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U.S. INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT

FINAL REPORT

FEASIBILITY STUDY OF THE KAYES-NIORO DU SAHEL ROAD

SEPTEMBER 1980

TAMS
TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORK BAMAKO

VOLUME I

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SUMMARY

GOALS AND OBJECTIVES

The overall project goals are to overcome deficit and subsistence agriculture in the northern part of Mali's First Region and to foster the economic well being and quality of life of the rural population. The project has been defined to achieve this goal by providing improved road access to an area long cut off from the urban and marketing centers of the remainder of Mali and by creating the type of access essential to the implementation of ongoing and planned development projects.

The objective of this study, as stated in the Terms of Reference, was to evaluate the feasibility of constructing an all-weather road, approximately 250 kilometers in length, between Kayes and Nioro du Sahel in the northwestern part of the First Region.

To further the project's overall goals of regional development in the area, additional access needs and development potential were examined. Within this context, a branch road (68 km) providing access to Yelimané was investigated and an agricultural project component was conceptually identified. Furthermore, special bridge studies were carried out in order to address the problem of the isolation of Kayes from its hinterland.

THE KAYES-NIORO ROAD AND ITS REGION

The existing Kayes-Nioro road, including a branch to Yelimané, is located in Mali's First Region, the northwest section of the country bordered to the north by Mauritania, to the west by Senegal, and to the south by Guinea. The road between Kayes and Nioro (National Route 1), and its branch to Yelimané (Regional Route 5), provide the principal means of access between the northern undeveloped region and the administrative and marketing center of the First Region, Kayes. Although variable in quality, the route is poorly maintained and is impassable or extremely difficult to travel during the rainy season. The combination of commercial traffic use and uncontrolled drainage has damaged the road to such an extent that in some sections it is virtually non-existent, except as a cleared path or a series of paths.

The service area of the road is rural, poor and "enclavé" or essentially cut off from the modern sector of the economy, both by access and by tradition. A USAID concepts paper about the transport sector in the Sahel identified the Kayes-Nioro road rehabilitation as representative of the type of intervention which can meet "crucial" access needs necessary for the development of a zone isolated from its marketing centers.

Currently, there are two large scale rural development projects underway in the First Region: one undertaken by the Opération du Développement Intégré de Kaarta (ODIK) and the second, the Kayes-Nord (Guidimaka) Pastoral Area Livestock Development Project. The success of the development projects and the feasibility of improving the Kayes-Nioro road are integrally linked.

THE ANALYSIS

The analytical process upon which this study is based consists of: first, the identification of all reasonable alternatives, second, the

evaluation of said alternatives in accordance with established criteria, and third, the selection of two optimum alternatives, one for each of two investment options.

The analysis included engineering, economic/financial, social/environmental and project implementation aspects. The Kaarta and Kayes-Nord studies were used extensively, after review, as a data base.

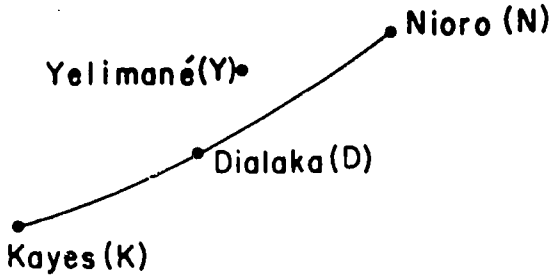
The Alternatives

Two alternative corridors were studied: (1) a northern corridor connecting Kayes with Nioro via Dialaka and Yélimané, and (2) a southern corridor linking Nioro with Kayes via Dialaka and Sandaré. The southern corridor was selected for improvement, as an investment option for later evaluation.

The study of alternative corridors revealed that one of the road sections (Dialaka to Yélimané), belonging to the discarded corridor, if improved in conjunction with an added agricultural investment in its area of influence, could make a significant contribution to the development potential of the First Region. Therefore, a second investment option was identified consisting of the improvement of the southern corridor, (Kayes-Nioro Road proper), the road section to Yélimané and an added agricultural investment.

Alternative road construction technologies were assessed. For technical and economic reasons, equipment-based construction methods were found to be more feasible than labor-based technologies.

Seven road improvement alternatives were identified for study. These alternatives represent three different road design standards (double surface treatment, laterite/gravel surface, and minimum cost) for the three road sections into which the road network was subdivided for analytical purposes. These alternatives are schematically presented in the diagram given below.



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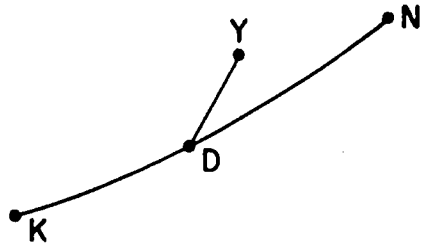

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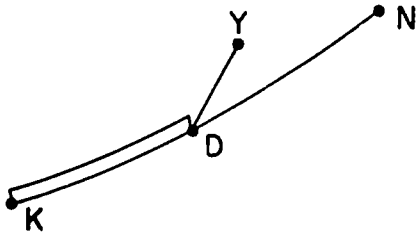

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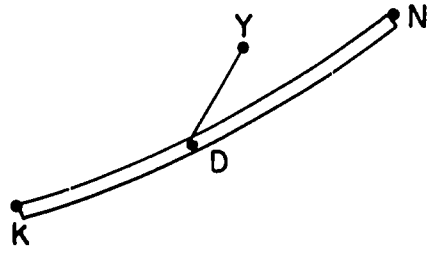

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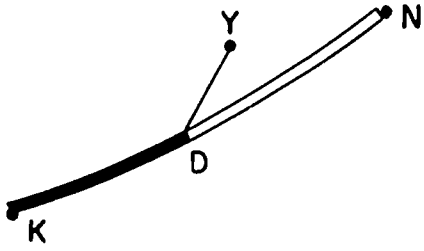

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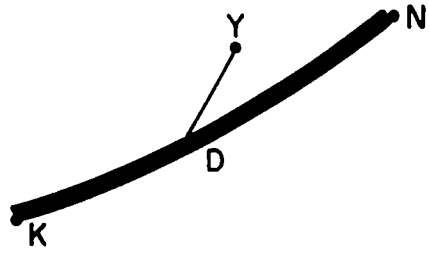

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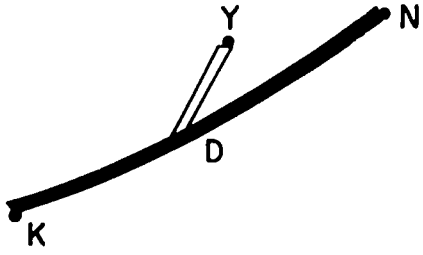

ALTERNATIVE 7 /
VARIANTE

LEGEND / *LEGENDE*

MINIMUM COST/*COUT MINIMUM*

LATERITE/GRAVEL/*LATERITE/GRAVIER*

PAVED (DBST)/*SURFACAGE RENFORCE*

TAMS

SCHEMATIC ILLUSTRATION OF ALTERNATIVE LEVELS OF ROAD DEVELOPMENTS/
ILLUSTRATION SCHEMATIQUE DES VARIANTES D'AMELIORATION DE LA ROUTE

The Evaluation

The Terms of Reference identified four decision-making disciplines to assess the feasibility of the project: Engineering, Economics, Sociology and Environmental planning. The study addressed the road improvement alternatives from the standpoint of each discipline.

The criteria of providing all-weather access guided the resolution of appropriate road design standards and road alignment, including drainage and bridges. Road maintenance needs, for the Kayes-Nioro road network, as well as for the entire First Region, were studied and maintenance methods were devised in conjunction with ongoing planning for a countrywide maintenance program. Two alternative implementation packages, one for each investment option and offering the flexibility of simultaneous construction and of joint financing with other international donor agencies, were prepared for all alternatives. For that purpose, the road network was subdivided into a maximum of four sections. Both alternative implementation programs combine the use of force account and contractor construction, as equipment acquisition for force account work will help in providing additional road maintenance capabilities.

A value added approach was adopted as the basis for the economic analysis. It combines an evaluation of the transport sector with those sectors of the regional economy which are impacted by road improvements. The approach offers a comprehensive framework within which committed rural development programs, as well as additional development investments, can be incorporated. This approach is particularly appropriate inasmuch as the Kayes-Nioro road network, if constructed, would dramatically improve regional economic conditions. By contrast, simpler road user savings approaches would have accounted for only a portion of the generated benefits. The results of the economic analysis have demonstrated conclusively the validity of this choice.

A deterministic simulation model was developed specifically for this study to jointly assess construction investment and recurrent maintenance costs versus the generated regional net agricultural value added. Furthermore, this model of the region's agricultural and transport sectors was computerized to handle the many computations required in the value added analysis.

A social soundness analysis, carried out to study the social feasibility of the road, analyzed social impacts, spread effects and benefit incidence. This component of the study examined the effects of road improvement on the regional social system, and those factors which car enhance or constrain the diffusion of benefits generated by development projects.

The overall environmental feasibility of the project road was studied by carrying out an environmental assessment of short and long-term environmental impacts and by investigating the relationships of the road network to land use and resources.

The Selection

The economic analysis was used to select two optimum road improvement alternatives, one for each of two investment options: (A) multi-sectoral investment in an overall road network and in agricultural development as well, and (B) investment in the Kayes-Nioro road alone. The criterion utilized to make the selection was the maximization of regional income within the context of a national economy.

The two selected optimum road improvement alternatives were tested for a range of possible future conditions. For investment option A, the selected optimum road improvement alternative was not found to be sensitive to the range of possible future conditions which were considered. For investment option B, the selected optimum road improvement alternative was found to be sensitive to the level of road maintenance and to the degree with which the population of the area will respond to the economic incentive of reduced transportation costs. For this investment option, road maintenance is a critical issue which needs to be resolved.

The social soundness analysis and environmental assessment were carried out independent of the economic evaluation. In general, both studies indicated that socio-environmental impacts do not differ markedly among alternatives, although higher levels of road improvements could have marginally greater positive impacts. Therefore, it is preferable, from a socio-environmental point of view, to select a higher level of road improvement.

The environmental and social analyses reinforce the conclusions reached in the economic analysis. Thus, for either of the two investment options the decision matrix for selecting the best alternative becomes a one alternative vector, the parameters of which are the impacts of the optimum alternative for that investment option being considered.

TWO RECOMMENDED PROJECT OPTIONS

Project Option A

The different aspects of this recommended project option A are summarized in Table A, attached hereto.

The recommended road network is estimated to cost 11,493 million MF (1979 prices) and consists of: (1) a double surface treated road between Kayes and Dialaka to be completed by March 1984 using contractor construction, (2) a minimum cost road between Dialaka and Yelimané to be completed by December 1984 using force account construction, (3) a laterite/gravel surfaced road between Dialaka and Sandaré to be completed by December 1985 using contractor construction, and (4) a laterite/gravel surfaced road between Sandaré and Nioro to be completed by May 1985 using contractor construction. Road design and supervision of construction by GRM will be reinforced by a proposed technical assistance program.

The recommended agricultural development, targeted to the Yelimané-Ségala areas, is estimated to cost 1,250 million MF (1979 prices). A Kaarta type development strategy is proposed. Also, this project component will

TABLE A

RECOMMENDED PROJECT OPTION A

KAYES-NIORO ROAD, YELIMANE BRANCH AND AGRICULTURAL DEVELOPMENT

PROJECT COMPONENT	DESIGN STANDARDS	MAGNITUDE	DESIGN PROCEDURE	IMPLEMENTATION	DATE OF COMPLETION	COST (Million MF, 1979)
THE KAYES-NIORO ROAD						
Kayes-Dialaka	Double surface treatment, 7 meter platform, 5 meter surfacing	82 km	GRM in-house with Technical assistance	Contractor by International bidding	March 1984	3,863
Dialaka-Yelimané	Minimum cost, 5.5 meter platform	68 km	GRM in-house with Technical assistance	Force account with equipment acquisition	Dec. 1984	1,683
Dialaka-Sandaré**	Laterite/gravel surface, 7 meter platform	61 km	GRM in-house with Technical assistance	Contractor by International bidding	Dec. 1983	2,954
Sandaré-Nioro**	Laterite/gravel surface, 7 meter platform	107 km	GRM in-house with Technical assistance	Contractor by International bidding	May 1985	2,993
						11,493
THE AGRICULTURAL COMPONENT						
Dialaka-Ségala area	Kaarta type strategy for introduction of improved production technology	10,000 ha	Funding Agency	GRM in-house with Technical assistance	Dec. 1984	1,250
TOTAL FOR PROJECT	n.a.*	318 km and 10,000 ha	n.a.*	n.a.*	May 1985	12,743

* n.a., not applicable

** The Dialaka-Sandaré and Sandaré-Nioro sections were combined, in the economic analysis, into one section.

require further study by interested donor agencies. The proposed funding for agricultural development will be completed by December 1981, at which time the agricultural program will become self-sufficient. A technical assistance program to CRM is proposed for the implementation phase.

The total project costs are estimated at 12,743 million MF (1979 prices). In current prices (ten percent per annum inflation), the project cost is estimated at 18,985.5 million MF, of which close to 30 percent is in local currency.

Project Option B

The different aspects of this recommended project option B are summarized in Table B, attached hereto.

The recommended improvements to the Kayes-Nioro road are estimated to cost 9,810 million MF (1979 prices) and consist of: (1) a double surface treated road between Kayes and Dialaka to be completed by the end of 1984 using contractor construction, (2) a laterite/gravel surfaced road between Dialaka and Sandaré to be completed by February 1985 using force account construction, and (3) a laterite/gravel surfaced road between Sandaré and Nioro to be completed by the end of 1984 using contractor construction. Road design will be entrusted to an A/E consulting firm.

Total project costs, in current prices, are estimated at 14,670 million MF, of which close to 23 percent is in local currency.

Project Impacts

Recommended project option A has an internal rate of return of 16.4 percent and a net present value, i.e., the discounted value of the difference between total benefits and total costs, at a ten percent opportunity cost of capital, of 7,261 million MF. Project option B has an internal rate of return of 13.0 percent and a net present value of 2,288 million MF, at a 10 percent opportunity cost of capital. The feasibility of

TABLE B

RECOMMENDED PROJECT OPTION B

KAYES-NIORO ROAD

PROJECT COMPONENT	DESIGN STANDARDS	MAGNITUDE	DESIGN PROCEDURE	IMPLEMENTATION	DATE OF COMPLETION	COST (Million MF, 1979)
Kayes-Dialaka	Double surface treatment, 7 meter platform, 5 meter surfacing	82 km	A/E Consultant	Contractor by International bidding	December 1984	3,863
Dialaka-Sandaré*	Laterite/gravel surface, 7 meter platform	61 km	A/E Consultant	Force account with equipment acquisition**	February 1985	2,954
Sandaré-Nioro*	Laterite/gravel surface, 7 meter platform	107 km	A/E Consultant	Contractor by International bidding	December 1984	2,993
TOTAL FOR PROJECT	n.a.***	250 km	One A/E Consultant	One or several Contractors	February 1985	9,810

* The Dialaka-Sandaré and Sandaré-Nioro sections were combined, in the economic analysis, into one section.

** The Dialaka-Sandaré section could also be carried out using contractor construction, provided road maintenance issues in the First Region are resolved independently of this project.

*** n.a.: not applicable

the two selected project options is due mainly to two major factors: (1) the reduction in transport costs, and (2) the spreading of effects, generated by ongoing development projects; the latter being the more significant.

The two selected project options will significantly improve many of the conditions prevalent in the northern part of the First Region of Mali. These major changes are:

- Transport costs will be reduced to about one-third of present costs, for either project options;

- Due to road improvements, about twenty percent of the rural population (about 35,000 or 40,000 persons, depending on which project option is implemented) will adopt improved agricultural production technology, which the Kaarta project is now introducing and which is appropriate for the additional agricultural investment recommended as part of project option A.

- Net regional agricultural production value will, in constant prices, increase close to fourfold and threefold by the year 1995, for project options A and B respectively. Average per capita income in the region will increase by similar proportions.

