
77109 YEARLY AVERAGE OF HECTARES IN CULTIVATION
52036 YEARLY AVERAGE OF TOTAL TONS PRODUCED
220.43 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
326.65 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W4 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1418	.1418	.1417	.1417	.1416	.1419
3	TOT NON AGRI VHCL COST	103F	296663	297837	297837	320638	320638	170478	170478	174927	183575	186544	193312
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	3099051	3324133	3538721	3764486	3988925	4007238
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	152856	172460	191357	211778	236110	238352
6	ROAD CONSTRUCTION COST	106F	156	1447	6673	2846	569	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	5964	7713	9453	16823	8506	44768	42769
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5272691	6033924	6762282	7496736	8186391	8093485
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	297005	335098	371813	411491	458768	463127
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2317759	2872429	3404017	3931963	4420124	4311022
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76479	77910	79025	80250	81375	81970
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	50260	55707	60935	66293	71577	72102

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1419	.1419	.1419	.1418	.1418	.1418	.1417	.1417	.1418	.1418	.1418	.1418	.1417	.1417
3	193312	196417	198051	213914	213914	215057	219475	219475	235959	235959	239061	239061	251621	256353
4	4036297	4065306	4094413	4123526	4152535	4181620	4210679	4239688	4268795	4297876	4326907	4355970	4385029	4414060
5	240482	242606	244741	246884	245486	247629	249804	251954	254134	256333	258502	260737	262960	265211
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2221-
7	7713	9453	17616	8306	44175	42769	7713	10276	17416	7713	44175	42769	8506	10076
8	8139540	8185237	8231247	8275827	8321083	8365180	8408637	8452183	8495879	8538065	8580022	8622216	8663700	8704360
9	447267	471393	475543	479707	477575	481746	485975	490158	494398	498678	502896	507246	511573	515948
10	4330028	4348718	4367636	4385124	4400637	4417677	4434129	4450699	4467348	4482534	4497509	4512755	4527284	4541037
11	82565	83160	83755	84350	84945	85540	86135	86730	87325	87920	88515	89110	89705	90300
12	72623	73147	73672	74195	74719	75242	75765	76287	76814	77336	77857	78383	78906	79429

18532852 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
78127 YEARLY AVERAGE OF HECTARES IN CULTIVATION
53744 YEARLY AVERAGE OF TOTAL TONS PRODUCED
237.21 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
344.84 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W5 - ALL CROPS.

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1214	.1214	.1207	.1216	.1211	.1218
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	145952	145952	149003	157535	159537	165930
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	3132719	3393183	3644219	3909013	4174368	4195698
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	131437	149196	167729	191640	215611	216497
6	ROAD CONSTRUCTION COST	106F	184	1786	7213	2987	572	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	6565	8314	9069	17424	10277	24460	43370
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5482259	6362167	7207336	8035968	8857943	8788934
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	276503	313865	352852	403156	453582	455446
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2494606	3133653	3748240	4338471	4921546	4832185
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76647	78245	79516	80892	82163	82810
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	51289	57482	63511	69744	75956	76556

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1216	.1213	.1211	.1219	.1219	.1218	.1211	.1211	.1218	.1218	.1214	.1214	.1216	.1211
3	165930	167903	169020	183894	183894	184725	187568	187568	202678	202678	204669	204669	215929	219085
4	4228441	4261228	4294034	4326795	4359601	4392341	4425084	4457871	4490677	4523460	4556212	4588974	4621695	4654534
5	218052	219649	221254	222809	221057	222594	224176	225665	227201	228722	230239	231765	233277	234788
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2424-
7	65154	9069	19386	8907	23867	43370	8314	11032	74857	8314	23867	43370	10277	9662
8	8849733	8911060	8971922	9032512	9092607	9152725	9211899	9271572	9330927	9389660	9448357	9506543	9564146	9622325
9	458717	462079	465454	468725	465383	468620	471845	475082	478318	481522	484714	487929	491108	494290
10	4861957	4892262	4921988	4951633	4977332	5006410	5034534	5063118	5091367	5119000	5146620	5173733	5200282	5227291
11	87457	84105	84753	85400	86048	86695	87342	87990	88638	89285	89933	90580	91227	91875
12	77151	77752	78351	78951	79547	80147	80743	81343	81944	82542	83141	83738	84335	84936

20455244 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
78552 YEARLY AVERAGE OF HECTARES IN CULTIVATION
55733 YEARLY AVERAGE OF TOTAL TONS PRODUCED
260.40 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
367.02 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W6 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1016	.1016	.1013	.1011	.1010	.1024
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	122148	122148	125054	130977	133058	139501
4	TOT AGRI PRODUCTION COST	103F	2505720	2602189	2692985	2781876	2870612	3150885	3429376	3699492	3984901	4271714	4292097
5	TOT AGRI TRANSPORT COST	103F	204679	215698	227393	241939	257376	113699	129469	147294	169055	191000	191807
6	ROAD CONSTRUCTION COST	106F	184	1867	8370	3618	834	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	7012	9545	9545	17331	12377	11663	17331
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5574571	6513229	7406960	8299191	9189791	9122649
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	259118	295056	335676	385272	435282	437119
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2569105	3249440	3895850	4530507	5162359	5075864
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76874	78689	80169	81748	83213	83860
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	51603	58149	64559	71214	77882	78485

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1024	.1022	.1022	.1017	.1017	.1017	.1015	.1015	.1019	.1019	.1018	.1018	.1015	.1013
3	139501	141465	142641	153421	153421	154241	157210	157210	169564	169564	171625	171625	180236	183264
4	4325195	4358315	4391435	4424538	4457658	4490731	4523820	4556949	4590101	4623163	4656315	4689343	4722476	4755628
5	193171	194565	195949	197319	196575	197916	199268	200612	201969	203297	204643	205966	207294	208631
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2850-
7	108665	83675	20163	11663	9545	17331	9545	12377	118569	83675	9545	17331	12377	11663
8	9185162	9242112	9310399	9372574	9434758	9496076	9557374	9618254	9679242	9739480	9799606	9859650	9919074	9978626
9	440231	443407	446561	449683	447304	450356	453430	456494	459578	462599	465662	468673	471693	474735
10	5107027	5136639	5169576	5200400	5227829	5257785	5287716	5317187	5346750	5375619	5404310	5433014	5460997	5489102
11	84507	85155	85663	86450	87098	87745	88392	89040	89688	90335	90983	91630	92277	92925
12	79091	79698	80304	80908	81518	82122	82728	83335	83941	84546	85153	85757	86364	86971

21300424 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
79902 YEARLY AVERAGE OF HECTARES IN CULTIVATION
56543 YEARLY AVERAGE OF TOTAL TONS PRODUCED
269.62 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
376.71 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W7 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1002	.1002	.1000	.0999	.0998	.1009
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	120313	120313	123290	129250	131300	137268
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	3160679	3449194	3730025	4026759	4325677	4347379
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241239	257376	113641	129583	148591	170990	193644	194547
6	ROAD CONSTRUCTION COST	106F	255	1847	8594	3842	1861	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	7012	7309	7309	8150	10141	9804	24639
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5614072	6585069	7505287	8431969	9359613	9297853
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	259297	295668	339043	390151	441844	443900
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2599049	3301960	3965714	4624371	5282136	5199827
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76953	78844	80398	82047	83580	84254
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	51786	58536	65174	72071	79000	79640

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1009	.1007	.1007	.1003	.1003	.1003	.1002	.1002	.1005	.1005	.1004	.1004	.1002	.1000
3	137268	139195	140352	151088	151088	151895	155083	155083	167095	167095	169005	169005	177764	180626
4	4382372	4417240	4451921	4436837	4521661	4556390	4591240	4626055	4660908	4695781	4730471	4765257	4800252	4835031
5	196021	197489	198960	200420	199275	200713	202145	203571	204995	206435	207826	209239	210667	212072
6	0	0	0	0	0	0	0	0	0	0	0	0	0	3159-
7	16429	81439	10982	9804	7309	24639	7309	10141	109765	81439	7309	24639	10141	9804
8	9365313	9432991	9499520	9566457	9632940	9699529	9765043	9830939	9896202	9961399	10025908	10090350	10155041	10218839
9	447264	450617	453971	457302	454555	457831	461098	464356	467601	470889	474062	477286	480542	483745
10	5234184	5268879	5302610	5336502	5366559	5400257	5432756	5465669	5497900	5530072	5561673	5593140	5624664	5655481
11	84932	85608	86281	86958	87634	88308	88984	89659	90335	91012	91685	92360	93038	93713
12	80279	80919	81556	82196	82835	83472	84111	84749	85388	86027	86663	87300	87942	88581

21745032 PRESENT WORTH OF NET VALUE STREAM, I = 10%
79206 YEARLY AVERAGE OF HECTARES IN CULTIVATION
57062 YEARLY AVERAGE OF TOTAL TONS PRODUCED
274.54 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
381.08 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W1 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	4549	8137	11483	14718	18201	18191
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	10285-	10060-	9780-	9640-	9457-	9887-
3	INCR RD CNSTRCTION CST	104F	2700	41900	209800	83500	29500	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	4304	7525	23899	19777	7525	23899	19777
5	TOTAL INCRMTL COSTS	104F	2700	41900	209800	83500	33804	1789	21976	21480	12603	32643	28081
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	57492	72098	84470	96616	107871	109277
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	13123	13123	13450	14271	14486	14608
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	7316-	6491-	5634-	4955-	4237-	4548-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	63299	78730	92286	105932	118120	119337
10	TOT NET BENEFITS (9 - 5)	104F	2700-	41900-	209800-	83500-	33804-	61510	56754	70806	93329	85477	91256
11	PW NET BENEFITS I=10*	104F	2454-	34628-	157625-	57031-	20989-	34720	29123	33031	39580	32955	31984

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	19727	19250	19762	20284	20805	21293	21801	22323	22838	23375	23890	24420	25009	25527
2	9929-	9969-	10009-	10046-	9901-	9934-	9977-	10017-	10063-	10102-	10146-	10183-	10201-	10210-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	73500-
4	7525	23899	19777	7525	23899	19777	7525	23899	19777	7525	23899	19777	7525	23899
5	16319	33180	29530	17763	34803	31136	19349	36205	32552	20798	37643	34014	22333	34284-
6	110374	111375	112362	113351	114351	115333	116301	117298	118138	119075	119979	120895	121644	122271
7	14605	14815	15008	16449	16449	16567	16901	16901	18055	18055	18262	18262	19426	19760
8	4531-	4515-	4495-	4472-	4361-	4333-	4317-	4298-	4286-	4264-	4248-	4221-	4155-	4074-
9	120451	121675	122875	125328	126439	127567	128885	129901	131907	132866	133993	134936	136915	137957
10	104132	88495	93345	107565	91636	96431	109536	93696	99355	112068	96350	100922	114582	172241
11	33179	25677	24580	25750	19942	19078	19701	15320	14768	15143	11836	11270	11633	15897

192403 PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
21196 ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
387957 PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
580361 PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.50 BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1640

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W3 AND W2

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	4304	8652	13132	17802	22619	22778
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	660-	651-	610-	529-	394-	445-
3	INCR RD CNSTRCTION CST	104F	5300	60300	97400	24400	0	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	2695-	2695-	11069-	2695-	2241-	8825	2695-
5	TOTAL INCRMTL COSTS	104F	5300	60300	97400	24400	2695-	949	3068-	9827	15032	31050	19638
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	19859	33780	48224	63564	79236	80276
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	709	709	752	749	774	785
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	597-	502-	351-	123-	203	141
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	19971	33987	48625	64190	80213	81202
10	TOT NET BENEFITS (9 - 5)	104F	5300-	60300-	97400-	24400-	2695	19022	37055	38798	49158	49163	61564
11	PW NET BENEFITS I=10*	104F	4818-	49834-	73178-	16665-	1673	10737	19015	18099	20847	18954	21577

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	23106	23361	23636	23867	24083	24343	24601	24863	25132	25389	25653	25913	26177	26446
2	446	448-	449-	449-	460-	460-	464-	463-	465-	463-	466-	470-	467-	471-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	37500-
4	2695	11069-	2240-	2695-	8825	2695-	2695-	10614-	2695-	2695-	8825	2695-	2241-	11069-
5	19965	11864	20947	20723	32448	21188	21442	13786	21972	22231	34012	22748	23469	22594-
6	81140	81951	82699	83527	84403	85251	86008	86835	87657	88478	89323	90111	91023	91734
7	785	811	832	866	866	870	937	937	969	969	981	981	1031	1068
8	148	153	159	167	193	201	201	213	219	231	235	237	251	254
9	82173	82915	83690	84560	85462	86322	87146	87985	88845	89678	90539	91329	92305	93056
10	62108	71051	62743	63837	53014	65134	65704	74199	66873	67447	56527	68581	68836	115650
11	19789	20580	16522	15282	11537	12886	11817	12132	9940	9114	6944	7659	6988	10674

138278	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
15233	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
222523	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
360801	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.62	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1734

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W5 AND W4

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	3363	6905	10549	14452	18544	18846
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	2141-	2326-	2362-	2013-	2049-	2185-
3	INCR RD CNSTRCTION CST	104F	2800	33900	54000	14100	400	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	601	601	414-	601	1771	20308-	601
5	TOTAL INCRMTL COSTS	104F	2800	33900	54000	14100	1001	1823	4165	8788	14210	3813-	17262
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	20956	32824	44505	53923	67155	69544
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	2452	2452	2592	2604	2700	2738
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	2050-	2123-	1896-	833-	518-	768-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	21358	33153	45201	55694	69337	71514
10	TOT NET BENEFITS (9 - 5)	104F	2800-	33900-	54000-	14100-	1001-	19535	28988	36413	41484	73150	54252
11	PW NET BENEFITS I=10*	104F	2545-	28016-	40571-	9630-	621-	11027	14875	16986	17593	28202	19015

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	19214	19592	19962	20326	20706	21072	21440	21818	22188	22558	22930	23300	23666	24047
2	2243-	2295-	2348-	2407-	2442-	2503-	2567-	2628-	2693-	2761-	2826-	2897-	2968-	3042-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	20300-
4	57441	414-	1770	601	20308-	601	601	756	57441	601	20308-	601	1771	414-
5	74412	16883	19394	18520	2044-	19170	19474	19946	76936	20398	204-	21004	22469	291
6	71019	72592	74057	75668	77152	78754	80326	81938	83504	85159	86833	88432	90044	91796
7	2738	2851	2903	3002	3092	3033	3190	3190	3328	3328	3439	3439	3569	3726
8	855-	931-	1008-	1098-	1219-	1312-	1413-	1507-	1608-	1715-	1818-	1931-	2046-	2165-
9	72992	74502	75952	77572	78935	80475	82103	83621	85224	86772	88454	89940	91567	93357
10	1510-	57619	56568	59052	80979	61305	62629	63675	8288	66374	88658	68936	69098	93066
11	481-	16490	14896	14136	17423	12128	11264	10411	1231	8969	10891	7698	7015	8589

167381	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
18440	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
166328	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
333710	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
2.01	BENEFIT/COST RATIO, I = 10%-

INTERNAL RATE OF RETURN = 0.2328

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W4 AND W3

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	3007	6096	9132	12441	15822	16120
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	495-	468-	421-	247-	339	270-
3	INCR RD CNSTRCTION CST	104F	0	11600	216700	65400	27300	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	2005-	5524-	11753-	16451-	5185-	3638	9495
5	TOTAL INCRMTL COSTS	104F	0	11600	216700	65400	25295	3012-	6125-	7740-	7009	19799	25345
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	17013	26172	35924	45444	52712	58348
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	715	715	722	398	812	813
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	470-	358-	209-	187	1385	225
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	17258	26529	36437	46429	54909	59386
10	TOT NET BENEFITS (9 - 5)	104F	0	11600-	216700-	65400-	25295-	20270	32654	44177	39420	35110	34041
11	PW NET BENEFITS I=10*	104F	0	9586-	162809-	44669-	15706-	11441	16756	20608	16717	13536	11931

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	16430	16777	17158	17539	17914	18289	18672	19042	19422	19804	20177	20557	20931	21304
2	262-	255-	247-	241-	244-	241-	229-	224-	218-	213-	206-	198-	194-	185-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	65000-
4	5524-	11753-	16113-	4931-	3045	9495	5524-	11415-	15858-	5524-	3045	9495	5185-	11160-
5	10644	4769	798	12767	20715	27543	12919	7403	3346	14067	23016	29854	15552	55041-
6	59434	60503	61778	62801	63969	65039	66203	67304	68422	69548	70634	71799	72860	74039
7	813	812	805	917	917	922	926	926	1013	1013	1010	1010	1100	1085
8	246	268	290	308	348	362	392	408	427	445	464	487	502	526
9	60495	61583	62833	64026	65234	66323	67521	68638	69862	71006	72108	73296	74462	75650
10	49851	56814	62035	51659	44519	38780	54602	61235	66516	56939	49092	43442	58910	130691
11	15884	16457	16335	12366	9688	7672	9820	10012	9887	7694	6030	4851	5980	12062

2966	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
326	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
270300	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
273266	PRESENT WORTH OF TOTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.01	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1015

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W6 AND W5

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	1816	3419	5527	7588	9734	9639
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	1773-	1972-	2043-	2258-	2461-	2469-
3	INCR RD CONSTRCTION CST	104F	0	8100	115700	63100	26200	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	447	1271	476	93-	2100	12797-	26039-
5	TOTAL INCRMTL COSTS	104F	0	8100	115700	63100	26647	1274	2123	3391	7430	5524-	16869-
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	9231	15106	19962	26322	33184	33371
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	2380	2380	2394	2655	2647	2642
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	1738-	1880-	1717-	1788-	1830-	1832-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	9873	15606	20639	27189	34001	34181
10	TOT NET BENEFITS (9 - 5)	104F	0	8100-	115700-	63100-	26647-	8599	13483	17248	19759	39525	53050
11	PW NET BENEFITS I=10*	104F	0	6694-	86927-	43098-	16545-	4853	6918	8046	8379	15238	18593

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	9675	9708	9740	9774	9805	9839	9873	9907	9942	9970	10010	10036	10078	10109
2	2488-	2508-	2530-	2549-	2448-	2467-	2485-	2505-	2523-	2542-	2559-	2579-	2598-	2615-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	42600-
4	43511	74606	777	2756	14322-	26039-	1231	1345	43712	75361	14322-	26039-	2100	2001
5	50698	81806	7987	9981	6965-	18667-	8619	8747	51131	82789	6871-	18582-	9580	33105-
6	33542	33785	33857	34006	34215	34335	34547	34668	34831	34982	35124	35310	35492	35630
7	2642	2643	2637	3047	3047	3048	3035	3035	3311	3311	3304	3304	3569	3582
8	1848-	1867-	1889-	1904-	1807-	1826-	1841-	1858-	1874-	1892-	1905-	1925-	1941-	1955-
9	34336	34481	34605	35149	35455	35557	35741	35845	36268	36401	36523	36689	37120	37257
10	16362-	47325-	26618	25148	42420	54224	27122	27098	14863-	46388-	43394	55271	27540	70362
11	5213-	13708-	7009	6025	9231	10727	4878	4430	2209-	6268-	5330	6172	2796	6494

55536-	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
6118-	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
216963	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
151426	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
.73	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.0546

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W2 AND W1.

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	6725	13524	19868	26474	32591	33035
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	504	1279	2035	2733	3406	3634
3	INCR PD CNSTRCTION CST	104F	7600	30900	143400	111300	0	0	0	0	0	0	0
4	INCR PD MAINTNANCE CST	104F	0	0	0	0	0	2047	2046	9832	2047	2046	9832
5	TOTAL INCRMTL COSTS	104F	7600	30900	143400	111300	0	9276	16849	31735	31254	38043	46501
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	36416	63806	89675	115002	138479	124524
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	1492	1492	1482	1489	1498	1896
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	1386	2868	4312	5649	6936	7380
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	39294	68166	95469	122140	146903	133800
10	TOT NET BENEFITS (9 - 5)	104F	7600-	30900-	143400-	111300-	0	30018	51317	63734	90886	108860	87299
11	PW NET BENEFITS I=10*	104F	6909-	25537-	107738-	76019-	0	16944	26333	29732	38544	41970	30597

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	33560	34101	34643	35212	35786	36325	36853	37386	37921	38439	38970	39498	39965	40496
2	3672	3716	3752	3792	3741	3782	3820	3861	3901	3941	3979	4019	4030	4037
3	0	0	0	0	0	0	0	0	0	0	0	0	0	46100-
4	2047	2046	9832	2047	2046	9832	2047	2046	9832	2047	2046	9832	2047	2046
5	39279	39863	48227	41051	41573	49942	42720	43293	51654	44427	44995	53349	46042	479
6	125607	127208	128587	129949	131217	132529	133848	135176	136588	137860	139163	140532	141941	143501
7	1896	1889	1886	1886	1886	1896	1891	1891	2166	2166	2159	2159	2168	2153
8	7457	7544	7617	7695	7594	7674	7751	7831	7912	7991	8067	8147	8173	8191
9	135163	136651	138593	139530	140697	142099	143490	144898	146666	148017	149389	150838	152282	153845
10	95884	96788	89863	98479	99124	92157	100770	101605	95012	103590	104394	97489	106240	153366
11	30550	28076	23663	23575	21572	18232	18124	16613	14122	13998	12824	10887	10786	14155