- For those farmers who adopt an improved production technology, the per capita income will nearly increase fivefold for either project option.

- Increased accessibility of the region will generate beneficial impacts, from the social point of view, and will create additional options for the population without requiring marked changes in existing ways of life; and

- Short-term negative environmental impacts can be mitigated by proper road construction planning. Improved access may exacerbate unauthorized commercial wood cutting. This effect could be mitigated by the introduction of a reforestation program and assistance in enforcement of the existing forestry code.

In conclusion, the two project options offer significant economic benefits at an attractive rate of return, have neither unmitigatable environmental impacts nor adverse social effects, and permit the realization of significant social benefits.

FEASIBILITY STUDY

OF THE

KAYES-NIORO DU SAHEL ROAD

VOLUME I - REPORT

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CHAPTER 1

CHAPTER 1
INTRODUCTION

1.1 GOALS AND OBJECTIVES

The objective of this study is to prepare a comprehensive evaluation of the feasibility of constructing an all-weather road network approximately 318 kilometers in length, between Kayes and Nioro du Sahel and between Dialaka and Yélimané in the northwestern part of the First Region of the Republic of Mali. The analysis included engineering, economic/financial, socio-environmental and project implementation aspects.

The overall project goals are to overcome deficit and subsistence agriculture in the northern part of Mali's First Region and to foster the economic well being and quality of life of the rural population. The project has been defined to achieve this goal by providing improved road access to an area long cut off from the urban and marketing centers of the remainder of Mali and by creating the type of access essential to the implementation of ongoing and planned development projects.

The intended beneficiaries of the project are low income herders and small farmers, target populations for ongoing development schemes in the area, to whom the road will provide access for marketing, health care, education and extension services.

To further the goals of regional development in the area, overall access needs and development potential were identified. Within this context, a branch road (68 km) which could provide access to

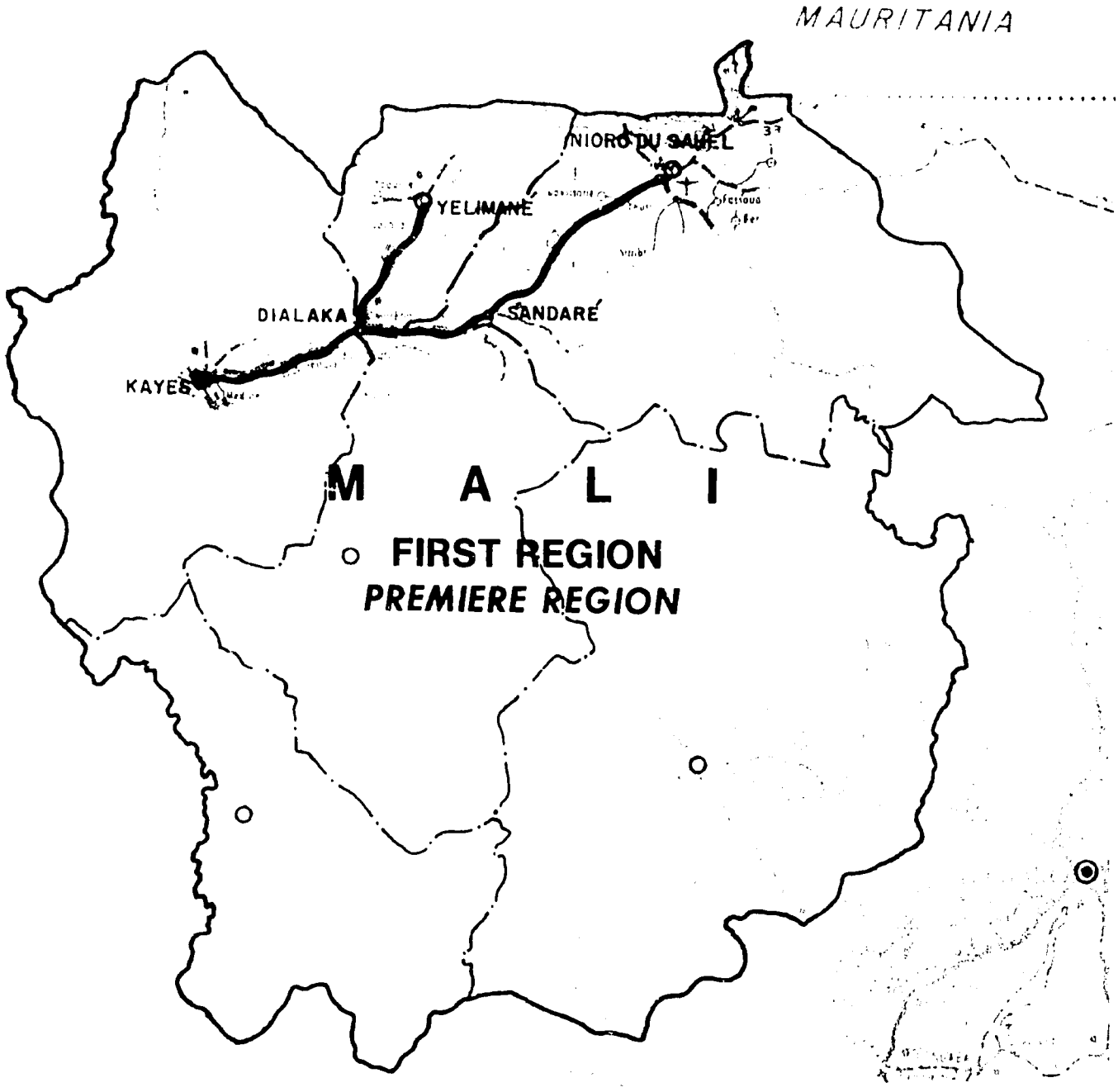
Yélimané is included in the study. In addition, an agricultural project component is conceptually identified to foster the economic development in the area around Yélimané. Furthermore, special bridge studies were carried out to reduce the isolation of Kayes from its hinterland.

1.2 PROJECT BACKGROUND

The existing Kayes-Nioro road, including its branch to Yélimané, is located in Mali's First Region, the northwest section of the country bordered to the north by Mauritania, to the west by Sénégal, and to the south by Guinea (Figure 1.1). The road between Kayes and Nioro (National Route 1) was built under French colonial administration prior to World War II. The branch to Yélimané (Regional Route 5) was built to lower standards at about the same period.

The road begins on the right bank of the Sénégal River, at Kayes N'di, across the river from the center of Kayes. A ferry and an Irish bridge currently provide passage across the Sénégal. The route provides the principal means of access between the northern undeveloped region and the administrative and marketing center of the First Region, Kayes. Kayes is located on the Dakar-Bamako railroad which presently provides the only overland access between Sénégal and Mali. Furthermore, the Kayes-Nioro road is a link scheduled for inclusion in the anticipated Trans-Sahelian road linking Dakar in the west to Njamena, Chad, in the east.

The service area of the road is rural, poor and "enclavé" or essentially cut off from the modern sector of the economy, both by access and by tradition. Although variable in quality, the route is poorly maintained and is impassable or extremely difficult to travel during the rainy season. The combination of heavy vehicle use and uncontrolled drainage



LEGEND/*LEGENDE*

- Limit of Region/*Limite de Region*
- Limit of Circle/*Limite de Cercle*
- Capital/*Capitale d'Etat*
- Administrative Seat of Region/*Chef-lieu de Region*
- Administrative Seat of Circle/*Chef-lieu de Cercle*
- Zone of Influence/*Zone d'Influence*

TAMS

FIGURE 1 – 1
LOCATION MAP/*CARTE DE SITUATON*

has damaged the road severely and in some sections it is virtually non-existent except as a cleared path, or a series of paths.

The road and the region it serves have been cited as having significant investment potential by foreign donors. A regional transport study, (Bamako-Kayes) conducted in 1975, identified the Kayes-Nioro road segment as important to the future development of the northern part of the region and to the success of proposed development projects in the area (IBRD and UNDP, 1976). The 1977 analysis of assistance requested by Mali from the United Nations Development Program identified the First Region as being among the most isolated in the country (UNDP 1977). The Permanent Interstate Committee for Drought Control in the Sahel (CILSS) and the Club du Sahel, in their diagnostic review of road maintenance in the Sahel, listed the Kayes-Nioro road as in need of rehabilitation (CILSS/Club du Sahel 1978). In a USAID concepts paper regarding the transport sector in the Sahel, in preparation for the CILSS/Club du Sahel meeting on transport in 1978, the Kayes-Nioro road rehabilitation was cited as representative of the type of road which can achieve "crucial" access for a development zone to major marketing centers.

Currently, there are two large scale development projects underway in the First Region: one undertaken by the Opération du Développement Intégré de Kaarta (ODIK) and the second, the Kayes-Nord (Guidimaka) Pastoral Area Livestock Development Project. Canadian International Development Agency (CIDA) funds totaling some U.S.$21 million cover the first five years of the Kaarta program, while the Kayes Nord project is being implemented under a U.S.$15 million agreement with Saudi Arabia. The success of the development projects and the feasibility of the road improvements to the Kayes-Nioro road are integrally related.

1.3 STUDY ELEMENTS

The study, reported on herein, is comprehensive in its scope. The feasibility of the road is addressed from the engineering, economic, socio-environmental and implementation points of view. In addition, the study is integrated with the ongoing rural development projects in the First Region and country-wide road maintenance planning.

The analyses which were carried out are based on available statistics from GRM sources, development studies for the First Region* and from information developed in the following special investigations:

- Soil sampling and testing;
- Origin-Destination surveys;
- Social soundness survey;
- Exchange of views with World Bank staff in Mali;
- Bridge reconnaissance including the area of Kayes; and
- Road reconnaissance

Two separate field trips were undertaken to the study area, the first in July-August and the second in September-October, 1979. During these trips said investigations were carried out and numerous interviews were undertaken.

The study is presented in three volumes; Volume I is the Main Report, Volume II contains the Appendices, and Volume III provides preliminary road plans. In addition, an executive summary volume is provided.

The main report is made up of a Summary and fifteen chapters, and Volume II includes nine appendices, A through I. The appendices are referred to, where appropriate, in the various chapters of the report.

The chapters of the report have been grouped into five parts. These are:

- Overview of the project (Chapters 1 & 2);
- Technical studies (Chapters 3 through 6);

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* Refer to Appendix A for the study bibliography and interviews.

- Economic analysis (Chapters 7 through 11);
- Socio-environmental considerations (Chapters 12 & 13); and
- Overall project evaluation (Chapters 14 & 15).

The overview of the project consists of identifying the goals and objectives of the project and in outlining the background of the study (Chapter 1). In addition, this part of the report covers the study of alternatives (Chapter 2). Therein, a road corridor is selected, the appropriate constructic technology is identified, the potential need for an agricultural componenent in the project is conceptualized and road improvement alternatives are defined for later analysis.

The technical studies cover the subjects of road design, including special bridge studies (Chapter 3), alternative implementation programs (Chapter 4), road construction costs (Chapter 5), and road maintenance (Chapter 6). The preliminary road design is based on a field reconnaissance and available aerial photographs. Implementaion program options are based on a survey of existing practices and consideration of project phasing and joint financing. Furthermore, an implementation program is proposed for the agricultural component of the project. The road construction costs are based on recent bids by European contractors presently active in Mali. In addition, costs for new bridges in the Kayes areas are presented, though not included in the body of the analysis. Road maintenance requirements for the First Region as well as for the project road are identified and related to the proposed Fourth Highway Program of the World Bank.

The economic analysis was carried out using a producer surplus or value-added approach (Chapter 7). Descriptions of existing economic conditions as well as reviews of ongoing development projects are covered (Chapter 8). Unit impacts of road improvements on transport costs and tariffs are defined (Chapter 9). In order to facilitate the numerous computations involved in such an economic analysis, a comprehensive model was devised and computerized to evaluate the total economic impact of the proposed investments upon the agricultural

and transport sectors. Furthermore, an agricultural component is defined and the impact of road improvements on the livestock sector is addressed (Chapter 10). The impact of the alternative road improvements upon all affected sectors in the region is assessed and projected, and net increases in national income are estimated for alternative design standards for each of the major road sections of the route. All the costs and revenues without and with all alternative investments, including an agricultural component, are quantified and economic feasibility indices are calculated. The optimum solution is considered to be the road that would maximize national income, taking into account potential administrative, environmental and social constraints (Chapter 11). The broad perspective that is inherent in an approach of this nature links the road with the potential for additional development in the area. The road, when analyzed together with existing and proposed agricultural development projects, provides a comprehensive package that covers all pertinent aspects of development.

The Fourth Part of the report covers the socio-environmental considerations. A social soundness study is carried out on the basis of field interviews, wherein benefit perceptions and social receptivity to economic incentives are addressed (Chapter 12). An environmental assessment is carried out, including the identification of mitigating measures which would insure the environmental viability of the project (Chapter 13).

The final part of the report provides a financial summary of project-costs for two alternative project options (Chapter 14). In addition, the project options are evaluated from a comprehensive view including all study aspects in one overall summary, (Chapter 15).

CHAPTER 2

CHAPTER 2
STUDY OF ALTERNATIVES

The types of alternatives analyzed in the course of this study are:

- The alternative of no road improvement;
- Alternative corridors or routes to serve the northern portion of the First Region;
- Alternative levels of road improvements;
- Alternative technologies of road construction (labor-intensive and capital/equipment-intensive);
- The alternative of additional rural development investments.

Based upon the USAID Project Identification Paper, this study focuses on road access as no alternative to road access exists for rural development of the isolated northern part of the First Region. In addition, the Initial Environmental Examination concluded that no alternative to road access producing similar results could be defined.

2.1 NO ACTION AND STATUS QUO ALTERNATIVES

The no-build or no-action alternative can be strictly defined as doing nothing. This definition implies continued deterioration of the road, given the absence of necessary maintenance, i.e. a decline in the status quo. In contrast, the status quo is defined as maintaining the current

condition of the road and keeping vehicle operating costs constant. This definition implies a larger and more effective maintenance effort than is currently the case.

Investment costs of the no-action alternative are none. However, this alternative leads to a lessening of access opportunities to markets and services than is currently the case because of continued deterioration of the existing road.

Furthermore, the no-action alternative, strictly defined, has no benefit potential and does not satisfy the goals established for the project. The potential social and economic gains to be foregone can be grouped in three categories: (1) no gains stemming from improved access to health and other social services and to marketing centers; (2) no benefits resulting from the road's relationship to development operations in the region, and (3) no increases in agricultural production and agricultural productivity resulting from cheaper transport costs.

In addition, the no-action alternative, by leaving the road in its current state, will imply a negative environmental impact: continued erosion and uncontrolled drainage along the road alignment. The no-action alternative can also have indirect deleterious consequences for the environment. The area's development operations have programs to combat desertification, to introduce range protection practices and to encourage reforestation. To the extent that lack of improved access will affect the success or increase the costs of these efforts, the no-action alternative can contribute to overall regional degradation.

The status quo alternative is similar to the do-nothing alternative, except that it carries with it the costs of increased maintenance in order to guarantee a constant level of transport costs, and hence the same level of accessibility. This alternative is chosen as the reference alternative against which alternative road improvements are compared. This choice was made,

as opposed to the do-nothing alternative, because the comparison between actions relates to a comparison between levels of accessibility which are stable and do not vary with time. Furthermore, the terms of status quo alternative and without improvement alternative are used interchangeably throughout this report.

2.2. ALTERNATIVE CORRIDORS AND ZONES OF INFLUENCE

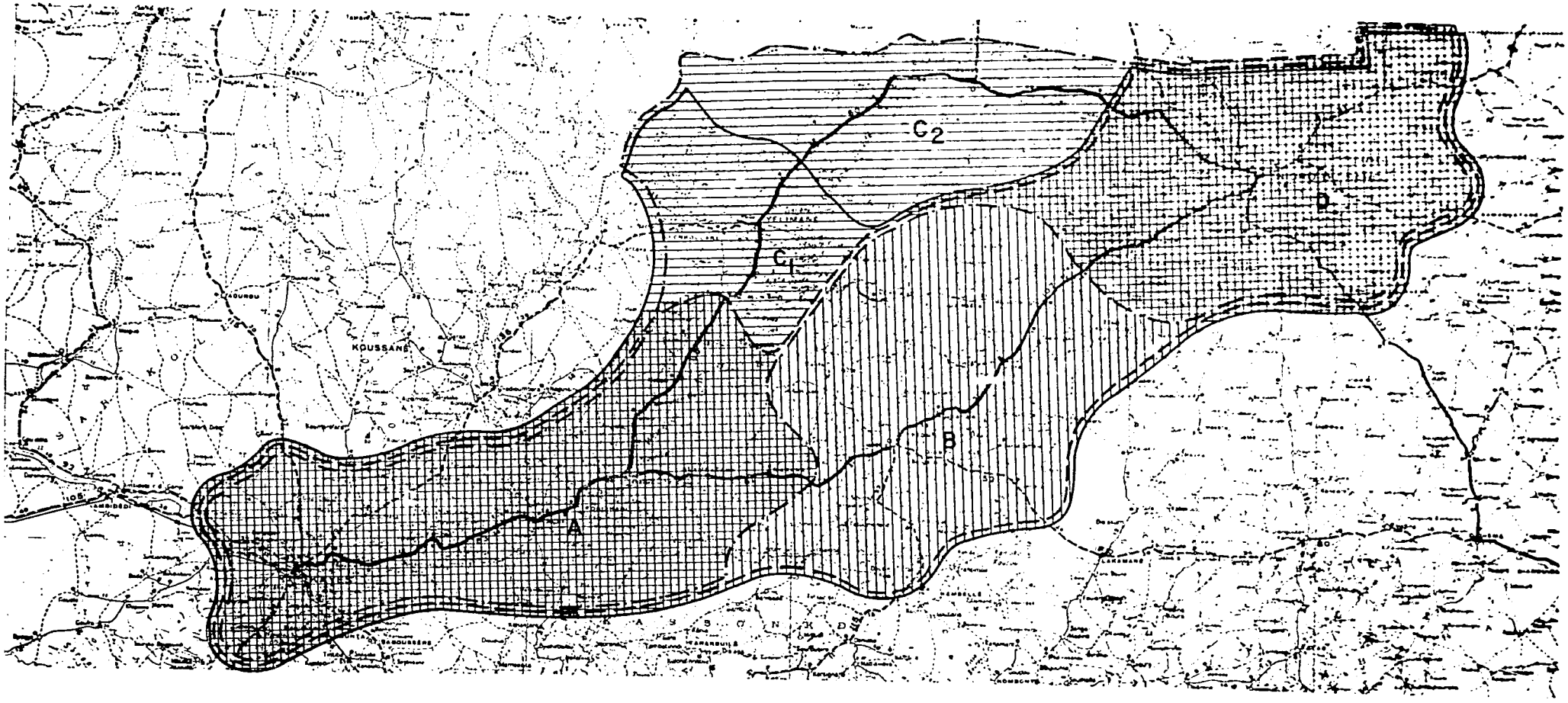
Two corridors were available for preliminary examination, based upon the concept that an improved road in the region should serve existing development projects and utilize existing road alignments. These alternative corridors and their respective zones of influence are shown in Figure 2-1.

The alternative Kayes to Nioro via Sandaré follows National Route 1 from Kayes to Nioro. The alternative Kayes to Nioro via Yélimané follows National Route 1 to Dialaka and Regional Route 5 through Yélimané to Nioro. These two routes are compared in the following sections in terms of their costs and their benefits, i.e. development potential.

The zones of influence for both alternative corridors were defined after two field trips to the regions, extensive interviews in the villages of the area, and a study of the road network and vehicular traffic of the region.

Several criteria were used in delimiting the zones of influence for both alternative corridors. These are as follows:

- The width of the zone of influence should be such that the road is reachable within a day's donkey ride.
- The width of the zone of influence is greater in the proximity of feeder roads, as compared to minor tracks and paths.
- The width of the zone of influence is greater in areas that depend solely on the road.
- The width of the zone of influence is reduced when alternative roads are available.



KAYES – NIORO ROAD VIA SANDARE + BRANCH/*EMBRANCHEMENT YELIMANE*
ZONE OF INFLUENCE/*ZONE D'INFLUENCE* = $A + B + C_1 + D$

KAYES – NIORO ROAD VIA YELIMANE
ZONE OF INFLUENCE/*ZONE D'INFLUENCE* = $A + C_1 + C_2 + D$

KAYES – NIORO ROAD VIA SANDARE
ZONE OF INFLUENCE/*ZONE D'INFLUENCE* = $A + B + D$

TAMS

FIGURE 2 – 1
ZONES OF INFLUENCE OF ALTERNATIVE CORRIDORS
ZONES D'INFLUENCE DES VARIANTES DE TRACE

The above criteria, when applied to the two alternative corridors, result in delimiting zones of influence with an average width of about 25 km on each side of the road. Comparable variations in the width are from 15 to 35 km.

2.2.1 COMPARATIVE COSTS

In order to carry out a cost comparison of the two corridors, a laterite/gravel surfaced road was chosen. This standard is a representative design level for comparison purposes. The section from Kayes to Dialaka is the same for either corridor. For some parts of the Dialaka-Yélimané-Nioro route, topographic maps (1:200,000) were used, rather than field reconnaissance, as the basis of the cost estimates. By correlating the map analyses with known field conditions and information supplied from other sources, however, a reasonable estimate could be made.

The route via Sandaré is distinctly shorter and less expensive than the alternative via Yélimané. Table 2-1 compares the construction costs of the two alternative corridors. The Dialaka-Nioro route via Sandaré is less costly by approximately 36%. Expressed in other terms, the route via Yélimané costs approximately 56% more. The higher cost is a function of the longer length of the Dialaka-Nioro via Yélimané route, the higher cost per kilometer for certain sections and the additional number of bridges and drainage structures which are required. Cost estimates for the Dialaka-Nioro via Yélimané route, however, did not include but a limited number of bridges on major water crossings.

Table 2.1

Comparative Costs of Alternative Corridors
(Laterite/Gravel Surface)

	Length (km)	Unit Cost	Construction Cost (MF x 10^6) 1/
Dialaka-Nioro via Sandaré			
Dialaka-Sandaré	61	38,279 (1,000 MF/km)	2,335
Sandaré-Nioro	107	21,832 "	2,336
TOTAL	168	27,804 "	4,671
Dialaka-Nioro via Yélimané			
Dialaka-Yélimané 2/	68	37,530 (1,000 MF/km)	2,552
Yélimané-Laronguémou 3/	50	37,530 " 4/	1,877
Laronguémou-Nioro 3/	92	27,840 " 5/	2,561
Bridges (5 @ 120m total)	--	2,500 (1,000 MF/meter)	300
TOTAL	210		7,290

1/ Construction costs do not include mobilization, design and supervision.
2/ Length based on calibrated odometer readings during field reconnaissance.
3/ Total length of these sections estimated during prior field reconnaissance by others on the basis of odometer readings. Actual lengths may vary. Road sections beyond Yélimané were not passable at time of field reconnaissances in August and September.
4/ Study of topographic maps indicated that Yélimané-Laranguémou section is similar to Dialaka-Yelimané where costs are based on field reconnaissance.
5/ Average cost per kilometer based on similarity to Dioka-Birou portion of Sandaré-Nioro section and increased by 20% to account for lack of existing pavement and drainage structures.

A sensitivity analysis was performed, showing that if the length of the Yélimané-Nioro segment were reduced by 10 %, cost per kilometer were reduced by 20 % and bridge costs were halved, the route via Yélimané would cost $5,369 \times 10^6$ MF. If, in addition, the cost of the route via Sandaré were increased by 10 % (assuming an underestimation of that route's cost), the route via Sandaré would cost $5,138 \times 10^6$ MF. The route via Sandaré is still cheaper despite highly unlikely conditions.

2.2.2 COMPARATIVE BENEFITS

In order to evaluate comparative benefits, the analysis is carried out on the basis of development potential, the latter being a function of population and economic resources available in the zones of influence of the two alternative corridors. Since each corridor shares some common area of influence, four sub-zones were defined, as illustrated and labeled in Figure 2-1. These four sub-zones can be combined to represent the specific zone of influence for each corridor. The zone of influence for Kayes-Nioro via Sandaré is comprised of sub-zones A, B and D. The zone for Kayes-Nioro via Yélimané is comprised of sub-zones A, C_1, C_2 and D.

The benefit comparisons between the two alternative corridors are made, using said sub-zones, in terms of population affected (an indicator of agricultural potential), numbers of livestock, development programs, and general environmental impacts and overall social soundness.

It is noted herein that benefits from road development do not accrue at a constant rate throughout the width of the zone of influence. These are maximum at the edge of the road and nil at the limit of the zone of influence. In the economic analyses, (Chapter 10) an average impact, applicable to the zone of influence as a whole, is estimated and used.

2.2.2.1 POPULATION

The population served within each corridor is roughly comparable.

The 1976 census of Mali, by arrondissements, provided the basic data for estimates of population. Portions of an arrondissement's population were allocated to the sub-zone according to area within the sub-zone and the location of principal towns. Prevailing growth rates were then applied to estimate the 1980 population. The estimates, shown in Table 2-2, indicate that very little difference exists between the population served by each corridor. The difference of less than 2% is not meaningful, given the method of estimation and the preliminary nature of the census data. This difference would not withstand any significancy test. In terms of population, the difference between the two routes is essentially the trade-off between serving sub-zone B and serving sub-zones C_1 and C_2.

2.2.2.2 LIVESTOCK

The estimated number of livestock within the sub-zones of influence was developed using livestock statistics from documents for development projects operating in the area (ODIK 1979, ITC 1977, OMBEVI 1976). These statistics should be used with caution, since they are indicative only of an order of magnitude.[1/] These estimates, shown in Table 2-3, reveal that approximately 13% more livestock (measured in 1980 UBT's) are present in the Kayes-Nioro via Yélimané corridor than in the Kayes-Nioro via Sandaré corridor. While the Yélimané corridor is farther to the north and may well

1/ The base estimates in the case of the Kaarta project (ODIK 1979, ITC 1977) came from the 1976 livestock census which is believed to underestimate cattle by a factor of 4 and sheep and goats by a factor of 2.5. Planners for Kaarta assumed that reported estimates were equally underestimated throughout the region and applied the factors above to produce a more realistic estimate for Kaarta's plans. The base and method of refinement for statistics of the Kayes-Nord livestock project are not documented in their report, but by comparison with Kaarta, appear to produce realistic estimates. Livestock by arrondissements, in the case of Kaarta statistics, and by development zones, in the case of Kayes-Nord statistics, were then allocated to the zone of influence according to the proportion of an arrondissement or development zone's area that was also contained in the road's sub-zone of influence. Estimated growth rates (3% per year for cattle and 2% per year for sheep and goats) were applied to estimate current livestock numbers.

Table 2.2

Population Served (in thousand)

Subzone	Alternative Corridors: Kayes-Nioro via Sandaré	Alternative Corridors: Kayes-Nioro via Yélimané
A	117.1	117.1
B	38.1	
C_1		17.4
C_2		24.6
D	73.5	73.5
Total	228.7	232.6

Table 2.3

Livestock Herds (in thousand)

	Alternative Corridors: Kayes-Nioro via Sandaré		Alternative Corridors: Kayes-Nioro via Yélimané	
Subzone	Cattle	Sheep & Goats	Cattle	Sheep & Goats
A	48.8	61.1	48.8	61.1
B	25.9	51.1		
C_1			23.0	23.9
C_2			27.6	49.1
D	91.8	176.8	91.8	176.8
Total (1979)	166.5	289.0	191.2	310.9
(1980)	171.4	294.8	196.9	317.1
Total UBT (1980) 1/	166.6		189.2	

1/ Computed using OMBEVI formula: 60% of cattle equal 1 UBT per head; 40% of cattle equal 0.5 UBT per head and one sheep or goat equals 0.10 UBT.

have a greater concentration of livestock, the basis of the estimates is not sufficiently firm to make this difference a very important one. Furthermore, subsequent analysis and field investigations indicated that road improvements have a limited impact on the livestock sector. In addition, it should be noted that Kayes-Nord plans for livestock and range improvement aim at reducing the over-stocking and concentration of cattle in these northern zones. Therefore, the present size of livestock herds is not really indicative of future development potential.

2.2.2.3 EXISTING DEVELOPMENT PROGRAMS

The relationship between an improved road and development projects is intrinsic to the feasibility study. An improved road can be viewed as infrastructure necessary to accelerated and successful development but not in itself sufficient to assure development. The two principal development projects in the area are Operation Mil Kaarta and the Kayes-Nord livestock development project. Roughly, Kaarta is directed to sub-zones B and D and Kayes-Nord to sub-zones A and C. Since either corridor serves both sub-zones A and D, the critical comparison concerns sub-zone B (Kaarta) by contrast with C_1 and C_2 (Kayes-Nord).

With respect to development projects, the choice of corridors rests upon the magnitude of the impact that an improved road will have on serving one or the other of said development projects. Analysis of socio-economic traditions and of the marketing system revealed that an improved road would generate a greater impact on the agricultural sector, but that there were greater constraints to the role that a road could play in affecting livestock production.

The Kaarta project places emphasis on agricultural production, including increases in area cultivated per farm unit and more orientation to cash crops, whereas the Kayes-Nord project stresses livestock development. Operation Vallée du Sénégal, Terakolé - Magui or OVSTM is an agriculturally-oriented project with an area that nearly overlaps that of Kayes-Nord, but

it has not yet concentrated activities in sub-zone C and future plans appear oriented to sub-zone A.

From the point of view of a road's relationship to development projects, the clear choice is the Kayes-Nioro corridor via Sandaré because it better serves ongoing agricultural development programs. The impact (i.e. generated benefits) of said corridor should be greater.

2.2.2.4 SOCIAL SOUNDNESS AND ENVIRONMENTAL CONCERNS

A review of published sources in conjunction with field investigations of the Dialaka-Yelimané segment showed that environmental conditions and thus impacts would not be significantly different, whichever corridor was chosen.

The social feasibility or social soundness of the two alternative corridors are not radically different, with one important exception. The social customs and traditional economic role in which livestock production is enmeshed make changes in livestock management practices especially difficult. From a social point of view, the route via Sandaré would better serve the region as a whole.

2.2.3 SELECTED CORRIDOR AND ZONE OF INFLUENCE

The Kayes-Nioro route via Sandaré appears to be the most appropriate corridor for an improved road, principally because of lower construction costs, lower vehicle operating costs, and its better relationship to the agricultural sector.

The portion of the Yelimané route between Dialaka and Yelimané, however, could be conceived as a branch from the principal Kayes-Nioro route. Such a branch would have the advantage of serving some of the population in the northern area (C_1 sub-zone but not C_2) and of establishing a better link to the Kayes-Nord development project.

Subsequent analyses included the option of this branch in order to determine its marginal feasibility. Its inclusion in the project would permit

the achievement of project goals for the Kayes-Nioro road in a wider area and open up the potential for an expanded network of economic linkages and spread effects.

Figure 2-2 illustrates this expanded zone of influence and the network chosen for study. The zone of influence encompasses 15,600 square kilometers with an estimated total population of 240,000. Detailed descriptions of this zone are presented in Chapters 8, 12 and 13 and in Appendices F and G.