225062	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
24794	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
399276	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
624338	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.56	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1859

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W7 AND W6

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	979	1981	3053	4185	5396	5528
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	5-	11	129	193	264	274
3	INCR RD CNSTRCTION CST	104F	7100	0	22400	22400	102700	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	0	2236-	2236-	9181-	2236-	1859-	7308
5	TOTAL INCRMTL COSTS	104F	7100	0	22400	22400	102700	1262-	244-	5999-	2142	3801	13110
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	3950	7184	9832	13277	16982	17520
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	183	183	176	172	175	223
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	17	61	336	487	656	678
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	4150	7428	10344	13936	17813	18421
10	TOT NET BENEFITS (9 - 5)	104F	7100-	0	22400-	22400-	102700-	5412	7672	16343	11794	14012	5311
11	PW NET BENEFITS I=10*	104F	6454-	0	16829-	15299-	63768-	3054	3936	7624	5001	5402	1861

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	5717	5892	6048	6229	6400	6565	6742	6910	7080	7261	7415	7591	7777	7940
2	285	292	301	310	270	279	287	295	302	313	318	327	337	344
3	0	0	0	0	0	0	0	0	0	0	0	0	0	30900-
4	2236-	2236-	9181-	1859-	2236-	7308	2236-	2236-	8804-	2236-	2236-	7308	2236-	1859-
5	3766	3948	2832-	4680	4434	14152	4793	4969	1422-	5338	5497	15226	5878	24475-
6	18015	18487	18912	19388	19818	20345	20766	21268	21696	22191	22630	23070	23596	24021
7	223	227	228	233	233	234	212	212	246	246	262	262	247	263
8	733	721	741	761	725	747	766	786	802	829	840	861	884	901
9	16941	19435	19881	20382	20776	21326	21744	22266	22744	23266	23732	24193	24727	25185
10	15175	15487	22713	15702	16342	7174	16951	17297	24166	17928	18235	8967	18849	49660
11	4835	4486	5981	3758	3556	1419	3048	2828	3592	2422	2240	1001	1913	4583

29802-	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
3283-	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,0.0 MF)
115065	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
85262	PRESENT WORTH OF TOTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
.74	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.0640

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W2 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	10$F	0	0	0	0	0	11275	21661	31352	41192	50792	51227
2	INCR AGRI TRANSPO COST	10$F	0	0	0	0	0	9761-	8781-	7744-	6906-	6050-	6253-
3	INCR RD CNSTRCTION CST	10$F	10300	72800	353200	194800	29500	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	10$F	0	0	0	0	4304	9572	25945	29609	9572	25945	29609
5	TOTAL INCRMTL COSTS	10$F	10300	72800	353200	194800	33804	11066	38825	53217	43858	70687	74583
6	INCRMTL AGRI PROD VALUE	10$F	0	0	0	0	0	93908	135904	174146	211619	246350	233801
7	INCR NON AGRI VEH SAVING	10$F	0	0	0	0	0	14615	14615	14932	15761	15974	16505
8	INCR AGRI TRANSPO REVENU	10$F	0	0	0	0	0	5930-	3622-	1322-	693	2699	2832
9	TOT INCR REVENUE/SAVINGS	10$F	0	0	0	0	0	102593	146897	187756	228073	265023	253138
10	TOT NET BENEFITS (9 - 5)	10$F	10300-	72800-	353200-	194800-	33804-	91527	108072	134539	184215	194336	178555
11	PW NET BENEFITS I=10*	10$F	9363-	60165-	265364-	133051-	20989-	51664	55458	62763	78125	74925	62582

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	52284	53352	54406	55496	56591	57621	58654	59709	60759	61815	62861	63919	64975	66023
2	6256-	6252-	6256-	6253-	6159-	6152-	6157-	6155-	6161-	6161-	6166-	6163-	6170-	6172-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	119600-
4	9572	25945	29609	9572	25945	29609	9572	25945	29609	9572	25945	29609	9572	25945
5	55600	73045	77759	58815	76377	81078	62069	79499	84207	65226	82640	87365	68377	33804-
6	236182	233584	240949	243301	245568	247863	250150	252475	254727	256936	259142	261428	263585	265772
7	16505	16714	16895	18336	18336	18464	18792	18792	20221	20221	20422	20422	21595	21913
8	2926	3029	3121	3223	3232	3341	3433	3533	3625	3726	3818	3925	4017	4117
9	255613	259327	261965	264260	267136	269668	272375	274800	278573	280883	283382	285775	289197	291802
10	200013	185282	193206	206045	190759	188590	210306	195301	194366	215657	200742	198410	220820	325606
11	63730	53669	48243	49325	41514	37311	37825	31933	28891	29141	24660	22158	22418	30052

417463	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
45991	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I =10% (10,000 MF)
787241	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1204704	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.53	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1734

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W3 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	15579	30314	44484	58994	73411	74005
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	10441-	9433-	8355-	7436-	6444-	6699-
3	INCR RD CNSTRCTION CST	104F	15600	133100	450600	219200	29500	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	1609	6877	14876	26914	7331	34770	26914
5	TOTAL INCRMTL COSTS	104F	15600	133100	450600	219200	31109	12015	35757	63043	58889	101737	94220
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	113767	169685	222370	275183	325587	314077
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	15325	15325	15685	16510	16748	17290
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	6527-	4125-	1673-	570	2903	2974
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	122565	180885	236382	292263	345238	334341
10	TOT NET BENEFITS (9 - 5)	104F	15600-	133100-	450600-	219200-	31109-	110550	145128	173339	233374	243501	240121
11	PW NET BENEFITS I=10*	104F	14181-	110000-	338542-	149716-	19316-	62402	74473	80864	98973	93880	84161

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	75390	76733	78043	79364	80675	81965	83255	84573	85891	87204	88515	89832	91153	92470
2	6707-	6701-	6705-	6703-	6619-	6612-	6622-	6619-	6626-	6624-	6633-	6633-	6637-	6643-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	157100-
4	6877	14876	27369	6877	34770	26914	6877	15331	26914	6877	34770	26914	7331	14876
5	75564	84908	98707	79538	108826	102267	83510	93285	106179	87457	116652	110113	91847	56397-
6	317322	320535	323648	326828	329972	333114	336158	339310	342384	345414	348466	351539	354609	357507
7	17290	17525	17727	19202	19202	19335	19730	19730	21191	21191	21403	21403	22626	22982
8	3074	3162	3281	3391	3425	3543	3635	3746	3845	3958	4053	4163	4269	4371
9	337686	341242	344656	349421	352599	355992	359523	362786	367420	370563	373922	377105	381504	384860
10	242122	256334	245949	269883	243773	253725	276013	269501	261241	283106	257270	266992	289657	441257
11	83520	74251	64766	64608	53052	50198	49643	44065	38831	38256	31604	29817	29407	40726

555745	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
61225	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1009763	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1565511	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.55	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1734

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W4 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	18586	36411	53617	71435	89234	90125
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	10936-	9901-	8776-	7683-	6105-	6970-
3	INCR RD CNSTRCTION CST	104F	15600	144700	667300	284600	56800	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	396-	1353	3123	10463	2146	38408	36409
5	TOTAL INCRMTL COSTS	104F	15600	144700	667300	284600	56404	9003	29633	55304	65898	121537	119564
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	130781	195857	258294	320628	378299	372426
7	INCR PCK AGRI VEH SAVING	104F	0	0	0	0	0	16041	16041	16407	17309	17560	18103
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	6997-	4483-	1882-	757	4288	3200
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	139825	207415	272819	338694	400147	393729
10	TOT NET BENEFITS (9 - 5)	104F	15600-	144700-	667300-	284600-	56404-	130822	177782	217515	272796	278610	274165
11	PW NET BENEFITS I=10*	104F	14181-	119586-	501352-	194385-	35022-	73845	91230	101472	115692	107416	96093

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	91821	93510	95201	96903	98589	100255	101926	103615	105314	107009	108693	110390	112084	113774
2	6965-	6956-	6953-	6944-	6864-	6853-	6851-	6844-	6845-	6837-	6839-	6832-	6832-	6829-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	222100-
4	1353	3123	11256	1946	37815	36409	1353	3916	11056	1353	37815	36409	2146	3716
5	86209	89677	99504	91905	129540	129811	96430	100687	109525	101525	139669	139967	107398	111439-
6	374755	381079	385387	389629	393941	398153	402362	406615	410806	414963	419101	423339	427469	431546
7	18103	18338	18532	20120	20120	20257	20656	20656	22205	22205	22413	22413	23727	24067
8	3322	3451	3571	3699	3774	3906	4027	4154	4272	4403	4518	4650	4772	4898
9	398181	402828	407490	413448	417835	422316	427045	431425	437283	441571	446032	450402	455968	460511
10	311972	313151	307986	321543	288295	292505	330615	330738	327758	340046	306363	310435	348570	511950
11	99404	90706	81102	76975	62741	57870	59464	54078	48719	45950	37635	34668	35388	52788

559719	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
61557	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1280064	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1838784	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.44	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1578

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W5 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	21950	43316	64167	85888	107778	108971
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	13078-	12228-	11139-	9697-	8155-	6155-
3	INCR RD CNSTRCTION CST	104F	18400	178600	721300	298700	57200	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	205	1954	2709	11064	3917	18100	37010
5	TOTAL INCRMTL COSTS	104F	18400	178600	721300	298700	57405	10826	33797	64092	80108	117723	136826
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	151738	228681	302799	374551	445455	441971
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	18493	18493	19000	19913	20261	20642
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	9048-	6607-	3778-	76-	3769	2432
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	161183	240567	318021	394388	469485	465245
10	TOT NET BENEFITS (9 - 5)	104F	18400-	178600-	721300-	298700-	57405-	150357	206770	253929	314280	351762	328419
11	PW NET BENEFITS I=10*	104F	16727-	147603-	541923-	204016-	35644-	84872	106105	118459	133285	135619	115109

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	111035	113102	115164	117230	119296	121327	123368	125434	127502	129567	131623	133691	135751	137822
2	9206-	9251-	9301-	9352-	9307-	9357-	9419-	9473-	9538-	9598-	9665-	9729-	9800-	9872-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	242400-
4	58794	2709	13026	2547	17507	37010	1954	4672	68497	1954	17507	37010	3917	3302
5	140621	116560	118889	110425	127496	148980	115903	120633	186461	121923	139465	160972	129868	111148-
6	447776	453421	459444	465298	471093	476908	482688	488554	494311	500122	505935	511771	517514	523342
7	21842	21189	21435	23122	23122	23291	23847	23847	25533	25533	25852	25852	27296	27794
8	2467	2519	2562	2601	2555	2593	2614	2647	2664	2687	2700	2719	2725	2732
9	471185	477329	483441	491021	496775	502792	509149	515048	522508	528342	534487	540342	547535	553868
10	310464	370769	364552	350596	369274	353812	393246	394415	336047	406419	395022	379370	417667	665016
11	98923	107399	95998	91111	80365	70000	70729	64490	49951	54919	48527	42367	42404	61378

726103	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
79993	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1444392	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
2172497	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.50	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1640

KAYES-NIORO ROAL NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W6 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	23767	46935	69694	93477	117513	118611
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	14852-	14200-	13183-	11955-	10616-	11624-
3	INCR RD CNSTRCTION CST	104F	18400	186700	837000	361800	83400	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	652	3185	3185	10971	6017	5303	10971
5	TOTAL INCRMTL COSTS	104F	18400	186700	837000	361800	84052	12100	35920	67482	87539	112200	117958
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	160969	243787	322762	400873	478639	475342
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	20874	20874	21395	22568	22909	23485
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	10786-	8488-	5496-	1864-	1939	599
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	171057	256173	338661	421577	503487	499426
10	TOT NET BENEFITS (9 - 5)	104F	18400-	186700-	837000-	361800-	84052-	158957	220253	271179	334038	391287	381468
11	PW NET BENEFITS I=10*	104F	16727-	154297-	628850-	247114-	52189-	89727	113024	126507	141664	150858	133702

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	120710	122811	124904	127005	129101	131166	133242	135341	137444	139538	141633	143728	145829	147931
2	11696-	11760-	11832-	11901-	11755-	11825-	11905-	11978-	12061-	12141-	12225-	12309-	12399-	12487-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	285000-
4	102305	77315	13803	5303	3185	10971	3185	6017	112209	77315	3185	10971	6017	5303
5	211319	188366	126875	120407	120531	130312	124522	129780	237592	204712	132593	142390	139447	144253-
6	481315	487327	493302	499304	505308	511243	517236	523222	529142	535104	541059	547082	553006	558972
7	23485	23633	24073	26169	26169	26339	26883	26883	28844	28844	29157	29157	30865	31376
8	619	652	673	697	747	767	773	788	790	795	795	793	784	776
9	505422	511812	518048	526170	532224	538349	544892	550993	558776	564743	571011	577032	584655	591124
10	294103	323446	391173	405763	411693	408037	420370	421513	321184	360031	438418	434642	445208	735377
11	93710	93691	103008	97176	89596	80728	75607	68921	47742	48651	53858	48540	45200	67872

675570	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
77875	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1653355	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
2323926	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.41	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1546

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: ADDED AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W7 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	24746	48917	72747	97663	122909	124139
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	14958-	14189-	13053-	11762-	10351-	11350-
3	INCR RD CNSTRCTION CST	104F	25500	186700	859400	384200	186100	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	652	949	949	1790	3781	3444	18279
5	TOTAL INCRMTL COSTS	104F	25500	186700	859400	384200	186752	10837	35677	61484	89682	116002	131068
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	164919	250971	332595	414151	495622	492863
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	21057	21057	21571	22741	23085	23708
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	10768-	8426-	5159-	1376-	2596	1277
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	175208	263602	349007	435516	521303	517848
10	TOT NET BENEFITS (9 - 5)	104F	25500-	186700-	859400-	384200-	186752-	164371	227925	287523	345834	405301	386780
11	PW NET BENEFITS I=10*	104F	23181-	154297-	645680-	262413-	115958-	92783	116961	134131	146667	156261	135564

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	126428	128704	130952	133234	135502	137732	139984	142252	144525	146799	149049	151319	153607	155871
2	11411-	11467-	11531-	11591-	11485-	11545-	11617-	11682-	11759-	11827-	11907-	11982-	12061-	12143-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	315900-
4	136069	75079	4622	3444	949	18279	949	3781	103405	75079	949	18279	3781	3444
5	215086	192316	124043	125087	124966	144466	129316	134351	236171	210051	138091	157616	145327	168728-
6	499334	505815	512214	518692	525126	531588	538003	544491	550838	557296	563690	570152	576603	582994
7	23708	24060	24302	24402	26402	26574	27096	27096	29091	29091	29419	29419	31112	31640
8	1322	1373	1414	1459	1472	1514	1539	1574	1593	1624	1635	1654	1668	1677
9	524364	531246	537930	546553	553000	559676	566638	573161	581522	588011	594744	601225	609383	616311
10	309278	336932	413887	421466	428034	415210	437322	438810	345351	377960	456653	443609	464056	785039
11	98545	98176	108929	100895	93152	82147	78656	71749	51334	51074	56098	49541	47113	72456

641771	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
70592	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1768425	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
2409197	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.36	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1484

I.2 PROJECT OPTION B

Kayes-Nioro Road, Only

The tables, hereafter given, refer to the Kayes-Nioro road improvement alternatives including the Yélimané branch but excluding the added Agricultural investment. In order to exclude the impacts and costs of the Yélimané branch, the results have to be modified by subtracting the difference between alternatives W2 and W1 (See Chapter 11).

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE WO - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.2728	.2728	.2722	.2729	.2725	.2724
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	330888	330888	339906	356666	362153	374351
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	2913215	2960023	3002547	3050129	3096579	3105982
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	268148	277613	285430	295134	303878	315014
6	ROAD CONSTRUCTION COST	106F	0	0	0	0	0	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	3964879	4075350	4179337	4290455	4403392	4369222
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	375449	388702	399647	413235	425476	441070
10	TOT NET AG VALUE (6+9-4-5)	103F	283390	470039	658006	835482	1007008	1158965	1226416	1291007	1356427	1428411	1389296
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75374	75800	76152	76567	76976	77278
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	43125	44117	45039	46043	47033	47218

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.2724	.2720	.2723	.2728	.2728	.2730	.2725	.2725	.2727	.2727	.2724	.2724	.2728	.2724
3	374351	379800	383379	415114	415114	417636	426044	426044	458009	458009	463196	463196	488891	497027
4	3118086	3130200	3142394	3154488	3166639	3179068	3191396	3203531	3215653	3227783	3239977	3252062	3264181	3276314
5	317142	319221	321375	323477	336749	338936	341243	343469	345813	348094	350439	352757	355141	357525
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6360
8	4371973	4374641	4377376	4379531	4381671	4383644	4385012	4386027	4387813	4388432	4389007	4388826	4389005	4388899
9	444050	446959	449976	452920	471448	474510	477739	480858	484138	487331	490613	493859	497197	500536
10	1380795	1372379	1363583	1354486	1349731	1340150	1330112	1319885	1310485	1299886	1289204	1277866	1266880	1255596
11	77579	77881	78184	78486	78787	79089	79391	79693	79994	80296	80599	80901	81202	81504
12	47402	47587	47774	47956	48141	48326	48510	48692	48881	49065	49250	49431	49617	49802

7762285 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
75716 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
42428 YEARLY AVERAGE OF TOTAL TONS PRODUCED
102.52 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
182.95 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

25

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W1 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1646	.1646	.1642	.1637	.1635	.1661
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	199649	199649	204500	213947	217292	228266
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	2958708	3041395	3117383	3197309	3278592	3287895
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	162734	174479	185151	196266	206873	213594
6	ROAD CONSTRUCTION COST	106F	27	419	2098	835	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	106F	6360	6360	6360	6360	10664	13885	30259	26137	13885	30259	26137
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4539800	4796334	5024038	5256618	5482106	5461995
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	300327	322003	341698	362210	381785	394189
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	1718685	1902463	2063202	2225253	2378426	2354695
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75476	75905	76155	76506	76890	77295
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	45745	47741	49536	51382	53180	53461

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1661	.1659	.1657	.1647	.1647	.1647	.1644	.1644	.1652	.1652	.1650	.1650	.1644	.1641
3	228266	231650	233294	250620	250620	251958	257033	257033	277459	277459	280570	280570	294625	299420
4	3305322	3322703	3340017	3357329	3374695	3392000	3409409	3426765	3444034	3461541	3478884	3496265	3514277	3531584
5	215296	216964	218704	220429	229824	231646	233484	235284	237130	238981	240849	242762	244952	247232
6	0	0	0	0	0	0	0	0	0	0	0	0	0	735-
7	13885	30259	26137	13885	30259	26137	13885	30259	26137	13885	30259	26137	13885	30259
8	5475716	5428599	5501001	5513043	5525182	5536982	5548031	5559012	5569196	5579187	5588803	5597782	5605447	5611618
9	397333	400410	403621	406806	423793	427152	430541	433861	437263	440679	444123	447649	451687	455892
10	2352431	2349342	2345901	2342091	2344456	2340488	2335679	2330824	2325295	2319344	2313193	2306404	2297905	2288694
11	77704	78113	78520	78927	79336	79743	80152	80560	80966	81375	81783	82189	82599	83006
12	53745	54026	54309	54589	54872	55156	55438	55720	55999	56282	56565	56844	57129	57411

11459136 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
75875 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
45417 YEARLY AVERAGE OF TOTAL TONS PRODUCED
151.03 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
252.31 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

25

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W2 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.84
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1523	.1523	.1523	.1523	.1523	.1523
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	184729	184729	189679	199048	202407	209301
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	2960429	3044608	3122311	3203775	3286748	3296241
5	TOT AGRI TRANSPORT COST	103F	204879	215498	227393	241939	257376	159682	171279	181841	192866	203437	214022
6	ROAD CONSTRUCTION COST	106F	103	418	2902	1638	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	10664	15932	32305	35969	15932	32305	35969
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4632058	4893921	5127699	5364951	5596112	5407690
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	298615	320303	340056	360670	380438	400233
10	TOT NET AG VALUE (6+9-4-5)	103F	283390	470039	658006	835482	1007008	1810562	1998337	2163603	2328980	2486365	2297660
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75516	75982	76273	76658	77077	77490
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	46098	48132	49964	51847	53686	53972