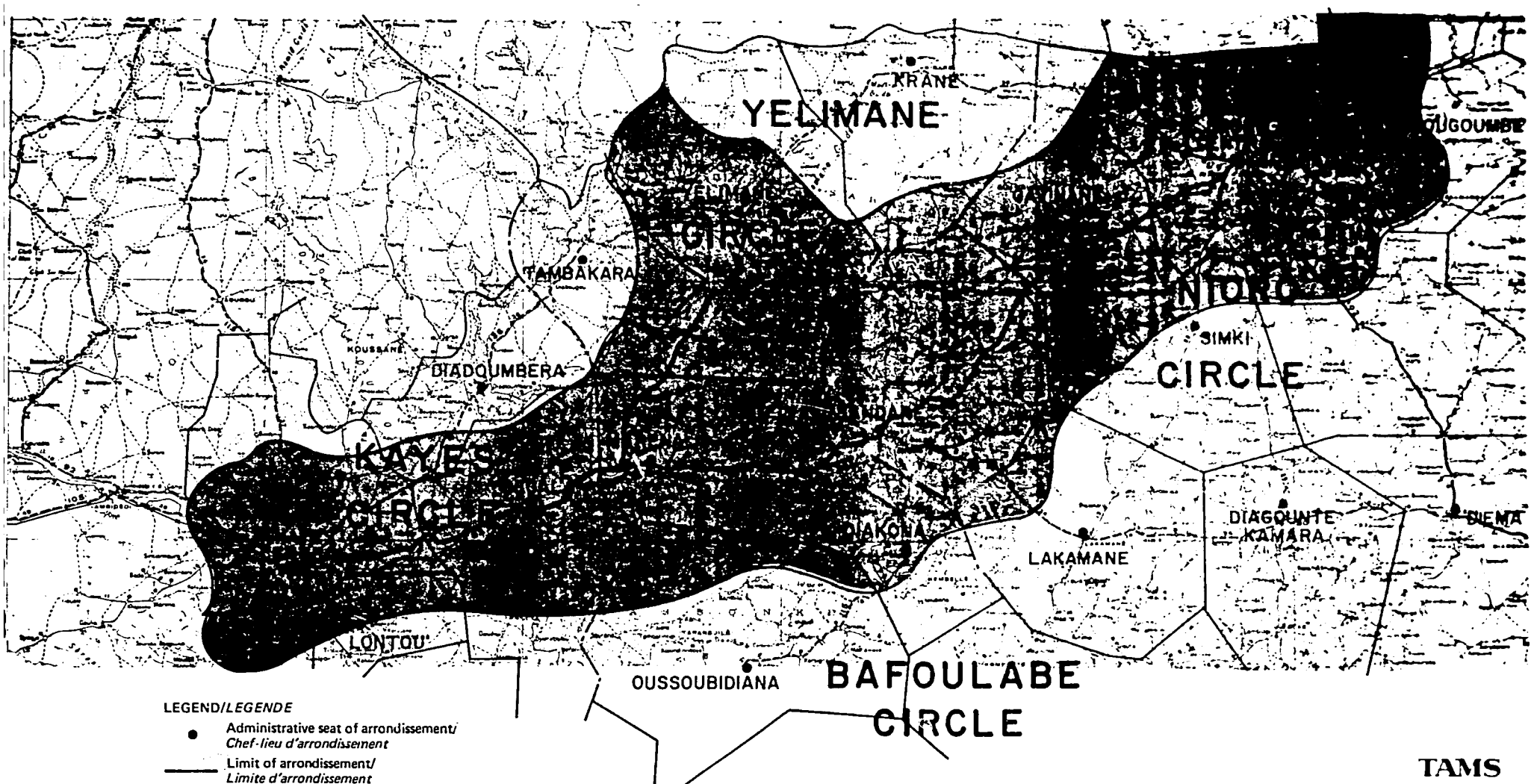
2.3 ALTERNATIVE TECHNOLOGIES

The technology applied to road construction can range from highly labor intensive to highly capital or equipment intensive. The more labor intensive the project, the more it relies upon numerous unskilled laborers. Such a technology can provide greater employment opportunities to the poorest of the poor. The more capital intensive the project, the more quickly the construction can proceed and the higher the quality and level of construction. Mixes of equipment-based and labor-based technologies, chosen according to the demands of each field activity, are more typically appropriate than both extremes.

The two groups of technologies are not mutually exclusive and represent a continuum of possibilities whose appropriate mix is defined by the social, economic and political contexts and by the design and construction needs of any given project.

2.3.1 PRE-CONDITIONS TO USE OF LABOR-INTENSIVE METHODS

An important hinderance to the application of labor-based technology is the lack of experience with the concept and the reluctance of decision-makers to reformulate design standards and administrative procedures to fit labor-based construction requirements. A pre-condition for the success of projects which replace equipment with labor is that the project be defined at the start as labor-oriented. Appropriate design standards must be developed and appropriate sets of specifications must be written. The timing of construction must consider the seasonal availability of any agricultural labor to be employed. Means for contract financing must be made available, since labor intensive contractors are seldom able to secure advances to finance



TAMS

FIGURE 2 – 2
ZONE OF INFLUENCE
ZONE D'INFLUENCE

mobilization expenses, as they do not have an inventory of equipment which could be used as a collateral.

Training for unskilled labor is essential and a program must be devised for that purpose, otherwise the quality, cost and speed of the work will suffer. Those who adopt the labor-intensive method must recognize that the work is management-intensive and requires detailed advance planning and programming. In addition, constant rescheduling will be required.

In cases where labor-based methods have a cost advantage, where modest road use can be anticipated and, therefore, modest design standards are adequate, and where employing the rural poor is a major consideration, efforts to meet these conditions are justified.

2.3.2 EVALUATION CRITERIA

In order to evaluate the appropriateness of labor-based methods for the Kayes-Nioro road, the following set of criteria were applied. These are derived from studies sponsored by the World Bank and From TAMS' experience with a labor-intensive pilot project in Haiti*.

- Sufficient labor must be available without disrupting other economically productive activities.
- Labor costs should be low. Studies indicate that for programs with an experienced labor force, the economic wage rate should be within the $2.00 per day limit.
- Lower quality construction in the initial phases of a program must be acceptable, i.e. for a period of 2-5 years.
- Mobilization of workers and supply of work camps with subsistence needs must not pose major logistic problems.

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* "Labor Intensive Road Construction: The Appropriate Technology?", R.F. Heins, U.R. Abdus-Samad and P.J. Couniotakis; IRF Inter-American Regional Conference, Buenos Aires, 1980.

- Conditions must be physically suitable, including good, easily available and easily movable materials. Also, labor-based methods do not produce satisfactory compaction of road embankment fills and bases, except where water is readily available to condition materials prior to compaction.

2.3.3 FEASIBILITY OF LABOR-INTENSIVE METHODS: KAYES-NIORO ROAD

Samplings in nine villages along the route indicated that villagers were interested in road construction work, but at the prevailing daily rainy season wage (1500 MF) or daily dry season wage (750-1000 MF) plus food and lodging. Afternoon work (included in the previous figures) is considered "extra" work and not ordinarily desired. Furthermore, while elders of the villages stated that young men would prefer road work at home to seeking long or short-term seasonal employment elsewhere, it cannot be assumed that young men would indeed do so. The low density of population and the fact that labor availability is already a constraint to agricultural production would necessitate the import of labor from other regions of Mali. Mobilization will be a serious problem.

Labor costs are relatively high and would not be competitive with equipment-based technology. Table 2-4 compares the costs of specific construction tasks where a labor-based appropriate* technology could be substituted for equipment-based construction. The comparison is made for the Dialaka-Yelimané section where field conditions are more appropriate to labor-intensive methods and where the most favorable comparison could be made. For the activities compared, labor-based technology is 90% more expensive or nearly double the cost of equipment-based technology. By comparison to the total costs of this road section, labor-based technology would be 20% more costly. These are order of magnitude comparisons.

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* The appropriate technology is defined herein as a mix of labor and light transport and compaction equipment.

Table 2.4

Comparative Evaluation of Alternative Construction Technologies for Selected Field Activities on Dialaka-Yelimané Road

		Equipment-Based Construction 1/		Appropriate Technology, Labor-Based 2/		
	Quantity	Unit Cost (MF)	Total (1,000 MF)	Productivity per manday	Unit Cost (MF)	Total (1,000 MF)
Fill (borrow material)	40,800m^3	2,000	82,000	0.7	3,570	146,000
Ditching (shallow)	61,200m^3	450	27,000	3.2	780	48,000
Base	59,160m^3	3,300	195,000	0.6	4,170	247,000
Transport of material within free haul	99,960m^3	--	--	1.8	1,390	139,000
Other Costs	N.A.	N.A.	1,026,000	N A.	N.A.	1,026,000
Total			1,330,000			1,606,000

1/ Costs and quantities taken from Table 5.4.

2/ Unit costs are based on a wage rate of 1500 MF per day and the criteria that laborers' wages are approximately 60% of the total cost.

The initial phases of a labor-based program (2-5 years) are relatively long given the time frame for construction of the Kayes-Nioro road. The present lack of training to reach acceptable productivity rates creates both time and cost problems, and is also likely to lead to poor quality construction.

The small size of villages in the region (see Appendix Table F-1) and the distances between villages will make the recruitment of a regional work force difficult and will pose logistic problems. From wherever the work force was mobilized, the workers would need to travel along the road and live in large work camps. Food and other supply problems are likely to be much larger than if construction is equipment based. Availability of water for such large work camps could be a serious constraint in many areas. The impacts of such work camps could also be negative: competition with residents for available water and firewood, and disruption of nearby communities. Disease could spread easily under conditions where sanitation and good water supply are lacking and would be further worsened by the distance to adequate medical facilities.

2.3.4 SELECTED TECHNOLOGY

The Kayes-Nioro road is not well-suited to the application of labor-intensive technology. Not only would such technology be more costly, but the road has limited physical suitability for its application. Added to these two conditions are the constraints of qualified available labor supply and serious logistical and mobilization problems created by importing a large work force to the region.

Furthermore, the capital-intensive method offers the advantage of more rapid and higher quality construction. The better quality construction resulting from the equipment based method will also be a distinct advantage to subsequent maintenance requirements.

2.4 ALTERNATIVE LEVELS OF ROAD DEVELOPMENT

The comparison of alternative levels of road development forms the crux of the feasibility analysis. To what level should the road be improved? What is the relationship between the costs and benefits of an improved road at each level of improvement; i.e. what is the rate of return for different levels of investments?

In order to define alternative levels of investment, design standards and road sections must first be identified and later combined to define a set of alternative road improvements which then would be analyzed.

2.4.1 DESIGN STANDARDS

Three types of road design standards were formulated for possible use in the reconstruction of the Kayes-Nioro road: (1) paved road with double surface treatment; (2) laterite/gravel surfaced road; and (3) minimum cost laterite/dirt road. Each would meet the criteria of an all-weather road. These standards (illustrated in Figure 3-1) are further defined in Chapter 3 and compared to route standards currently in use in Mali.

2.4.2 ROAD SECTIONS

The selected corridor for road improvement includes the possibility of serving Yelimané through a branch from the Kayes-Nioro route at Dialaka. In addition, the Kayes-Nioro route can be segmented into two sections: Kayes-Dialaka and Dialaka-Nioro. These three sections represent different levels of road use, different combinations of topographic and soil conditions and form convenient units of analysis.

2.4.3 LEVELS OF ROAD IMPROVEMENTS

The three design standards can be applied to the three road sections to produce a number of combinations or alternative levels of road development. Based upon anticipated road use and sequential marginal investments, seven combinations were selected for subsequent analysis. These include the

alternative of not serving Yelimané. These seven levels of development are illustrated schematically in Figure 2-3.

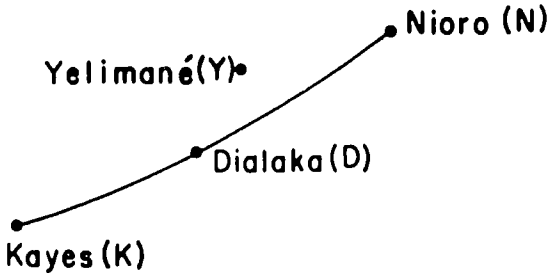
All seven levels of development are analyzed in subsequent chapters in terms of construction costs, maintenance costs and regional value added, including transportation cost savings. The synthesis of the economic analysis is presented in Chapter 11 where the relative costs and benefits are compared. Furthermore, the comparisons are made between each of the seven alternatives and the status quo alternative, and sequentially between each of the seven alternatives.

2.5 ADDITIONAL RURAL DEVELOPMENT INVESTMENT

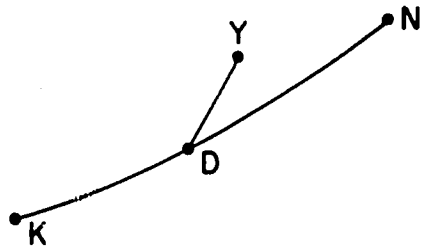
The goals of improving the road extend beyond the road itself; the road is but a part of the rural development of the First Region. For this reason, the approach to the feasibility analysis included from its inception the option of examining the effects of an integrated rural development package. Additional investment in rural development (agricultural), it was reasoned, could further the general goals of the project; i.e., to assist the rural poor and reduce dependence on deficit and subsistence agriculture.

With additional investment in the agricultural sector, what degree of spread effects and what investment return could be realized? By comparison with the costs and benefits of a road improvement without additional investments, what net gains could be derived from the extra investment in rural development? These questions deserve an answer, as an added agricultural investment in the zone of influence has a great bearing on the feasibility of the road study. In addition, several attempts have already been made in the past by AID to define an agricultural project in the area. To combine road investments with agricultural investments does therefore seem to be quite an appropriate subject for analysis.

For said reasons, the economic feasibility study was carried out



ALTERNATIVE 1/
VARIANTE



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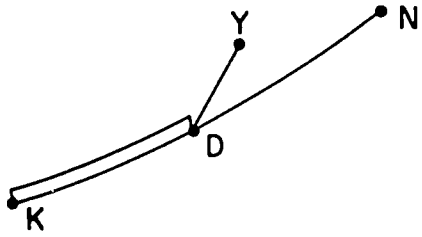

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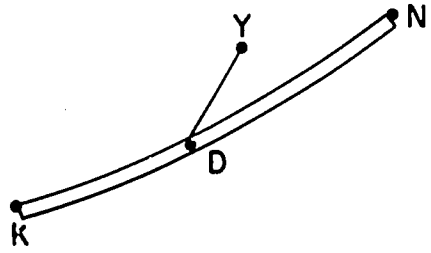

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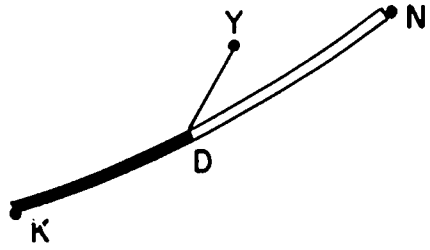

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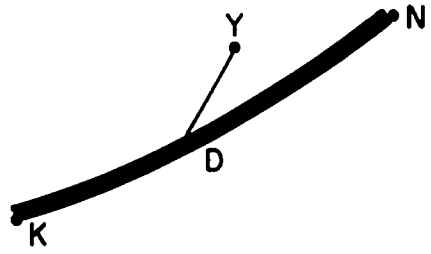
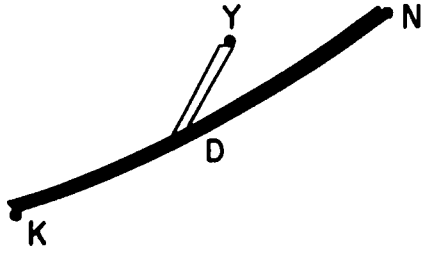
VARIANTE



ALTERNATIVE 6/
VARIANTE



ALTERNATIVE 7 /
VARIANTE

LEGEND / *LEGENDE*

MINIMUM COST/*COUT MINIMUM*

LATERITE/GRAVEL/*LATERITE/GRAVIER*

PAVED (DBST)/*SURFACAGE RENFORCE*

TAMS

FIGURE 2 – 3
SCHEMATIC ILLUSTRATION OF ALTERNATIVE LEVELS OF ROAD DEVELOPMENTS/
ILLUSTRATION SCHEMATIQUE DES VARIANTES D'AMELIORATION DE LA ROUTE

for two types of investments:

- Investment in road development; and
- Added investment in the Agricultural sector.

However, no Social Soundness Analysis nor Environmental Assessment of additional rural development was made, as part of this study, since the agricultural component of the project was defined at a conceptual level and not at a project preparation level. Further work on said component could require a Social Soundness Analysis and an Environmental examination and, where appropriate, an Environmental Assessment.

CHAPTER 3

CHAPTER 3
ENGINEERING ASPECTS

3.1 ROADWAY CATEGORY CLASSIFICATIONS

3.1.1 MALIAN DESIGN STANDARDS

Roads in Mali are classified in six technical categories as follows:

Category D - Dry season trail: A single lane track, following the existing ground contours with no or very limited drainage structures. Surface is traffic compacted natural soils. Such trails can be traversed only during the dry season by trucks or by four wheel drive vehicles.

Category C - Improved trail: A minimum standard all-weather road, except during heavy rains. The longitudinal profile is very close to the existing ground contours. Surfacing is either natural soils or borrowed select soils which would be stable except under inundation during heavy rains. Cross drainage structures are limited to small culverts and fords.

Category B_2 - Gravel Road: An all-weather road with low geometric standards. Surface consists of compacted select materials throughout its whole length. Drainage structures include fords, submersible bridges and single lane bridges. It can be traveled by all vehicles during most of the year.

Category B_1 - Improved Gravel Road: An all-weather road having adequate geometric characteristics. The surfacing consists of a basecourse throughout its length; drainage structures are adequate to assure a constant driving speed.

Category A_2 - Paved Road: A road similar to type B_1 road, with the addition of double bituminous surface treatment surfacing.

Category A_1 - Improved Paved Road: A superhighway of inter-state or high volume standards. Geometric characteristics are higher than Type A_2.

The principal design features of the various categories of roads are shown in Table 3.1.

3.1.2 APPLICABILITY OF MALIAN STANDARDS TO PROJECT

The project consists of a reconstruction and an upgrading of an existing road. The PIP anticipated that "the road alignment will generally coincide with the existing track". To accomplish this, with a capital investment compatible with projected development, the PIP offered the following design standards:

> "These standards include an all-weather surfacing, 5 meter traveled way and 2 meter shoulders. The surfacing will be selected laterite, and it is anticipated the road alignment will generally coincide with the existing track. No massive cuts and fills are anticipated. The road will follow existing contours wherever possible. No major drainage structures will be considered. Culvert pipe and headwalls will be used for small drainage areas, and concrete "dip" sections, with culvert pipe for low flows

Table 3.1

Design Standards Of Each Road Category*

	Dry Season Trail, D	Improved Trail, C	Gravel Road B_2	Improved Gravel Road, B_1	Paved Road A_2	Improved Paved Road A_1
Design Speed Km/h	- -	40	60	80	80	100
Roadway Width m	3	4	5	6	6	6+
Platform Width m	varies	6	7	9	9	9+
Minimum Radius - Horizontal m	-	40	120	240	240	425
Minimum Radius - Vertical crest m	-	500	1600	4500	4500	10,000
Minimum Radius - Vertical sag	-	700	1500	2200	2200	3000
Maximum Grade %	-	8	7	6	6	5
Subbase course cm	-	-	0-20	0-25	0-25	0-25
Base (or rolling) Course cm	-	Min.	10-20	10-25	10-25	10-25
Bituminous Surfacing	-	-	-	-	DBST	DBST

* These are average standards for flat terrain. They are based on a review of the following:

1) Etude des Transports Bamako-Kayes, 1977.
2) L'Entretien des Routes au Mali, D.N.T.P., 1975
3) Manuel sur les Routes dans les Zones Tropicales et Désertiques, BCEOM-CEBTP, 1975
4) Other information and data provided by D.N.T.P.

will be utilized for major flows. However drainage will be adequate to protect the integrity of the road bed in order to reduce the amount of maintenance required. The road will be designed to a 13 ton axle load, standard design in Francophone West Africa. Recognizing the limited maintenance capability of the GOM, the PP team will thoroughly investigate possible trade-offs between design level options and future maintenance. It should be noted that the 1976 First Region Transport Study concluded that regional transport planning could include the reconstruction of the Kayes-Dialaka section of the road to B_1 standards (slightly higher than B_2) and the Dialaka-Nioro section to B_2 levels, based on future traffic composition and volumes and an extensive economic analysis. It would not be impossible, therefore, that the PP team decide upon a split design level solution, such as the one presented in the previously mentioned Transport Study."

In addition the consultant was requested to investigate a "least cost" alternative, during the meetings held with USAID/Mali officials at the review stage of the Interim report.

3.1.3 PROJECT DESIGN STANDARDS

Three alternative levels of improvement were developed for the project road:

- Minimum cost improvement to make the road all-weather, except during heavy rains. (Consultant's classification "CC")
- Upgrading to an all-weather gravel road with adequate geometric characteristics. (Consultant's classification "BB")

- Upgrading to a paved road. (Consultant's classification "AA")

The design characteristics adopted for each category of road (average for flat terrain) are summarized below:

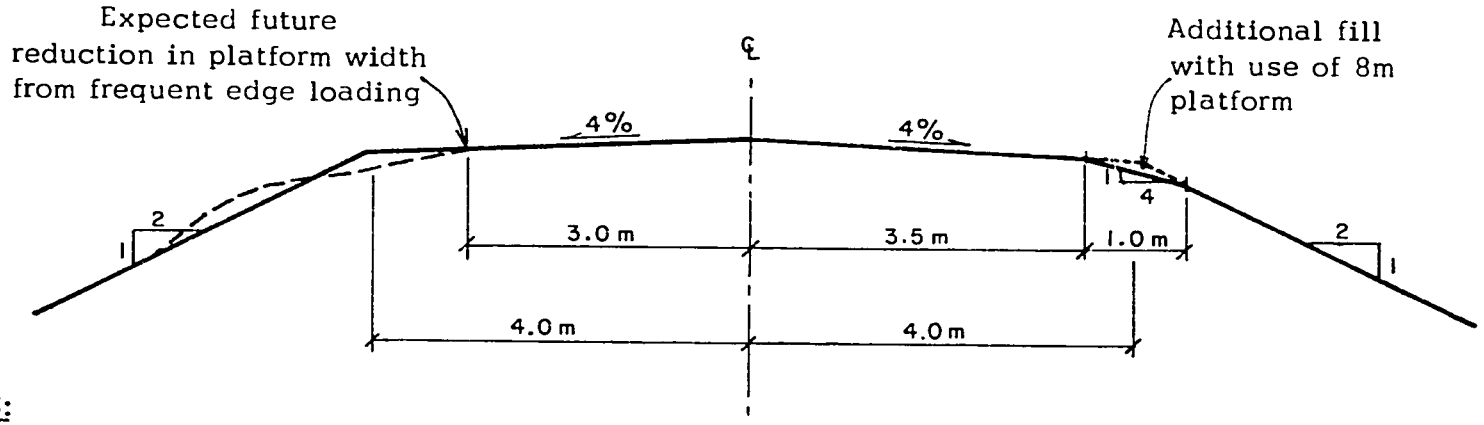
	Category CC	Category BB	Category AA
Design Speed - km/h	60	80	80
Roadway Width - m	5	6	5
Platform Width - m	5.5	7	7
Min. Radius Horizontal - m	120	240	240
Min. Radius Vertical crest - m	1600	4500	4500
Min. Radius Vertical sag - m	1500	2200	2200
Max. Grade %	6	5	5
Subbase Course - cm	-	0-40	0-40
Base (or Rolling) Course - cm	15	20	20
Surfacing	-	-	DBST

The consultant's category AA has a roadway and platform width less than Malian standard A_2. The consultant's categories BB and CC retain the same roadway width as B_1 and B_2 but with narrower platforms. For categories AA, BB a smooth transition (1:4) from pavement slope to the embankment slope of 1:2 has been adopted.

The overriding consideration in adopting said geometric standards was to provide for a sound and stable pavement structure at a limited level of construction costs. This could only be accomplished by choosing reduced geometric standards provided these were safe, operationally adequate and compatible with expected traffic levels and somewhat comparable to existing Malian standards. An alternative 8m wide platform roadway for Standards AA and BB was investigated, as shown in the following sketch. The latter was not adopted due to the reasons given therein as footnotes, but mainly due to increased costs with lesser advantages in the long run.

7 and 8m Alternative Platform Widths

Standards AA & BB



NOTES:

- A flatter cross-slope (1:4), for at least a portion of the embankment, will reduce side erosion due to lower runoff velocity. This will reduce maintenance requirements.
- The flatter cross-slope (1:4) will provide for a safer cross section as one should expect reduced accident severity in case vehicles run off the road.
- The narrower effective platform (7m) will require shorter cross drainage at significant savings in cost, in addition to some minor saving in earthwork, as shown above.
- The wider platform (8m) will encourage consistent usage of the road as a two-lane roadway, resulting in frequent critical edge application of wheel loads, with attendant subsidence of the embankment and subsequent reduction in the effective platform width to about 6m, as shown above.
- The narrower platform will reduce travel speed during vehicle passing and crossing. These maneuvers are so limited in number for the expected traffic volume as to significantly reduce the overall average travel speed.

For Standard AA, an additional typical cross section was investigated consisting of a 6m wide DBST roadway instead of the adopted 5m width. The increased roadway width is not believed to offer a significant higher level of operations, and therefore will not reduce vehicular operating costs. When two commercial vehicles cross each other, they would still have to reduce their travel speed to negotiate the maneuver and they would still infringe on the shoulder in exactly the same manner as if the roadway width was 5m. On the other hand, the increased roadway width will increase the cost of surfacing by close to 20 percent. This is a significant increase for no anticipated benefit, since the road would still be used as a one lane roadway except during passing and crossing maneuvers.

The increased costs of a 6m wide DBST roadway and the resultant lower internal rates of return are listed below* for those roadway improvement alternatives using standard AA:

Road Improvement Alternatives (See Figure 2.3)	Costs (1979 million MF) Increase	Total	IRR Reduction (%)	IRR (%)
With Yélimané branch				
5	203.0	11,697.1	0.2	16.2
6	629.1	14,253.8	0.4	15.1
7	629.1	15,799.0	0.4	14.4
Without Yélimané branch				
5M	203.0	10,014.2	0.2	12.8
6M	629.1	12,570.9	0.5	11.4
7M	629.1	12,570.9	0.5	11.4

Should unit construction costs prove to be lower than estimated in this report, it could be possible to review the adopted typical cross sections with a view at providing higher standards without jeopardizing the economic conclusions of the study.

The adopted typical cross sections for standards AA, BB and CC are shown in Figure 3.1.

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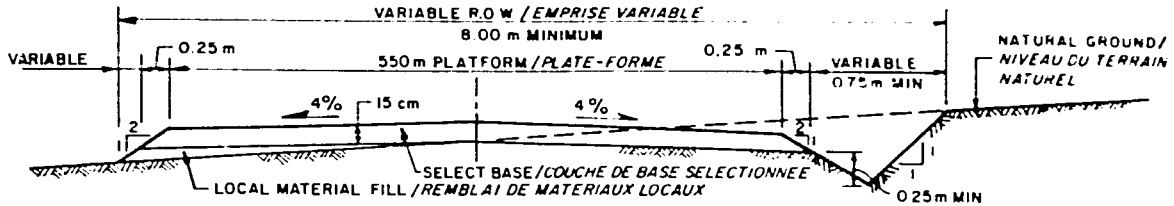
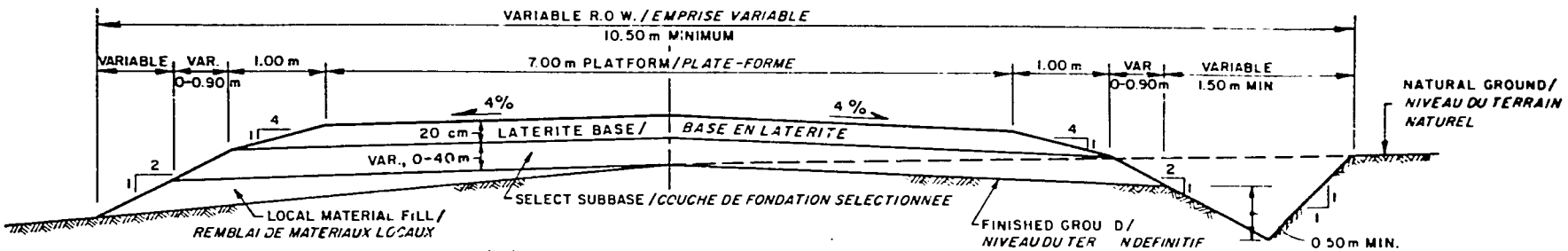
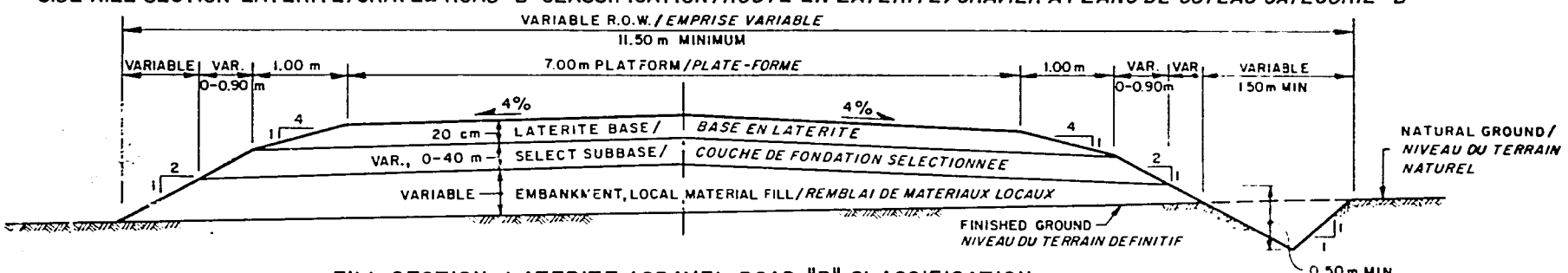
* Estimates are based on costs provided in Chapter 5 and by interpolation of results given in Chapter 11.



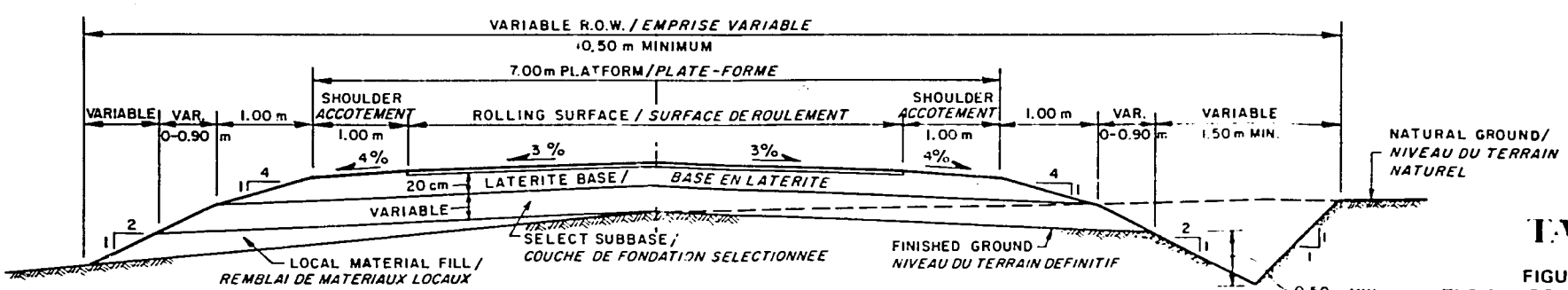
MINIMUM COST ROAD "C" CLASSIFICATION
ROUTE AVEC COUT MINIMUM CATEGORIE "C"



SIDE HILL SECTION-LATERITE/GRAVEL ROAD "B" CLASSIFICATION / *ROUTE EN LATERITE/GRAVIER A FLANC DE COTEAU CATEGORIE "B"*



FILL SECTION-LATERITE / GRAVEL ROAD "B" CLASSIFICATION
ROUTE EN LATERITE/GRAVIER EN REMBLAI CATEGORIE "B"



PAVED ROAD "A" CLASSIFICATION
ROUTE REVETUE CATEGORIE "A"

TAMS

FIGURE 3 – 1
TYPICAL ROADWAY SECTIO
COUPES TYPES DE LA ROUT

An analysis of the impact of each of these three standards was made on (a) construction costs, (b) maintenance costs, (c) development revenues and (d) user savings. The economic feasibility analysis was carried out to select that road standard (for each road section) which optimizes the net present value of the difference between costs and revenues/savings.