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523	.1523
3	209301	212660	214428	231752	231752	232989	238115	238115	255793	255793	258975	258975	272940	277890
4	3313777	3331371	3348976	3366516	3384070	3401682	3419188	3436847	3454527	3472083	3489673	3507844	3525471	3543128
5	216104	218177	220267	222446	231909	234147	236449	238714	241039	243394	245754	248116	250537	252984
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1071-
7	15932	32305	35969	15932	32305	35969	15932	32305	35969	15932	32305	35969	15932	32305
8	5416509	5425321	5433314	5440896	5448108	5454373	5460664	5466712	5471669	5476565	5480535	5484541	5488207	5491305
9	414125	406003	411950	415987	434316	438504	442817	447062	451415	455822	460245	464666	469196	473784
10	2290753	2283776	2276001	2267921	2266445	2257048	2247844	2238213	2227518	2216910	2205353	2193247	2181395	2168977
11	77903	78317	78731	79143	79556	79970	80382	80797	81210	81622	82036	82449	82862	83276
12	54259	54548	54836	55125	55413	55699	55988	56276	56563	56851	57138	57426	57714	58005

11488002 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
75964 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
45677 YEARLY AVERAGE OF TOTAL TONS PRODUCED
151.23 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
251.51 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

25

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W3 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.43	10.43	10.71	11.24	11.43	11.82
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1471	.1471	.1469	.1472	.1471	.1472
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	177633	177633	182153	191558	194664	201443
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	2978306	3079836	3175274	3274984	3376610	3387138
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	153327	165076	175908	187304	198331	207147
6	ROAD CONSTRUCTION COST	106F	156	1021	3876	1882	295	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	7969	13237	21236	33274	13691	41130	33274
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4753798	5068857	5358772	5654857	5946710	5773604
9	AGRI TRANSP PRICE REVENUE	103F	286997	302147	318532	338908	360531	292781	315212	335894	357657	378713	395546
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	1914946	2139157	2343484	2550226	2750482	2574865
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	75745	76432	76937	77532	78155	78604
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	46805	49185	51382	53646	55881	56202

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.82	12.01	12.11	13.09	13.09	13.16	13.44	13.44	14.44	14.44	14.63	14.63	15.41	15.70
2	.1472	.1471	.1470	.1472	.1472	.1472	.1470	.1470	.1472	.1472	.1471	.1471	.1472	.1470
3	201443	204542	206105	223087	223087	224280	228740	228740	246094	246094	249163	249163	262625	267204
4	3406496	3425891	3445148	3464537	3483854	3503380	3522760	3542276	3562136	3581542	3600874	3620193	3639580	3658946
5	209157	211217	213267	215330	224873	227055	229272	231515	233760	236054	238340	240681	243031	245406
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1446-
7	13237	21236	33729	13237	41130	33274	13237	21691	33274	13237	41130	33274	13691	21236
8	5786086	5801912	5815076	5827761	5840044	5852137	5863699	5874704	5884949	5895625	5905093	5914108	5922945	5931351
9	399381	40[illegible]21	407232	411171	429421	433586	437819	442105	446390	450770	455135	459607	464093	468633
10	2571814	2568125	2563893	2559065	2560738	2555298	2549486	2543018	2535443	2528799	2521014	2512841	2504427	2495632
11	79054	79503	79951	80401	80850	81299	81749	82198	82646	83096	83545	83994	84444	84893
12	56525	56846	57166	57487	57808	58129	58450	58772	59091	59415	59735	60056	60378	60701

12488174 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
764R5 YEARLY AVERAGE OF HECTARES IN R CULTIVATION
46700 YEARLY AVERAGE OF TOTAL TONS PRODUCED
163.28 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
267.41 PRESENT WORTH OF NET VALUE PER TON (1 000 MF)

25

KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W4 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1418	.1418	.1417	.1417	.1416	.1419
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320639	320638	170478	170478	174927	183575	186544	193312
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	3007622	3137874	3262424	3392188	3524650	3537036
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	148193	160285	171642	183715	195557	203774
6	ROAD CONSTRUCTION COST	106F	156	1134	6043	2536	568	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	106F	6360	6360	6360	6360	5964	7713	9483	16823	8506	44768	42769
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	4918610	5317621	5692414	6078339	6462172	6302083
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	288127	311637	333720	357195	380217	396192
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2050922	2331099	2592068	2859631	3122182	2957465
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74797	74945	76199	77332	78265	79279	80311	80832
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	47791	50713	53464	56313	59154	59536

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1419	.1419	.1419	.1419	.1418	.1418	.1417	.1417	.1418	.1418	.1418	.1418	.1417	.1417
3	193312	196417	198051	213914	213914	215057	219475	219475	235959	235959	239061	239061	251621	256353
4	3559981	3582671	3606114	3629249	3652015	3674815	3697603	3720440	3743214	3765944	3788731	3811567	3834290	3857159
5	205571	207373	209143	210952	220033	221903	223834	225830	228048	230326	232598	234909	237234	239592
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2096-
7	7713	9483	17616	8306	44175	42769	7713	10276	17416	7713	44175	42769	8506	10076
8	6337622	6354017	6376755	6403276	6428170	6451977	6475987	6498634	6519111	6539018	6558826	6578404	6596410	6614619
9	399685	403189	406630	410146	427548	431184	434933	438816	443123	447551	451963	456455	460972	465553
10	2941955	2966962	2970128	2973221	2983670	2986443	2989483	2991180	2990972	2990299	2989460	2988383	2985858	2983421
11	81352	81875	82396	82916	83437	83958	84479	85001	85522	86042	86563	87085	87605	88127
12	59920	60306	60688	61071	61456	61838	62224	62609	62991	63375	63759	64143	64526	64909

13901052 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
77527 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
43235 YEARLY AVERAGE OF TOTAL TONS PRODUCED
179.31 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
288.19 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W5 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1214	.1214	.1207	.1216	.1211	.1218
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	145952	145952	149003	157535	159537	165930
4	TOT AGRI PRODUCTION COST	103F	2505760	2602189	2692985	2781876	2870612	3018536	3159576	3295370	3436944	3581650	3594846
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	127296	138184	148459	159470	170346	177447
6	ROAD CONSTRUCTION COST	106F	184	1476	6583	2677	572	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	6565	8314	9069	17424	10277	24460	43370
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5053752	5491446	5905663	6334231	6762675	6608199
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	267711	290611	312218	335375	358252	373184
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2175631	2484297	2774052	3073192	3368931	3209090
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76313	77556	78597	79716	80850	81389
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	48358	51521	54519	57639	60763	61169

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1218	.1213	.1211	.1219	.1219	.1218	.1211	.1211	.1218	.1218	.1214	.1214	.1216	.1211
3	165930	167903	169020	183894	183894	184725	187568	187568	202678	202678	204669	204669	215929	219085
4	3618620	3643077	3667153	3690926	3714709	3738505	3762310	3786074	3809879	3833684	3857458	3881231	3905049	3928854
5	179022	180566	182153	183734	191677	193366	195052	196698	198403	200132	201824	203625	205657	207681
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2299-
7	65154	9069	19386	9607	23867	43370	8314	11032	74857	8314	23867	43370	10277	9662
8	6677677	6667059	6695713	6724789	6752705	6780494	6808054	6834777	6861375	6887443	6913348	6938130	6960848	6982581
9	376498	379742	383081	386407	403125	406675	410223	413687	417273	420906	424467	428255	432527	436785
10	3216533	3223158	3229488	3236536	3249444	3255298	3260915	3265692	3270366	3274533	3278533	3281529	3282669	3282831
11	81928	82467	83006	83545	84084	84623	85162	85701	86240	86779	87318	87857	88396	88935
12	61574	61979	62384	62790	63195	63600	64006	64409	64813	65220	65624	66030	66436	66840

14848706 PRESENT WORTH OF NET VALUE STREAM, I = 10%(1,000 MF)
77787 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
48986 YEARLY AVERAGE OF TOTAL TONS PRODUCED
190.89 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
303.12 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO ROAD NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W6 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.44	10.44	10.72	11.25	11.44	11.83
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1016	.1016	.1013	.1011	.1010	.1024
3	TOT NON AGRI VHCL COST	103F	296463	297877	297837	320638	320638	122148	122148	125054	130977	133058	139501
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870612	3035999	3194214	3347769	3507840	3671712	3686781
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	109843	119566	126878	138850	148816	155038
6	ROAD CONSTRUCTION COST	106F	184	1557	7740	3308	834	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	104F	6360	6360	6360	6360	7012	9545	9545	17331	12377	11663	17331
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5143325	5633147	6103682	6589878	7080560	6932139
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	250606	272792	294034	316786	339528	353721
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2248089	2592159	2921069	3259974	3599560	3444041
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76542	78006	79261	80590	81928	82504
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	48661	52150	55497	58982	62493	62932

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.83	12.02	12.12	13.10	13.10	13.17	13.45	13.45	14.45	14.45	14.64	14.64	15.42	15.71
2	.1024	.1022	.1022	.1017	.1017	.1017	.1015	.1015	.1019	.1019	.1018	.1018	.1015	.1013
3	139501	141465	142641	153421	153421	154241	157210	157210	169564	169564	171625	171625	180236	183264
4	3712630	3738339	3764038	3789638	3815353	3841061	3866630	3892352	3918060	3943653	3969366	3995061	4020630	4046374
5	156442	157823	159221	160651	167506	168987	170483	171964	173478	174995	176529	178059	179615	181159
6	0	0	0	0	0	0	0	0	0	0	0	0	0	2725-
7	11665	83675	20163	11663	9545	17331	9545	12377	118569	83675	9545	17331	12377	11663
8	6967271	7002243	7036874	7070989	7104424	7138293	7170347	7203177	7235700	7267270	7298612	7329173	7359761	7389755
9	356924	360075	363268	366525	382337	385716	389132	392512	395970	399429	402933	406425	409974	413500
10	3455123	3466156	3476883	3487225	3503902	3513961	3522366	3531373	3540132	3548051	3555650	3562478	3569490	3575722
11	83077	83653	84228	84802	85378	85953	86527	87102	87678	88252	88827	89403	89976	90552
12	63366	63805	64246	64685	65123	65563	65998	66439	66878	67316	67756	68192	68631	69069

15693156 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
78308 YEARLY AVERAGE OF HECTARES IN R CULTIVATION
49764 YEARLY AVERAGE OF TOTAL TONS PRODUCED
200.40 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
315.35 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

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KAYES-NIORO RO D NETWORK
REGIONAL SUMMARY
CASE: NO AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W7 - ALL CROPS