3.2 EXISTING ROAD

3.2.1 ROAD INVENTORY

A field reconnaissance trip was undertaken from Oct 4 to Oct 12 by the Highway Engineer. The purpose of the trip was to make an inventory of the existing road and structures and to obtain sufficient data to permit a preliminary study and cost estimate of the proposed improvement. The reconnaissance covered the Kayes-Sandare-Nioro road as well as the Dialaka-Yélimané branch. All road sections were traveled at least twice, once at regular driving speed without stops to form a general picture of the area and the prevailing road characteristics and conditions, and once at slow speed stopping every one or two kilometers to measure the road characteristics and examine road conditions. A DNTP Kayes Engineer accompanied the team in all field trips and inspections.

The itinerary of the field trip was as follows:

Oct 4 - Inspection of bridges around Kayes
Oct 5 - Kayes-Niaminga-Kayes
Oct 6 - Kayes-Dialaka-Mongoro-Yélimané
Oct 7 - Yélimané-Mongoro-Yélimané
Oct 8 - Yélimané-Mongoro-Dialaka-Nioro
Oct 9 - Nioro-Monsanbougou-Nioro
Oct 10 - Nioro-Monsanbougou-Nali
Oct 11 - Nali-Niaminga-Kayes
Oct 12 - Inspection of Sénégal River Bridge and Bridges in Kayes

Inventory methodology is presented in Appendix B. On the basis of ratings given to (a) roadway surface, (b) geometry, (c) drainage ditches and (d) average running speed, the length of the existing road considered to be within the various Malian roadway classifications (see section 3.1.1) was classified as follows:

Section	Category* B_2	C	D
Kayes-Dialaka	34 km	14 km	34 km
Dialaka-Sandaré	5		56
Sandaré-Nioro	13	6	88
Dialaka-Yelimané	8	17	43

The better sections of the Kayes-Nioro road were near Kayes, Sandaré and Nioro, most probably because of regular maintenance and the better sections of the Dialaka-Yelimané road are those recently constructed and did not yet fail.

3.2.2 BRIDGE INVENTORY

In conjunction with the Highway Engineer (see paragraph 3.2.1) a field trip was made from October 4, 1979 to October 12, 1979 to inspect major bridge structures on the Kayes-Nioro-du-Sahel road and in the vicinity of Kayes, at the request of USAID/Mali. The inspection was limited to visual means to locate damage and approximate repair costs for estimating purposes. All bridges were photographed. Bridges on Kayes-Nioro-du-Sahel road are at Station 11+41, 19+34, 29+77, 31+20, 57+67, 60+11, 93+67,

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*Note: Classifications refer to present Malian standards, exclusive of small cross drainage culverts and pipes as well as pavement adequacy, both of which were judged to be inadequate throughout most of the roadway.

103+31, 144+43, 149+92, 156+78, 177+85, 177+89, 214+20, 217+08, 222+40 and 250+25. The bridges in the vicinity of Kayes are discussed in a later section of this Chapter.

Generally, the existing bridges on Kayes-Nioro-du-Sahel road appear to be in good condition. With some exceptions, the structural damage under existing loading conditions is minimal. All bridges are described and evaluated in Appendix D. The most common problem seen on the bridges was erosion due to scour of approaches and footings.

3.2.3 DRAINAGE STRUCTURES INVENTORY

As part of the field trip, discussed under paragraphs 3.2.1 and 3.2.2, all drainage structures were examined in detail and the results presented in Appendix B.

A number of box culverts and pipe culverts on the Dialaka-Yelimané section were found to have been uncovered because the approach roadways were washed out during floods. The roadway embankments constricted drainage waterways and thus caused flooding in broad, flat stream valleys. Floods backed up by these constricted waterways often caused washouts around the ends of the culverts. Lowering of approach fills to provide overflow sections to pass flood waters over the highway have been recommended as one means of preventing the washouts around the structures. The low water crossing forms a large natural waterway which minimizes the flooding of adjacent lands and chances of causing a channel change. High approaches to achieve flood-free crossings may be expensive and maintenance costs may be high.

A low level bridge consisting of a series of stone arches crosses the Terakole river outside Yelimané. Since the rest of the roadway section

will be designed with low water crossings (Fords), it is not desirable to up-grade this bridge.

3.2.4 GEOTECHNICAL INVENTORY

As reported in the TAMS Interim Report of September 14, 1979, the consultant conducted a "wind shield" reconnaissance of the project road during the last week of July 1979. Geotechnical visual observations were conducted to confirm the results of earlier studies by others, to evaluate ambient subgrade, roadway and construction materials conditions and to interpret causes and effects of roadway deterioration.

3.2.4.1 STATUS OF PRESENT TRAVELED WAY

The trafficability of the roadway has been observed and reported by another USAID consultant, and by Messers. Thompson and Kowalczyk of USAID. All reports agree on the existence of major problems which make use of the road an adventure during the dry season and often an impossibility during the rainy season. Heavily laden trucks carry goods and passengers on a commercial basis to desired destinations between Kayes and Nioro. During the driest months (March-May) the Kayes-to-Nioro trip can usually be made in one long day of travel. On the other hand, during the rainiest months (August and September) no guarantees of travel time are made and it is reported that trips to Nioro can take as long as one week and trips to Yelimané can be interrupted for a whole month.

3.2.4.2 CAUSES OF ROADWAY DETERIORATION

Many factors contribute to the deteriorated condition of the roadway.

(a) Lack of Total Design: Portions of the roadbed are inundated by surface waters at various times of the rainy season as the embankments may be too low or cross drainage is not adequate. Washouts at bridges, culverts and fords occur where cross drainage does not handle surface water and

unprotected embankments are subject to erosive velocities. Soil Aggregate surfacings have frequently been punched downward into soft subgrades by heavily loaded trucks as a result of uncontrolled vehicle weights, inadequate surfacings, unsuitable subgrades and drainage conditions which contribute to softening of subgrade and/or surfacings.

(b) Lack of Maintenance: Except for short sections near the terminal towns of Kayes and Nioro, most of the roadway maintenance has been limited to the patching up of emergencies. Where washouts have started, repair is usually not effected until vehicles cannot pass. An embankment submerged during heavy rains is not considered a situation to be addressed by maintenance. Soil-aggregate surfacing lost by traffic abrasion, water erosion or wind erosion is not replenished.

3.2.4.3 CATEGORIZATION BY REHABILITATION NEEDS

Rehabilitation needs of such a deteriorated roadway are often masked by overlapping causes. A deeply rutted sector may appear to have unsuitable subgrade whereas in fact the rutting has all occurred during periods of softening caused by inundation. Although moisture resistant materials would contribute to an adequate roadbed, adequate cross drainage and embankment height are the root causes. Nevertheless, in order to organize rehabilitation methodologies despite the possibility of misinterpreting root causes of distress the roadway was categorized into sectors having similar needs. The limits of the sectors are tabulated in Appendix C wherein the findings of the reconnaissance are contained. Factors used in developing the limits of similar ambient conditions are as follows:

(a) Level of Service
(b) Subgrade Characteristics
(c) Root causes of Deterioration
(d) Traffic: Distribution and type

3.2.4.4 ENGINEERING INSPECTION AND COLLECTION OF SAMPLES

Also as reported on Page 16 of the TAMS Interim Report the soils/materials engineer completed his assignment in the field during the height of the rainy season of August 1979. This consisted of a more detailed engineering inspection of subgrade conditions, review of available borrow soil-aggregates and collection of representative samples for testing in the central laboratory in Bamako.

The findings of subgrade inspection were incorporated in the reconnaissance report to be found in Appendix C.

Location of borrow materials consisting of potential quarries for coarse aggregate; and potential pit run, soil-aggregates (laterite and broken schist) for potential subbase, base or surfacing materials as reported by BCEOM were spot-checked. The soil aggregate materials survey by BCEOM is included in Appendix C.

Laboratory classification tests on representative samples and the determination of moisture-density-CBR relationships of certain potential troublesome subgrade soils are included in Appendix C.

3.2.4.5 GEOTECHNICAL REPORTS BY OTHERS

Approximately ten years ago the French consulting firm, B.C.E.O.M. surveyed potential borrow sources for soil-aggregate materials within short haul distance to the then Kayes-Nioro alignment. The results of this survey are included in Appendix C. As alignment shifts in the past decade have altered roadway distances and BCEOM personnel in Bamako and Paris were unable to provide enlightenment on location of stationing survey points, the exact "PK" stationings referenced in the survey could not be confirmed. It was possible to substantiate general sectors having an abundance of laterite and/or broken schist and to substantiate those sectors having a dearth of high quality materials.

Based on this spot-check type of review, the generalized borrow availability map shown as Figure 3.2 was developed. The information from these sources is the basis for the preliminary weighted haul distances derived for this study.

Also, as part of this program, the detailed BCEOM design survey for PK 1.4 to PK 56 (see paragraph 3.3.2.4.1) including subgrade survey, materials sources, and pavement design, were spot-checked. In general, all components of the design were verified.

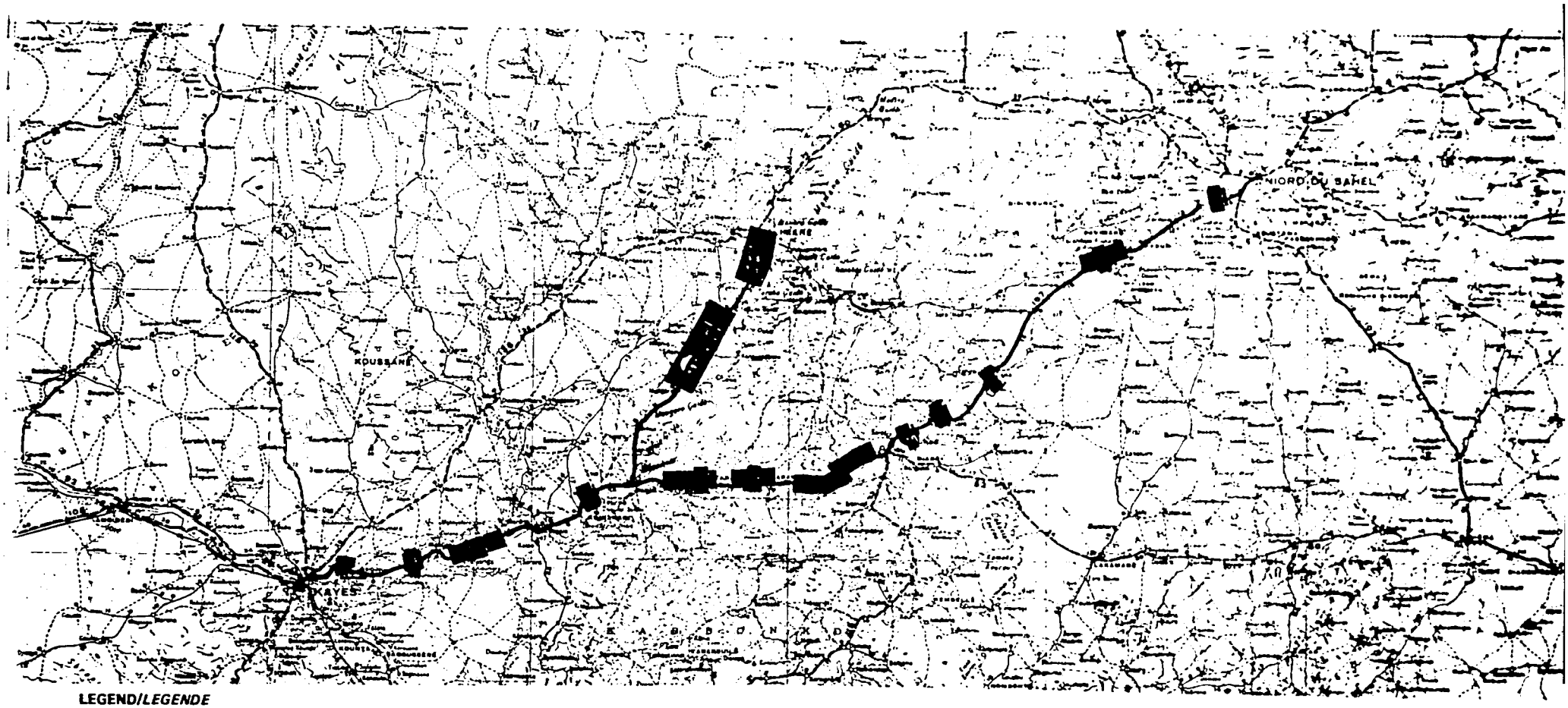
The World Bank is considering a highway maintenance program which may result in better upkeep in the future. During later design stages the question of maintenance should be resolved and with refined traffic projections the pavement thickness adopted in this studies should be adjusted.

The results of the BCEOM materials survey supplemented by field observations and limited laboratory testing, was compiled on the generalized materials source map shown as Figure 3.2. Sufficient materials are available for road building purposes. Some selective borrowing will be needed. Some portions of the alignment have no quality materials and will need the importation of materials.

3.3 PRELIMINARY DESIGN

3.3.1 GENERAL

The proposed preliminary design alignment is shown on 1:50,000 scale plans, contained in Volume III of this report as half size reductions. The plans show the present and proposed location of the roadway and bridges. Approximate quantities and distribution along the alignment are shown for fill, subbase and base. Furthermore, structure span length, culvert dimensions and ford lengths are given.



LEGEND/*LEGENDE*

SUBBASE/
COUCHE DE FONDATION

BASE COURSE OR SOIL AGGREGATE SURFACING/
COUCHE DE BASE OU COUCHE DE ROULEMENT EN AGREGATS

POTENTIAL QUARRY FOR COARSE AGGREGATE/
CARRIERE EVENTUELLE POUR LE GROS AGREGATS

TAMS

FIGURE 3 – 2
MATERIALS LOCATION MAP
CARTE DE SITUATION DES MATERIAUX

The information shown on the preliminary plans might be sufficient for construction by force account if engineering expertise is made available as technical assistance on an as needed basis and as recommended in implementation program - Alternative A (See Chapter 4). A design/construct approach similar to the ongoing UNSO program for the Didieni-Goumbou road, would be very appropriate. However, for construction by private contractor, detailed design plans, specifications and contract documents must be prepared.

Cost comparisons, for all road sections and for the design standards selected for study, are covered in Chapter 5.

3.3.1.1 KAYES-NIORO ROAD

One of the objectives of the project is to upgrade the Kayes-Nioro Road to an all-weather standard. The improved Kayes-Nioro road will essentially follow the alignment and profile of the existing road with minor modifications to improve the horizontal and vertical geometry and elevate some low-lying sections subject to frequent flooding during the rainy season. The existing bridges and many of the major culverts were found to be in an operational condition and therefore will be incorporated in the new road. Three levels of improvement were considered: AA, BB and CC. The only difference between levels AA and BB is the double bituminous surface treatment course of level AA.

3.3.1.2 DIALAKA-YELIMANE ROAD

The large amounts of water drainage over the road area would require construction of several bridges and major structures which combined with the necessary high volumes of embankment would render road construction unfeasible. A more economic alternative would be to construct the road on low embankment and provide fords and small culverts for cross drainage. Two levels of improvement were considered for that road section: BB and CC.

3.3.2 DESIGN CONSIDERATIONS

3.3.2.1 CLEARING AND GRUBBING, STRIPPING

Because of the limited amount of vegetation along the project road, it will be sufficient to clear a 16 m wide strip along the road alignment.