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	AVRGE NON AGRI TRAFFIC	VPD	9.38	9.42	9.42	10.13	10.13	10.45	10.45	10.73	11.26	11.45	11.8
2	AVRGE VEHCLE OPER COST	103F/VK	.2723	.2724	.2724	.2727	.2727	.1002	.1002	.1000	.0999	.0998	.100
3	TOT NON AGRI VHCL COST	103F	296463	297837	297837	320638	320638	120313	120313	123290	129250	131300	137268
4	TOT AGRI PRODUCTION COST	103F	2505780	2602189	2692985	2781876	2870812	3038463	3199190	3355006	3517721	3684029	3699568
5	TOT AGRI TRANSPORT COST	103F	204879	215698	227393	241939	257376	109660	119412	128749	138790	148813	155036
6	ROAD CONSTRUCTION COST	106F	255	1557	7964	3532	1861	0	0	0	0	0	0
7	ROAD MAINTENANCE COST	106F	6360	6360	6360	6360	7012	7309	7309	8150	10141	9804	24639
8	TOT AGRI PRODUCTION VALUE	103F	2707056	2985779	3259852	3520389	3774465	5159276	5656314	6132 27	6626844	7124543	6977791
9	AGRI TRANSP PRICE REVENUE	103F	286993	302147	318532	338908	360531	250252	272506	293819	316734	339605	353807
10	TOT NET AG VALUE (8+9-4-5)	103F	283390	470039	658006	835482	1007008	2261405	2610218	2942991	3287067	3631304	3476994
11	TOT AREA IN CULTIVATION	HA	72540	73195	73814	74397	74945	76598	78120	79428	80808	82198	82783
12	TOT AGRI PRODUCTION	TON	33919	35989	38049	40110	42156	48699	52227	55613	59142	62699	63145

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11.84	12.03	12.13	13.11	13.11	13.18	13.47	13.47	14.47	14.47	14.65	14.65	15.44	15.72
2	.1009	.1007	.1007	.1003	.1003	.1003	.1002	.1002	.1005	.1005	.1004	.1004	.1002	.1000
3	137268	139195	140352	151088	151088	151895	155083	155083	167095	167095	169005	169005	177764	180626
4	3725784	3751941	3777966	3804156	3830399	3856452	3882642	3908718	3934962	3961125	3987204	4013326	4039581	4065677
5	156438	157843	159253	160674	167555	169041	170559	172056	173568	175100	176632	178180	179741	181322
6	0	0	0	0	0	0	0	0	0	0	0	0	0	3034-
7	176429	81439	10982	9804	7309	24639	7309	10141	109765	81439	7309	24639	10141	9804
8	7014217	7051103	7086200	7121730	7157278	7191543	7226198	7259776	7293990	7326893	7359040	7391637	7423492	7454920
9	357004	360214	363433	366674	382542	385939	389401	392819	396275	399772	403268	406799	410365	413973
10	3488999	3501533	3512414	3523574	3541866	3551988	3562398	3571821	3581735	3590440	3598472	3606930	3614535	3621894
11	83370	83956	84539	85125	85713	86297	86884	87468	88055	88641	89226	89813	90398	90983
12	63591	64039	64483	64930	65378	65823	66273	66716	67167	67613	68057	68505	68951	69398

15819476 PRESENT WORTH OF NET VALUE STREAM, I = 10% (1,000 MF)
78441 YEARLY AVERAGE OF HECTARES IN B CULTIVATION
49854 YEARLY AVERAGE OF TOTAL TONS PRODUCED
201.67 PRESENT WORTH OF NET VALUE PER HECTARE (1,000 MF)
317.25 PRESENT WORTH OF NET VALUE PER TON (1,000 MF)

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W1 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	4549	8137	11483	14718	18201	18191
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	10541-	10313-	10027-	9886-	9700-	10142-
3	INCR RD CNSTRCTION CST	104F	2700	41900	209800	83500	29500	0	0	0	0	0	0
4	INCR RD MAINTENANCE CST	104F	0	0	0	0	4304	7525	23899	19777	7525	23899	19777
5	TOTAL INCRMTL COSTS	104F	2700	41900	209800	83500	33804	1533	21723	21233	12357	32400	27826
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	57492	72098	84470	96616	107871	109277
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	13123	13123	13450	14271	14486	14608
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	7512-	6669-	5794-	5102-	4369-	4688-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	63103	78552	92126	105765	117988	119197
10	TOT NET BENEFITS (9 - 5)	104F	2700-	41900-	209800-	83500-	33804-	61570	56829	70893	93428	85588	91371
11	PW NET BENEFITS I=10*	104F	2454-	34628-	157625-	57031-	20989-	34754	29162	33072	39622	32997	32025

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	18723	19250	19762	20284	20805	21293	21801	22323	22838	23375	23890	24420	25009	25527
2	10184-	10225-	10267-	10304-	10692-	10729-	10775-	10818-	10868-	10911-	10959-	10999-	11018-	11029-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	73500-
4	7525	23899	19777	7525	23899	19777	7525	23899	19777	7525	23899	19777	7525	23899
5	16064	32924	29272	17505	34012	30341	18551	35404	31747	19989	36830	33198	21516	35103-
6	110374	111375	112362	113351	114351	115333	116301	117298	118138	119075	119979	120895	121644	122271
7	14608	14815	15008	16449	16449	16567	16901	16901	18055	18055	18262	18262	19426	19760
8	4671-	4654-	4735-	4611-	4765-	4735-	4719-	4699-	4687-	4665-	4649-	4621-	4551-	4464-
9	120311	121536	122735	125189	126035	127165	128483	129500	131506	132465	133592	134536	136519	137567
10	104247	88612	93463	107684	92023	96824	109932	94096	99759	112476	96762	101338	115003	172670
11	33216	25667	24611	25778	20026	19156	19772	15385	14828	15199	11886	11317	11675	15936

193365	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
21302	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
385813	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
579178	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.50	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1640

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W3 AND W2

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	1787	3522	5296	7120	8986	9089
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	635-	620-	593-	556-	510-	687-
3	INCR RD CNSTRCTION CST	104F	5300	60300	97400	24400	0	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	2695-	2695-	11069-	2695-	2241-	8825	2695-
5	TOTAL INCRMTL COSTS	104F	5300	60300	97400	24400	2695-	1543-	8167-	2008	4323	17301	5707
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	12174	17493	23107	28990	35059	36591
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	709	709	752	749	774	785
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	583-	509-	416-	301-	172-	468-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	12300	17693	23443	29438	35661	36908
10	TOT NET BENEFITS (9 - 5)	104F	5300-	60300-	97400-	24400-	2695	13843	25860	21435	25115	18360	31201
11	PW NET BENEFITS I=10*	104F	4818-	49834-	73178-	16665-	1673	7814	13270	9999	10651	7078	10935

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	9271	9452	9617	9802	9978	10169	10357	10542	10760	10945	11120	11234	11410	11581
2	694-	696-	702-	711-	703-	709-	717-	719-	727-	734-	741-	743-	750-	757-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	37500-
4	2695-	11069-	2240-	2695-	8825	2695-	2695-	10614-	2695-	2695-	8825	2695-	2241-	11069-
5	5882	2313-	6675	6396	18100	6765	6945	791-	7338	7516	19204	7796	8419	37745-
6	37157	37659	38176	38686	39193	39776	40303	40799	41328	41906	42455	42956	43473	44004
7	785	811	832	866	866	870	937	937	969	969	981	981	1031	1068
8	474-	468-	471-	481-	489-	491-	499-	495-	502-	505-	511-	505-	510-	515-
9	37468	38002	38537	39071	39570	40155	40741	41241	41795	42370	42925	43432	43994	44557
10	31586	40315	31862	32675	21470	33390	33796	42032	34457	34854	23721	35636	35575	82302
11	10064	11677	8390	7822	4672	6606	6078	6872	5121	4709	2914	3979	3611	7596

7044	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
776	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
162799	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
169843	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.04	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1046

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W5 AND W4

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	1091	2170	3294	4475	5700	5781
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	2089-	2210-	2318-	2424-	2521-	2632-
3	INCR RD CNSTRCTION CST	104F	2800	34200	54000	14100	400	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	601	601	414-	601	1771	20308-	601
5	TOTAL INCRMTL COSTS	104F	2800	34200	54000	14100	1001	397-	454-	1577	3822	17129-	3750
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	13514	17382	21324	25589	30050	30611
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	2452	2452	2592	2604	2700	2738
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	2041-	2102-	2150-	2182-	2196-	2300-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	13925	17732	21766	26011	30554	31049
10	TOT NET BENEFITS (9 - 5)	104F	2800-	34200-	54000-	14100-	1001-	14322	18186	20189	22189	47683	27299
11	PW NET BENEFITS I=10%	104F	2545-	28264-	40571-	9630-	621-	8084	9332	9418	9410	18383	9568

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	5863	6020	6103	6167	6269	6369	6470	6563	6666	6774	6872	6966	7075	7169
2	2654-	2680-	2699-	2721-	2835-	2853-	2878-	2913-	2964-	3019-	3077-	3128-	3157-	3191-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	20300-
4	57441	414-	1770	601	20308-	601	601	756	57441	601	20308-	601	1771	414-
5	60650	2926	5174	4047	16874-	4117	4193	4406	61143	4356	16513-	4439	5689	16736-
6	30985	31304	31695	32151	32453	32851	33206	33614	34226	34842	35452	35972	36443	36796
7	2738	2851	2903	3002	3002	3033	3190	3190	3328	3328	3439	3439	3569	3726
8	2318-	2344-	2354-	2373-	2442-	2450-	2471-	2512-	2585-	2664-	2749-	2820-	2844-	2876-
9	31405	31811	32244	32720	33013	33434	33925	34292	34969	35506	36142	36591	37168	37646
10	29245-	28585	27070	28733	49887	29317	29732	29886	26174-	31150	52655	32152	31479	54382
11	9318-	8366	7128	6878	10856	5800	5347	4886	3890-	4209	6468	3590	3195	5019

41104	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
4528	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
106540	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
147644	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.39	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1453

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W4 AND W3

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	2931	5803	8715	11720	14804	14989
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	513-	479-	426-	358-	277-	337-
3	INCR RD CNSTRCTION CST	104F	0	11300	216700	65400	27300	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	2005-	5524-	11753-	16451-	5185-	3638	9495
5	TOTAL INCRMTL COSTS	104F	0	11300	216700	65400	25295	3106-	6429-	8162-	6177	18165	24147
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	16481	24876	33364	42348	51546	52847
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	715	715	722	798	812	813
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	465-	357-	217-	46-	150	64
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	16731	25234	33869	43100	52508	53724
10	TOT NET BENEFITS (9 - 5)	104F	0	11300-	216700-	65400-	25295-	19837	31663	42031	36923	34343	29577
11	PW NET BENEFITS I=10*	104F	0	9338-	162809-	44669-	15706-	11197	16248	19607	15658	13240	10366