Removal of topsoil will be carried out over the width of the roadbed (average width 11 m) in the areas where embankment will be less than 40 cm.

The above widths were reduced by the width of the existing pavement, expected to fall within the new roadbed, given below:

Section	Station	Average width of Existing Pavement to be Incorporated in New Roadbed
Kayes-Dialaka	1-48	4.5
	48-60	3.5
	60-82	3.5
Dialaka-Sandaré	82-95	2.0
	95-143	2.5
Sandaré-Nioro	143-177	2.5
	177-205	0.5
	205-250	3.5
Dialaka-Yélimané	80 - Yelimané	1.0

Preparation of subgrade will be carried out over the entire width of the roadbed.

3.3.2.2 EARTHWORK

To reduce drainage problems the proposed improvements in profile will be mostly carried out through filling lower areas rather than excavation of higher areas. Average embankment heights were estimated on the basis of the quality of subgrade, roadside drainage conditions and the existing profile. In areas where the present road is located within the confines of the natural drainage channels, the road will be moved to higher elevations and will be located on side hill slopes, using low rubble masonry retaining walls when necessary. The quantities of earthwork were estimated from typical cross

sections indicating terrain cross slopes, pavement thickness and embankment height. Four average cross slopes were considered: 3%, 7%, 25% and 60%. Four embankment heights were considered for the Kayes-Nioro Road: 15 cm, 30 cm, 50 cm, and one meter, and a 20 cm average embankment height for the Dialaka-Yelimané Branch (see preliminary roadway plans, Volume II). It was estimated that 20% of the road length in steep side hill excavation would require protection by rubble masonry retaining walls (average 2 m high).

3.3.2.3 DRAINAGE

Ditching requirements are estimated at an average of 900 m/km.

Drainage studies for the Kayes-Nioro and Dialaka-Yelimané roads were carried out on the basis of topographic maps (scale 1:200,000), rainfall data, and field trip notes and photographs. Available rainfall data for Kayes indicated a maximum 121.6 mm daily rainfall in 1936, which was the highest in an 84 year period from 1895 to 1979. Based on this maximum rainfall as well as isohyets from a 20 year observation period and monthly rainfalls for 1968 for Kayes, Yelimané and Nioro, the consultant developed Rainfall-Intensity-Frequency-Duration Curves (given in figure 3-3) for 1, 5, 10, 25, 50 and 100 year frequencies. Observed monthly rainfall data was supplemented by use of such data from Oklahoma City, Oklahoma, USA, which is considered similar to the monthly rainfall patterns in this study area. Using the topographic maps, runoff areas, times of concentration, and estimated runoff coefficients, the runoffs for 50, 1 year and 3 month frequencies were computed.

For the Kayes-Nioro Road, it was estimated that, on the average, in addition to the existing structures, one to two pipe culverts per kilometer would be necessary for cross-drainage (A fifty-year frequency was considered, to assure protection of existing bridges). Existing structures that need replacement as well as water crossings where no structures exist were identified during the field survey and new drainage structure requirements were estimated. A minimum of two 80 cm pipe culverts per kilometer were

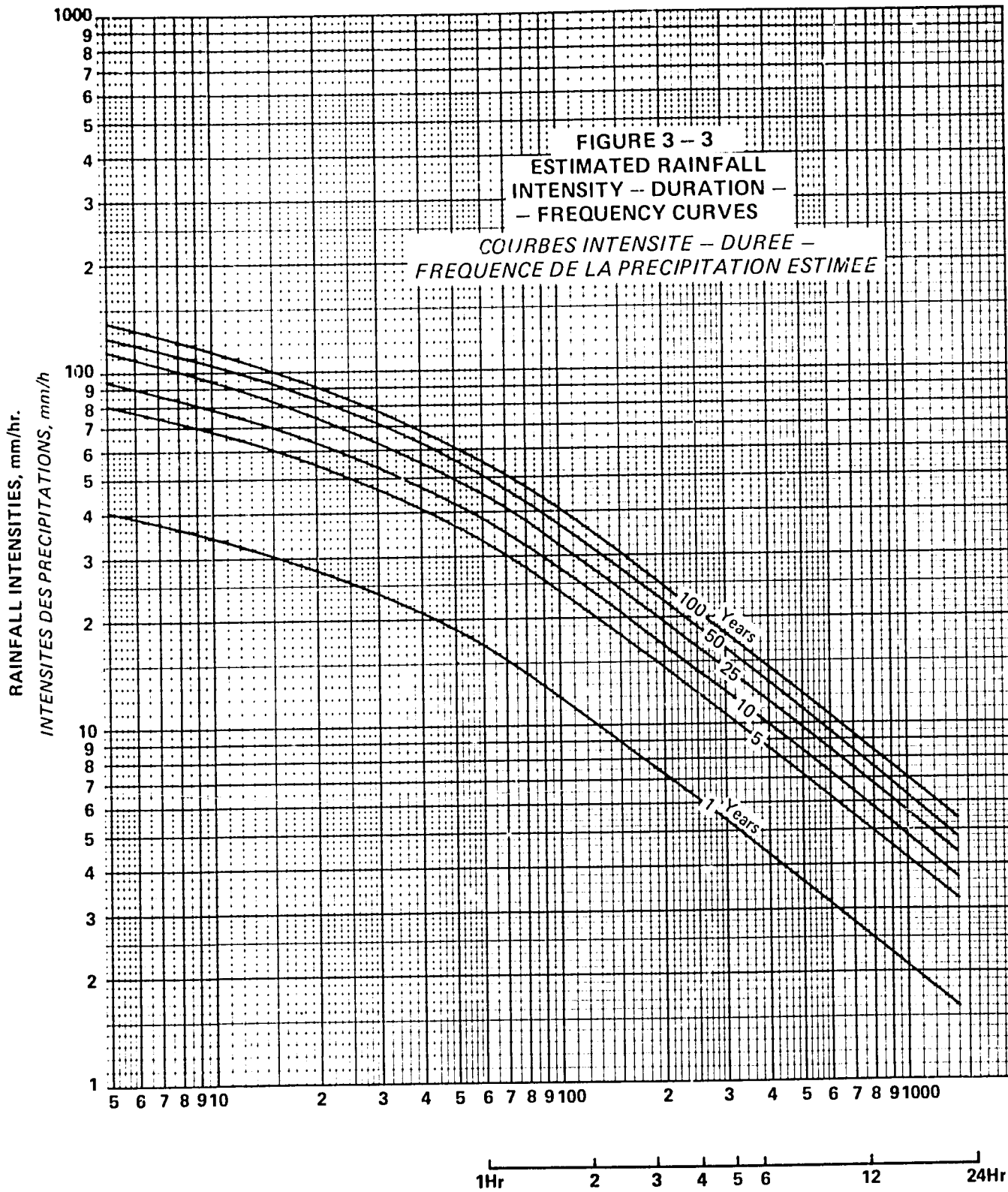


FIGURE 3 – 3
ESTIMATED RAINFALL
INTENSITY – DURATION –
– FREQUENCY CURVES
COURBES INTENSITE – DUREE –
FREQUENCE DE LA PRECIPITATION ESTIMEE
RAINFALL INTENSITIES, mm/hr.
INTENSITES DES PRECIPITATIONS, mm/h
100 Years
50
25
10
5
1 Years
1000
100
10
1
5 6 7 8 9 10 2 3 4 5 6 7 8 9 100 2 3 4 5 6 7 8 9 1000 2
1Hr 2 3 4 5 6 12 24Hr

TAMS

provided to meet cross-drainage requirements. This is a usual provision for all-weather roads.

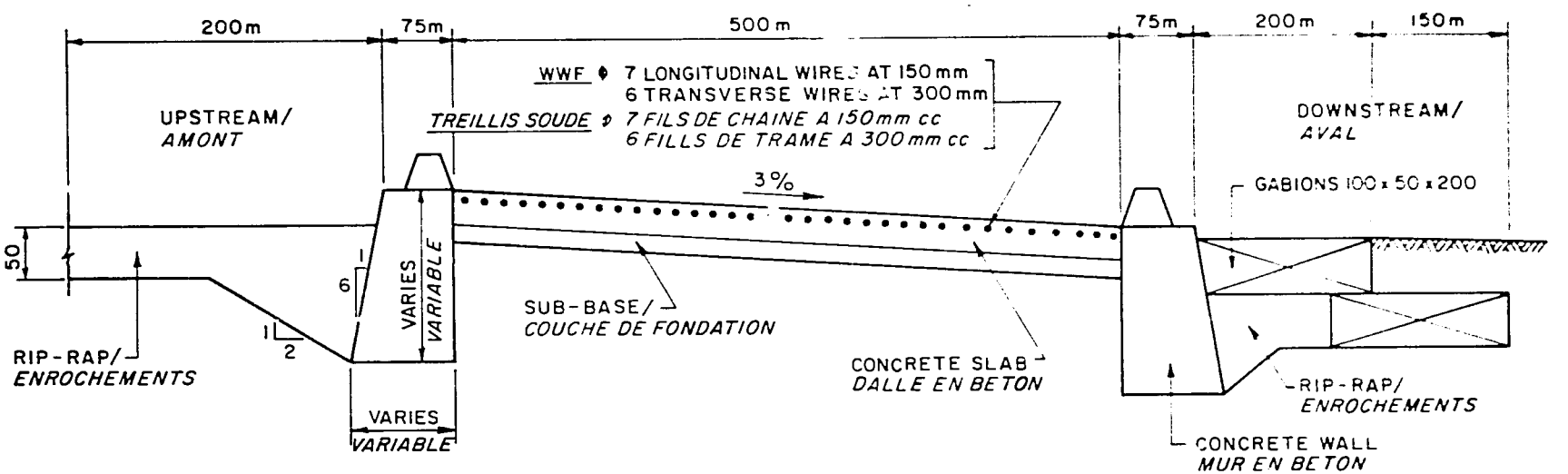
Most of the existing structures are very inadequate for cross-drainage on the Dialaka-Yélimané road. This inadequacy has resulted in excessive embankment washouts. As was noted earlier, adequate cross-drainage would necessitate construction of several bridges with high embankment approaches. Furthermore, several of the catchment basins do not have well-defined cross-drainage channels, suited for bridge construction. As a result, it is advisable to accommodate cross-drainage with a series of fords and culverts (see Figure 3.4) rather than with bridges including significant training works, as the first scheme would be much less expensive. Indeed, local topography, soils and vegetation are well suited to a series of fords on the selected alignment.

It is advisable that the depth of water in the proposed fords should not be deeper than 0.5 m for average ford construction in areas where drainage channels are ill-defined. Any greater depth would require additional materials and earthworks and careful consideration of hydraulic factors up and downstream. On the other hand, definite natural drainage channels with depths of 0.5 m to 1.0 will require reinforced concrete or corrugated pipes for run-off crossing. For a one year rainfall frequency it is estimated that one 20 m long ford and one 80 cm pipe per kilometer would be sufficient for cross-drainage. Most existing structures would not be used. (Recently, additional metal culverts were placed on the first sections of this road, in an attempt to salvage the existing structures. However, after one rainy season, most of them have washed away.)

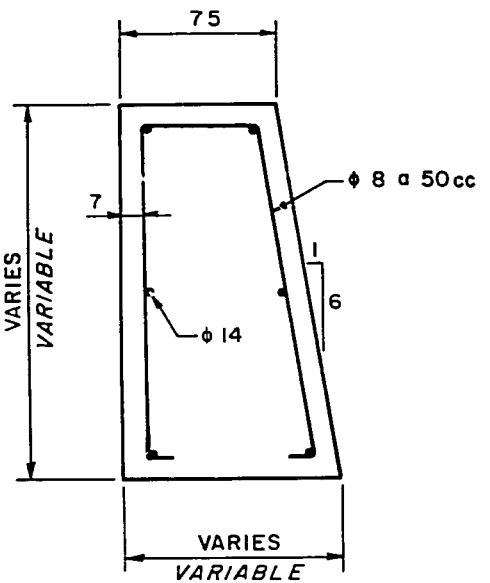
3.3.2.4 PAVEMENT

3.3.2.4.1 SUBGRADE BEARING VALUES

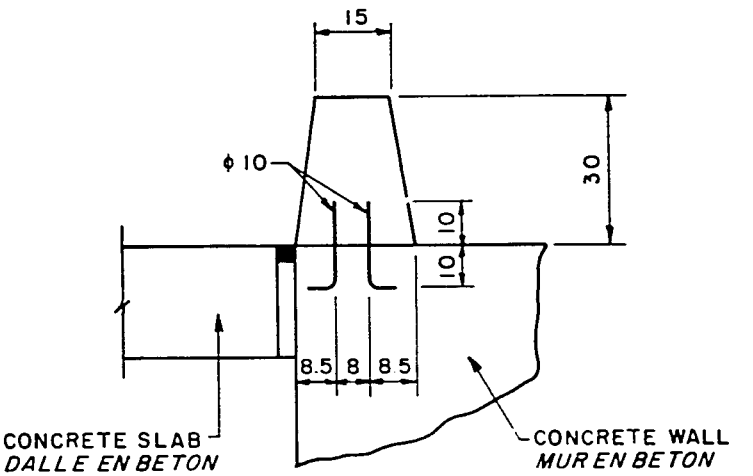
The firm of BCEOM carried out a detailed geotechnical study as part of a final design construction plan and document analysis for the



CROSS SECTION / *COUPE EN TRAVERS*



DETAIL-CONCRETE WALL
DETAILS DE MUR EN BETON



DETAIL-SIGNALIZATION POST
DETAILS DE BORNE DE SIGNALISATION

TAMS

FIGURE 3 – 4
ROADWAY FORD
RADIER DE LA ROUTE

sectors of road from Kayes to Ségala (PK 1.0 to 60). The results of the analysis are available with the Ministère des Travaux Publics in Bamako and are summarized in Appendix C.

Numerous subgrade and potential soil-aggregate borrow soils were collected and shipped to Bamako for laboratory testing. The four general soil formations representing major portions of the alignment (beyond P.K. 60) were selected for classification testings as follows:

Station	Soil Type	Remarks
80 to 92	Very fine grained soils displaying a poor performance record.	Laboratory results confirmed fine grained characteristics. CBR values are low but still are considered somewhat higher than indicated by the extremely low level of performance. Poor drainage and periodic inundation are considered contributing factors to pavement failures.
98 to 148	Fine grained, silty, upland soils.	Laboratory results indicated a very high silty and clay content. A-6 and A-4 classifications are compatible with CBR values of 8.
148 to 177	Upland silty/sandy soils containing varying amounts of broken schist.	Laboratory results indicated little medium to coarse sand. Selective earthwork operations should result in higher concentrations of broken schist at the top of embankments. A CBR of 20 should be achievable.

Station	Soil Type	Remarks
177 to 250	"Dune" Sand	If confined and provided with a wearing course to absorb traffic abrasion these soils should yield a CBR of 20. Due to the fine, rounded, uniform nature of the sand particles, compaction may be a construction problem.
80 to Yélimané	Fine grained, silty upland soils	Estimated CBR value of about 10.

3.3.2.4.2 HAUL DISTANCES

Transportation of materials beyond free haul distances were computed on the basis of the weighted haul distances estimated during the soils survey (See Table 3.2) for the following materials:

Subbase

Soil-Aggregate/Base/Surfacing

Aggregate for D.B.S.T. and P.C.C.

Subbase should be available between distances ranging from the free haul distance (1/2 kilometer) up to 9 kilometers. Base course material will have to be the subject of more selective borrowing and may have to be hauled as much as almost thirteen kilometers. Rock suitable for aggregate is available within economical distances considering the normal cost trade offs between hauling and quarry development, except near Nioro where a dearth of high quality aggregate must be anticipated.