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	15348	15698	16096	16471	16816	17143	17484	17816	18107	18440	18785	19137	19471	19821
2	358-	384-	412-	437-	484-	515-	543-	568-	571-	572-	574-	577-	579-	581-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	65000-
4	5524-	11753-	16113-	4931-	3045	9495	5524-	11415-	15858-	5524-	3045	9495	5185-	11160-
5	9466	3561	429-	11103	19377	26123	11417	5833	1678	12344	21256	28055	13707	56920-
6	53973	55210	56367	57551	58812	59984	61228	62393	63416	64339	65373	66429	67346	68326
7	813	812	805	917	917	922	926	926	1013	1013	1010	1010	1100	1085
8	30	13-	60-	102-	187-	240-	288-	328-	326-	321-	317-	315-	312-	308-
9	54816	56009	57112	58366	59542	60666	61866	62991	64103	65031	66066	67124	68134	69103
10	45350	52448	57541	47263	40165	34543	50449	57158	62425	52687	44810	39069	54427	126023
11	14449	15192	15152	11314	8741	6834	9073	9345	9279	7119	5504	4363	5525	11631

12676-	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1396-	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
264535	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
251858	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
.95	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.0953

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W6 AND W5

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	1746	3463	5239	7089	9006	9193
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	1745-	1861-	1958-	2062-	2153-	2240-
3	INCR RD CNSTRCTION CST	104F	0	8100	115700	63100	26200	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	447	1231	476	93-	2100	12797-	26039-
5	TOTAL INCRMTL COSTS	104F	0	8100	115700	63100	26647	1232	2078	3188	7127	5944-	19086-
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	8957	14170	19801	25564	31788	32394
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	2380	2380	2394	2655	2647	2642
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	1710-	1781-	1818-	1858-	1872-	1946-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	9627	14769	20377	26361	32563	33090
10	TOT NET BENEFITS (9 - 5)	104F	0	8100-	115700-	63100-	26647-	8395	12691	17189	19234	38507	52176
11	PW NET BENEFITS I=10*	104F	0	6694-	86927-	43098-	16545-	4738	6512	8018	8157	14846	18287

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	9401	9526	9688	9871	10064	10255	10432	10627	10818	10996	11190	11383	11558	11752
2	2258-	2274-	2293-	2308-	2417-	2437-	2456-	2473-	2492-	2513-	2529-	2556-	2604-	2652-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	42600-
4	43511	74606	777	2756	14322-	26039-	1231	1345	43712	75361	14322-	26039-	2100	2001
5	55654	81858	8172	10319	6675-	18221-	9207	9499	52038	83844	5661-	17212-	11054	31499-
6	32959	33518	34116	34420	35171	35779	36229	36840	37432	37982	38526	39104	39891	40717
7	2642	2643	2637	3047	3047	3048	3035	3035	3311	3311	3304	3304	3569	3582
8	1957-	1966-	1981-	1988-	2078-	2095-	2109-	2117-	2130-	2147-	2153-	2183-	2255-	2328-
9	33644	34195	34772	35679	36140	36732	37155	37758	38613	39146	39677	40225	41205	41971
10	17010-	47663-	26600	25360	42815	54953	27948	28259	13425-	44698-	45338	57437	30151	73470
11	5419-	13606-	7004	6070	9317	10872	5026	4620	1995-	6040-	5569	6414	3061	6781

55227-	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
6084-	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
207842	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
152615	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
.73	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.0578

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W2 AND W1

YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1 INCRMTL AGRI PROD COST	104F	0	0	0	0	0	172	321	492	646	815	834
2 INCR AGRI TRANSPO COST	104F	0	0	0	0	0	305-	320-	331-	340-	343-	42
3 INCR RD CNSTRCTION CST	104F	7600	100-	80400	80300	0	0	0	0	0	0	0
4 INCR RD MAINTNANCE CST	104F	0	0	0	0	0	2047	2046	9832	2047	2046	9832
5 TOTAL INCRMTL COSTS	104F	7600	100-	80400	80300	0	1914	2047	9993	2353	2518	10708
6 INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	9225	9758	10366	10833	11400	5430-
7 INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	1492	1492	1482	1489	1488	1896
8 INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	171-	170-	164-	154-	134-	604
9 TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	10546	11080	11684	12168	12754	2930-
10 TOT NET BENEFITS (9 - 5)	104F	7600-	100	80400-	80300-	0	8632	9033	1691	9815	10236	13638-

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	845	866	895	918	937	968	977	1008	1049	1054	1078	1157	1119	1154
2	80	121	158	201	208	250	296	343	390	441	490	535	558	575
3	0	0	0	0	0	0	0	0	0	0	0	0	0	33600-
4	2047	2046	9832	2047	2046	9832	2047	2046	9832	2047	2046	9832	2047	2046
5	2972	3033	10885	3166	3191	11050	3320	3397	11271	3542	3614	11524	3724	29825-
6	5920-	6327-	6768-	7214-	7707-	8260-	8736-	9230-	9752	10262-	10826-	11324-	11724-	12031-
7	1896	1899	1886	1886	1886	1896	1891	1891	2166	2166	2159	2159	2168	2153
8	679	759	832	918	1052	1135	1227	1320	1415	1514	1612	1701	1750	1789
9	3345-	3669-	4050-	4410-	4769-	5229-	5618-	6019-	6171-	6582-	7055-	7464-	7806-	8089-
10	6317-	6702-	14935-	7576-	7960-	16279-	8938-	9416-	17442-	10124-	10669-	18988-	11530-	21736

SUM NET BENEFIT STREAM IS NEGATIVE. NO FURTHER CALCULATION THIS COMPARISON.

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W7 AND W6

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	246	497	723	988	1231	1278
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	18-	15-	12-	6-	0	0
3	INCR RD CNSTRCTION CST	104F	7100	0	22400	22400	102700	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	0	2236-	2236-	9181-	2236-	1859-	7308
5	TOTAL INCRMTL COSTS	104F	7100	0	22400	22400	102700	2008-	1754-	8470-	1254-	628-	8586
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	1595	2316	2924	3696	4398	4565
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	183	183	176	172	175	223
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	35-	28-	21-	5-	7	8
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	1743	2471	3079	3863	4580	4796
10	TOT NET BENEFITS (9 - 5)	104F	7100-	0	22400-	22400-	102700-	3751	4225	11549	5117	5208	3790-

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	1315	1360	1392	1451	1504	1539	1601	1636	1690	1747	1783	1826	1895	1930
2	0	2	3	2	4	5	7	9	9	10	10	12	12	16
3	0	0	0	0	0	0	0	0	0	0	0	0	0	30900-
4	2236-	2236-	9181-	1859-	2236-	7308	2236-	2236-	8804-	2236-	2236-	7308	2236-	1859-
5	921-	874-	7786-	406-	728-	8852	628-	591-	7105-	479-	443-	9146	329-	30813-
6	4694	4886	4932	5074	5285	5324	5585	5659	5829	5962	6042	6246	6373	6516
7	223	227	228	233	233	234	212	212	246	246	262	262	247	263
8	8	13	16	14	20	22	26	30	30	34	33	37	39	47
9	4925	5126	5176	5321	5538	5580	5823	5901	6105	6242	6337	6545	6659	6826
10	5846	6000	12962	5727	6266	3272-	6451	6492	13210	6721	6780	2601-	6988	37639

SUM NET BENEFIT STREAM IS NEGATIVE. NO FURTHER CALCULATION THIS COMPARISON.

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W2 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	4721	8458	11976	15364	19016	19025
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	10846-	10633-	10358-	10226-	10044-	10099-
3	INCR RD CNSTRCTION CST	104F	10300	41800	290200	163800	29500	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	4304	9572	25945	29609	9572	25945	29609
5	TOTAL INCRMTL COSTS	104F	10300	41800	290200	163800	33804	3447	23770	31227	14710	34917	38535
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	66717	81957	94836	107449	119272	103846
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	14615	14615	14932	15761	15974	16505
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	7683-	6839-	5959-	5256-	4503-	4083-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	73649	89633	103809	117954	130743	116268
10	TOT NET BENEFITS (9 - 5)	104F	10300-	41800-	290200-	163800-	33804-	70202	65863	72582	103244	95826	77733
11	PW NET BENEFITS I=10*	104F	9363-	34545-	218031-	111877-	20989-	39627	33798	33860	43785	36945	27244

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	19569	20117	20658	21202	21743	22261	22779	23331	23887	24430	24969	25578	26129	26681
2	10103-	10104-	10108-	10103-	10484-	10478-	10479-	10475-	10477-	10470-	10468-	10464-	10460-	10454-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	107100-
4	9572	25945	29609	9572	25945	29609	9572	25945	29609	9572	25945	29609	9572	25945
5	19038	35958	40159	29671	37204	41392	21872	38801	43019	23532	40446	44723	25241	64928-
6	104453	105048	105593	106136	106643	107072	107565	108068	108385	108813	109152	109571	109920	110240
7	16505	16714	16895	18336	18336	18464	18792	18792	20221	20221	20422	20422	21595	21913
8	3992-	3895-	3802-	3693-	3713-	3600-	3492-	3379-	3272-	3150-	3036-	2919-	2800-	2675-
9	116966	117867	118686	120779	121266	121936	122865	123481	125334	125884	126538	127074	128715	129478
10	97928	81909	76527	100108	84062	80544	100993	84680	82315	102352	86092	82351	103474	194406
11	31202	23726	20678	23965	18294	15935	18164	13845	12235	13830	10576	9196	10505	17942

60554	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
6671	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
531402	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
591956	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.11	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1171

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W3 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	6509	11981	17272	22485	28003	28115
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	11482-	11253-	10952-	10783-	10554-	10786-
3	INCR RD CNSTRCTION CST	104F	15600	102100	387600	188200	29500	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	1609	6877	14876	26914	7331	34770	26914
5	TOTAL INCRMTL COSTS	104F	15600	102100	387600	188200	31109	1904	15604	33234	19033	52219	44243
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	78891	99350	117943	136440	154331	140438
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	15325	15325	15685	16510	16748	17290
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	8266-	7349-	6375-	5557-	4676-	4552-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	85950	107326	127253	147393	166403	153176
10	TOT NET BENEFITS (9 - 5)	104F	15600-	102100-	387600-	188200-	31109-	84046	91722	94019	128360	114184	108933
11	PW NET BENEFITS I=10*	104F	14181-	84380-	291209-	128543-	19316-	47441	47067	43860	54437	44022	38180

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	28841	29569	30275	31004	31721	32431	33136	33874	34648	35375	36089	36813	37539	38263
2	10798-	10800-	10810-	10814-	11187-	11188-	11197-	11195-	11205-	11204-	11209-	11207-	11211-	11211-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	144600-
4	6877	14876	27369	6877	34770	26914	6877	15331	26914	6877	34770	26914	7331	14876
5	24920	33645	46834	27067	55304	48157	28816	38010	50357	31048	59650	52520	33659	102673-
6	141611	142707	143770	144823	145837	146849	147868	148867	149713	150719	151608	152528	153394	154245
7	17290	17525	17727	19202	19202	19335	19730	19730	21191	21191	21403	21403	22626	22982
8	4466-	4363-	4274-	4174-	4202-	4092-	3992-	3875-	3774-	3656-	3547-	3425-	3310-	3190-
9	154435	155849	157223	159851	160837	162092	163606	164722	167130	168254	169464	170506	172710	174037
10	129515	122224	110389	132784	105533	113935	134790	126712	116773	137206	109814	117986	139051	276709
11	41267	35404	29068	31787	22967	22541	24243	20718	17357	18540	13490	13176	14117	25539

67600	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
7447	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
694202	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
761802	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.10	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1140

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W4 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	9440	17785	25987	34205	42807	43105
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	11995-	11732-	11378-	11141-	10832-	11124-
3	INCR RD CNSTRCTION CST	104F	15600	113400	604300	253600	56800	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	396-	1353	3123	10463	2146	38409	36409
5	TOTAL INCRMTL COSTS	104F	15600	113400	604300	253600	56404	1202-	9176	25072	25210	70383	68390
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	95373	124227	151307	178788	205878	193286
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	16041	16041	16407	17309	17560	18103
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	8732-	7706-	6592-	5604-	4525-	4487-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	102682	132562	161122	190493	218913	206902
10	TOT NET BENEFITS (9 - 5)	104F	15600-	113400-	604300-	253600-	56404-	103884	123386	136050	165283	148530	138512
11	PW NET BENEFITS I=10*	104F	14181-	93719-	454019-	173212-	35022-	58639	63316	63468	70096	57264	48547

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	44189	45267	46372	47476	48537	49574	50620	51690	52756	53816	54875	55950	57010	58084
2	11157-	11184-	11223-	11252-	11671-	11703-	11740-	11763-	11776-	11776-	11784-	11784-	11790-	11793-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	209600-
4	1353	3123	11256	1946	37815	36409	1353	3916	11056	1353	37815	36409	2146	3716
5	34385	37206	46405	38170	74681	74280	40233	43843	52036	43393	80906	80575	47366	159593-
6	195584	197917	200177	202374	204649	206833	209097	211260	213129	215058	216981	218957	220740	222572
7	18103	18338	18532	20120	20120	20257	20656	20656	22205	22205	22413	22413	23727	24067
8	4436-	4377-	4334-	4277-	4390-	4332-	4280-	4204-	4101-	3978-	3865-	3740-	3622-	3498-
9	219251	211872	214335	218217	220379	222758	225473	227712	231233	233285	235529	237630	240845	243141
10	174866	174672	167970	180047	145698	148478	185240	183869	179197	189892	154623	157055	193479	402734
11	55717	50596	44221	43101	31708	29375	33317	30064	26636	25660	18994	17539	19643	37170

54927 PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
6051 ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
958737 PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1013665 PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.06 BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1078

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - WS AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	10532	19955	29282	38681	48507	48886
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	14085-	13942-	13697-	13566-	13353-	13756-
3	INCR RD CNSTRCTION CST	104F	18400	147600	658300	267700	57200	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	205	1954	2709	11064	3917	18100	37010
5	TOTAL INCRMTL COSTS	104F	18400	147600	658300	267700	57405	1599-	8722	26649	29032	53254	72140
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	108887	141609	172632	204377	235928	223897
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	18493	18493	19000	19913	20261	20842
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	10773-	9809-	8742-	7786-	6722-	6788-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	116607	150293	182890	216504	249467	237951
10	TOT NET BENEFITS (9 - 5)	104F	18400-	147600-	658300-	267700-	57405-	118206	141571	156241	187472	196213	165811
11	PW NET BENEFITS I=10*	104F	16727-	121983-	494590-	182842-	35644-	66724	72648	72887	79506	75648	58115

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	50053	51287	52475	53643	54807	55943	57091	58254	59422	60590	61748	62916	64086	65254
2	13812-	13865-	13922-	13974-	14507-	14557-	14619-	14677-	14741-	14796-	14861-	14913-	14948-	14984-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	229900-
4	58794	2709	13026	2547	17507	37010	1954	4672	68497	1954	17507	37010	3917	3302
5	95035	40131	51579	42216	57807	78396	44426	48249	113178	47748	64394	85013	53055	176328-
6	226570	229221	231833	234525	237103	239685	242304	244875	247356	249901	252434	254930	257184	259368
7	21842	21169	21435	23122	23122	23291	23847	23847	25533	25533	25852	25857	27296	27794
8	6755-	6721-	6689-	6671-	6832-	6783-	6751-	6717-	6686-	6642-	6614-	6560-	6467-	6375-
9	248657	243889	246579	250196	253393	256193	259400	262005	266203	268792	271672	274222	278013	280787
10	145622	203558	195000	208780	195586	177797	214974	213756	153025	221044	207278	189209	224958	457115
11	46399	58963	51349	49980	42565	35176	38665	34950	22746	29869	25463	21130	22839	42190

96034	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
10579	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1065277	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1161311	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.09	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1109

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W6 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	12278	23419	34522	45771	57513	58079
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	15830-	15904-	15655-	15628-	15506-	15997-
3	INCR RD CNSTRCTION CST	104F	18400	155700	774000	330800	83400	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	652	3185	3185	10971	6017	5303	10971
5	TOTAL INCRMTL COSTS	104F	18400	155700	774000	330800	84052	367-	10300	29838	36160	47310	53053
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	117844	155779	192434	229942	267716	256291
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	20874	20874	21395	22568	22909	23485
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	12484-	11591-	10561-	9644-	8594-	8734-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	126234	165062	203268	242866	282031	271042
10	TOT NET BENEFITS (9 - 5)	104F	18400-	155700-	774000-	330800-	84052-	126601	154262	173430	206706	234721	217989
11	PW NET BENEFITS I=10*	104F	16727-	128677-	581517-	225941-	52189-	71463	79160	80906	87663	90495	76403

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	59454	60813	62164	63515	64871	66199	67523	68882	70240	71587	72938	74299	75644	77006
2	16070-	16139-	16215-	16292-	16924-	16994-	17076-	17150-	17233-	17309-	17391-	17469-	17552-	17636-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	272500-
4	102305	77315	13503	5303	3185	10971	3185	6017	112209	77315	3185	10971	6017	5303
5	145689	121989	59752	52536	51132	60176	53632	57749	165216	131593	58732	67801	64109	207827-
6	259529	262740	265949	269145	272275	275464	276533	281715	284788	287883	290960	294034	297075	300085
7	23485	23933	24073	24169	26169	26339	26883	26883	28844	28844	29157	29157	30865	31376
8	8712-	8688-	8670-	8639-	8911-	8879-	8860-	8834-	8816-	8790-	8768-	8743-	8722-	8703-
9	274302	277685	281352	286675	289533	292924	296556	299764	304816	307937	311349	314448	319218	322758
10	128613	155896	221600	234139	238401	232748	242924	242015	139600	176344	252617	246647	255109	530585
11	40980	45157	56354	56051	51883	46048	43692	39571	20750	23829	31033	27545	25900	48971

49802	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
4495	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1273121	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1313930	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
1.03	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.1046

KAYES-NIORO ROAD NETWORK
VALUE ADDED ANALYSIS
CASE: NO AGRICULTURAL INVESTMENT

COMPARISON BETWEEN ALTERNATIVES - W7 AND STATUS QUO

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	INCRMTL AGRI PROD COST	104F	0	0	0	0	0	12524	23916	35245	46759	58745	59358
2	INCR AGRI TRANSPO COST	104F	0	0	0	0	0	15848-	15820-	15668-	15634-	15506-	15997-
3	INCR RD CNSTRCTION CST	104F	25500	155700	796400	353200	186100	0	0	0	0	0	0
4	INCR RD MAINTNANCE CST	104F	0	0	0	0	652	949	949	1790	3781	3444	18279
5	TOTAL INCRMTL COSTS	104F	25500	155700	796400	353200	186752	2375-	9045	21367	34906	46683	61640
6	INCRMTL AGRI PROD VALUE	104F	0	0	0	0	0	119439	158096	195359	233638	272114	260856
7	INCR NON AGRI VEH SAVING	104F	0	0	0	0	0	21057	21057	21571	22741	23085	23708
8	INCR AGRI TRANSPO REVENU	104F	0	0	0	0	0	12519-	11619-	10582-	9650-	8587-	8726-
9	TOT INCR REVENUE/SAVINGS	104F	0	0	0	0	0	127977	167534	206348	246729	286612	275838
10	TOT NET BENEFITS (9 - 5)	104F	25500-	155700-	796400-	353200-	186752-	130352	158489	184981	211823	239929	214198
11	PW NET BENEFITS I=10*	104F	23181-	128677-	598347-	241240-	115958-	73580	81330	86295	89833	92503	75075

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	60769	62174	63557	64966	66376	67738	69124	70518	71930	73334	74722	76126	77540	78936
2	16070-	16137-	16212-	16280-	16919-	16989-	17068-	17141-	17224-	17299-	17380-	17457-	17540-	17620-
3	0	0	0	0	0	0	0	0	0	0	0	0	0	303400-
4	130069	75079	4622	3444	949	18279	949	3781	103405	75079	949	18279	3781	3444
5	144768	121116	51967	52130	50406	69028	53005	57158	158111	131114	58291	76948	63781	238640-
6	264224	267626	270882	274219	277560	280789	284118	287374	290617	293846	297003	300281	303448	306602
7	23708	24040	24302	26402	26402	26574	27096	27096	29091	29091	29419	29419	31112	31640
8	8704-	8674-	8654-	8624-	8890-	8857-	8833-	8803-	8786-	8755-	8734-	8706-	8683-	8656-
9	279228	283912	286530	291997	295072	298506	302381	305667	310922	314182	317688	320994	325877	329586
10	134460	161896	234563	239867	244666	229478	249376	248509	152811	183068	259397	244046	262096	568226
11	42843	46895	61767	57422	53246	45401	44852	40633	22714	24738	31866	27254	26609	52445

30096-	PRESENT WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
3315-	ANNUALIZED WORTH OF TOTAL NET BENEFITS, I = 10% (10,000 MF)
1367383	PRESENT WORTH OF TOTAL INCREMENTAL COSTS, I = 10% (10,000 MF)
1337287	PRESENT WORTH OF TOTAL INCREMENTAL REVENUE/SAVINGS, I = 10% (10,000 MF)
.98	BENEFIT/COST RATIO, I = 10%

INTERNAL RATE OF RETURN = 0.0984