3.3.2.4.3 PAVEMENT NEEDS

Experience of the consultant is in agreement with criteria, for the design of unpaved roads, in USAID publications for Malian-like conditions. The adequacy of surface maintenance often is the most influential factor in determining pavement life as the deterioration of unpaved roads results mainly

Table 3.2

Haul Distances For Kayes - Nioro Road

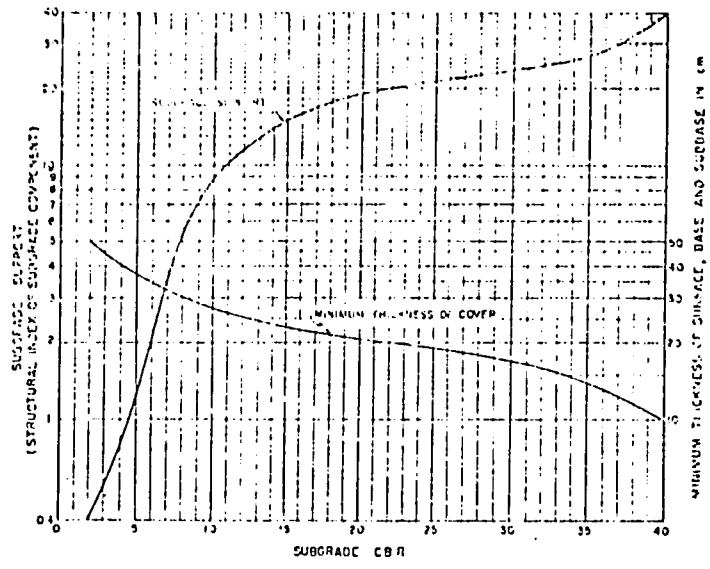
Section	Station	(km) Length	Weighted Haul Distance (Kilometers) Subbase	Base	DBST Aggregate
Kayes - Ségala	1- 60	58	4.1	8.4	20.5
Ségala - Dialaka	60- 71	11	5.0	5.0	5.5
Ségala - Dialaka	71- 82	9	4.4	4.4	4.5
Dialaka - Lambatara	82- 88	8	3.1	5.0	13.0
Dialaka - Lambatara	88- 92	4	(Free Haul)	3.0	19.0
Dialaka - Lambatara	92- 95	3	(Free Haul)	1.0	19.0
Lambatara - Sandaré	95- 98	6	1.2	6.0	17.0
Lambatara - Sandaré	98-143	41	0.5	5.4	7.8
Sandaré - Dioka	143-148	7	1.1	2.6	1.8
Sandaré - Dioka	148-177	27	2.6	3.5	7.2
Dioka - Birou	177-205	29	9.0	12.6	17.5
Birou - Nioro	205-212	7	(Free Haul)	5.5	35.5
Birou - Nioro	212-221	8	(Free Haul)	2.5	43.0
Birou - Nioro	221-233	12	4.3	8.1	53.0
Birou - Nioro	233-250	17	3.2	4.5	67.5
Dialaka-Yélimané	80--Yélimané	68	0.5	5.4	--

from the loss of surface materials through abrasion and erosion, the formation of corrugations, and the softening of the surface during the rainy season. Sophisticated analyses based on vehicle mix and ADT are less applicable than a pavement makeup based on published designs.

Criteria for the BCEOM pavement is from Chapter 5 of "Manual Sur les Routes dans les Zones Tropicales et Desertiques, Tome 2, Etudes et Construction". Within the past few years another USAID consultant reviewed this design and, as part of a transportation study, expressed general agreement. No new geotechnical information was developed.

The BCEOM pavement design appears to have been based on a conservatively high traffic prediction of $4x10^6$ to 10^7 trucks. This approach may have been influenced by the known propensity in Mali of not maintaining roadways. Lack of maintenance can be partially compensated for by a conservative design.

Criteria for pavement thickness for roadways outside the BCEOM design (beyond Station 54) was based on a conservative application of thickness design which is reproduced below from a USAID publication for



SUBGRADE SUPPORT AND MINIMUM THICKNESS OF COVER BASED ON SUBGRADE CBR VALUES

Source: "Laterite and Lateritic Soils and Other Problem Soils of the Tropics", by W. J. Morim and P. D. Todor, for USAID & AID/csd 3682.

conditions in Africa. A minimum base course thickness of 20 cm was used for all sectors and, in general, the required subbase thickness was rounded upward to more nearly agree with the above-referenced French Standard which has been accepted in Mali since its publication in 1972. CBR design values and proposed pavement thicknesses are shown in Table 3.3.

1. DBST Surfaced Pavements (Standard AA)

Double bituminous surface treatment will include a prime coating over 5.20 m and a DBST (approximately 2 cm thick) over 5 m in width.

Mali is a country with a very pronounced concentration of rainfall into a rigidly defined rainy season. Erosion of an unsurfaced roadway is certain to occur during each rainy season unless the traveled way is covered with a bituminous surface course.

The road surfaces include all traffic areas treated to resist traffic wear and dusting, and to prevent infiltration of surface water. Even the highest type of pavement will fail if base course and subgrade design strength is inadequate. The preliminary thicknesses tabulated on Table 3.3 should provide adequate support, subject to detailed investigations during later design stages.

Bituminous surface treatments constructed upon a base course will serve as an abrasion and weather-resisting structural medium. The term surface treatment is reserved for wearing surfaces which are less than 1 inch thick.

Maintenance patrols should make frequent inspection of bituminous pavements for early detection of failures. Small defects quickly

Table 3.3

Hayes-Niono Road
Preliminary Pavement Thicknesses
Project Paper Review
Design Standard for Category B

Station		Subgrade CBR		Estimated Thicknesses (cm)		
From	To	From Test	Estimated	Subbase*	Base	Total
1.0	4.2	5	--	30	20	50
4.2	6.5	3	--	15 Sand + 15	20	50
6.5	11.0	6	--	30	20	50
11.0	14.0	15	--	--	20	20
14.0	20.0	6	--	30	20	50
20.0	21.7	3	--	15 Sand + 15	20	50
21.7	26.0	10	--	30	20	50
26.0	30.0	40	--	--	20	20
30.0	38.0	13	--	20	20	40
38.0	52.0	60	--	--	20	20
52.0	54.0	11	--	20	20	40
54.0	71.0	--	4	30	20	50
71.0	80.0	--	15	10	20	30
80.0	88.0	2	--	15 Sand + 15	20	60
88.0	92.0	4	--	15 Sand + 15	20	50
92.0	98.0	--	30	--	20	20
98.0	148.0	--	8	20	20	40
148.0	177.0	--	20	--*	20	20
177.0	205.0	20	--	--	20	20
205.0	212.0	--	15	10*	20	30
212.0	220.0	--	20	--	20	20
220.0	233.0	20	--	--	20	20
233.0	250.0	--	20	--	20	20
80.0	Yelimané	--	10	15	20	35

*SPECIAL NOTE: Construction specifications must provide authorization for resident engineer to delete subbase where the alignment crosses high quality laterite or schist as well as authorization to increase subbase thickness over significantly lower than average quality subbase soils.

develop into greater ones under the effects of weather and traffic, and may result in pavement failure unless promptly corrected. Minor repairs are quickly made with small crews and hand tools, with a minimum interruption of traffic. Larger bituminous repairs require more time, personnel, and equipment, and may result in interference with traffic, or in extreme cases, require construction of detours to avoid complete traffic stoppage.

2. Soil Aggregate Surfaced Roads (Standard BB)

Grading requirements for soil-aggregate which are to be used directly as surfaces are generally similar to those indicated in the table below. Preference should be given to mixtures which have a maximum size of aggregate equal to 1 inch, or perhaps 1-1/2 inches, as experience has indicated that particles larger than this tend to work themselves to the surface over a period of time under the action of traffic. Somewhat more fine soil is desirable in a mixture which is to serve as a surface, as compared with one for a base, since it is more resistant to the abrasive effects of traffic, and more resistant to the penetration of precipitation which falls directly upon the surface, and can, to some extent, replace by capillary action the moisture which is lost by evaporation.

Suggested Grading Requirements for
Gravel and Composite Type Surface Courses of
Processed Materials

Sieve Designation	Percent passing, by Weight
1 - inch	- 100
3/4 - inch	85 - 100
3/8 - inch	65 - 100
No. 4	55 - 85
No. 10	40 - 70
No. 40	25 - 45
No. 200	10 - 25

Experience indicates that road surfaces of this sort should have a liquid limit not in excess of 35, and that the plasticity index should be between 4 and 9. The surface should be compacted as tight as possible and good surface drainage should be provided. It is to be noted that, for best results, the plasticity index of a stabilized soil which is to function first as a wearing surface and then as a base, with a bituminous surface being provided at a later date, should be held within very narrow limits. Considerations relative to compaction, and bearing values are as important for surfaces of this type as for bases.

A natural pit- or bank-run may meet these requirements without processing, other than screening. Other pit- or bank-run gravels may require both screening and washing to meet these requirements. Ability to carry heavy, sustained traffic will depend on the strength and hardness of the gravel, the cohesiveness of the clay binder, the thickness of the layer, and the stability of the subgrade.

The thicknesses shown in Table 3.3 under the heading of "Base" will be applicable to "Soil-Aggregate Surfacing". With suitable selective borrowing sufficient, high quality laterite and/or broken schist should be available within the haul limits shown in Figure 3.2. The broken schist occurs in deposits of less than 1 meter in thickness. This material will need windrowing prior to loading on transporting vehicles.

Maintenance is a continuing operation which commences as soon as a road is put into service and does not cease. It remains the aim of all road maintenance work to keep a road usable with a minimum of interference to traffic. All roads require maintenance and repair to render satisfactory service, and keep unit transport costs at a constant level.

Road maintenance and repair includes all measures designed to keep the road surface, shoulders, ditches, slopes and drainage structures

in serviceable condition. Such minor improvements to existing roads as the widening of fills and curves, the betterment of road surfaces, and the elimination of traffic hazards are often considered repair operations rather than being considered new construction operations. Preventive maintenance of surfaces, shoulders, and drainage systems is an important phase of proper maintenance activity. Prompt and adequate repairs at the first indication of failure and efficient planning for adequate supplies of labor, equipment, and material are important in assuring a rapid, unhindered flow of traffic. Continual shaping using a motor grader is needed to maintain a smooth riding surface and a uniform crown, and the drainage system must be kept functioning.

Soil aggregate surfaced roads subjected to heavy traffic require constant attention by maintenance patrols. Intensive maintenance is required when the surface is first open to travel, since any bumps that are compacted at this time remain in the surface and can only be corrected by scarifying or adding more material. Blading of the surface should be done soon after rains and it should be continued until all ruts and holes are filled. The crown should be maintained. Motor graders are necessary for heavy reshaping work. A slight excess of gravel should be kept available at edges of the roadway and bladed uniformly over the surface in wet weather. Material added or spread on the surface during warm dry weather is of little value.

Most potholes which are caused by displacement of material due to traffic are shallow and readily filled by blading when the surface is moist. Deeper holes require filling with additional material. In dry weather, new material should be moistened and compacted. All gravel roads tend to develop transverse or nearly transverse waves, called corrugations, which may progress into ruts as high as 4 inches and from 1 1/2 to 3 feet apart. After this stage, these corrugations become major grooves necessitating extensive

repair. Corrugations can be prevented to a considerable extent by securing greater frequency in maintenance operation, and by greater care in the use of maintenance equipment. Once corrugations form, they can only be removed by thoroughly scarifying, reshaping, and compacting. Regrading, as this is called, should begin with a thorough cleaning and reshaping of the shoulders and ditches.

3. "Minimum Cost" Alternative (Standard CC)

It has been suggested that a minimum cost alternative consisting of a 15 cm lift of laterite (or broken schist) be applied uniformly over the existing surface.

Such an approach violates most precepts of roadway pavement design considerations. In order to carry the required volume and weight of traffic, the design must normally provide a road surface of pavement of adequate strength, quality, and depth for all-weather use. An adequate drainage system is required to insure subgrade stability during wet weather and under heavy traffic. In the structural design of surfaces and pavements for carrying the maximum sheel load, these basic principles must be followed:

- Select a location that has a stable, easily drained soil of satisfactory bearing strength for the subgrade.
- Protect this subgrade by adequate drainage.
- Provide enough thickness of base or of base and pavement to spread the load sufficiently over the subgrade to prevent failure.

If the "least cost" approach is adopted, frequent rebuilding of the pavement must be undertaken and benefits are reduced and/or become less likely to mature. This implies higher maintenance costs and considerable skepticism in estimated benefits. Since existing maintenance levels are ruefully inadequate, a minimum cost alternative is highly undesirable, since its adequacy is very sensitive to maintenance.

4. Pavement Needs, Conclusion

Although a "least cost" road as defined under (3) is not sound from an engineering point of view, it nevertheless is a sensible approach from an economic point of view; i.e. to defer capital expenditures to the stage of recurrent maintenance costs. For this reason, standard cc was developed after Malian standard C1 as an alternative worthy of investigation as an option. Should this design standard prove to be the most economical when construction and maintenance costs are compared to expected benefits and user savings, then it would be appropriate to devise engineering solutions to the inherent pavement under design of standard CC. Cement soil stabilization at the final design stage and a demonstration project at the construction stage would be two possible mitigating courses of action. Such actions,if used, would also be beneficial in possibly reducing the construction costs attendant with Standards AA and BB (see Chapter 4).

3.3.2.5 EROSION PROTECTION

In certain areas, where large drainage channels run near and parallel to the road, the embankment will have to be protected against erosion. Similarly, most embankments of bridge approaches require slope protection. Also, most of the existing fords consist of only a concrete slab with almost no upstream or downstream erosion protection. Erosion protection will consist of grouted rip-rap; existing fords will be protected with gabions, placed upstream and downstream.

3.3.3 BRIDGES

3.3.3.1 LOADING CRITERIA

HS 15 - 44 truck as described in "standard specifications for Highway Bridges" adopted by the American Association of State Highway and Transportation officials is the recommended live loading for the design of bridge structures.

3.3.3.2 DESIGN STANDARDS

Standard Specifications for Highway Bridges - 1977 with applicable interim specifications as adopted by the American Association of State

Highway and Transportation Officials are recommended as design standards for bridge structures.

3.3.3.3 MAINTENANCE REQUIREMENTS

During routine maintenance of the roadway, visual observations should be made of the bridges for signs of obvious serious problems.

At least every 2 years, all major structures should be inspected by an engineer having a knowledge of bridge construction. The abutments and piers, bridge seats, pedestals, stems and footings should be inspected for signs of deterioration. Concrete should be inspected for mapcracking, spalling, leaching, and hollowness. Stone masonry should be inspected for deteriorating joints, loss of stones, or splitting of stones. Bridges seats should be checked for accumulation of debris and leakage. Backwalls should be checked for signs of tipping or other movement as well as loss of backfill material through joints. Abutment stems should be checked for tilting, splitting or movement (vertical or lateral). If visible, footings should be inspected for signs of settlement. Approaches should be inspected for stability of embankments and subgrade settlement. Excessive settlement may also be an indication of abutment tilt.

The wearing surface should be inspected for scaling, spalling, cracking, pot holes and exposed reinforcing steels. Railings and parapets should be inspected for physical condition. Concrete slabs and beams should be checked for scaling, spalling, cracking, efflorescence and leakage. Decks should be observed during the passage of live loads for looseness and excessive deflection. Concrete should be checked with a mason's hammer for soundness.

Stream channels should be checked for erosion and scour at the banks and at the bottom of the channel. It is desirable that inspections for scour be made during or after floods. Footings should be checked for undermining. When water covers the footing, probing can be made with a rod. Bank protection should be checked for loss of material.

Corrective measures should be taken as soon as possible depending upon the extent of the deterioration.

3.4 SPECIAL STUDIES

The consultant was requested to inspect and make recommendations for selected bridges in the vicinity of Kayes. These are in addition to those located on the Kayes-Nioro Road network. Several bridges were looked at, in the company of an engineer from D.N.T.P. These bridges were selected by the Governor of the First region and the regional director of D.N.T.P. and are reviewed in Appendix D.

3.4.1 SENEGAL RIVER BRIDGE

3.4.1.1 CONCEPTUAL DESIGN

The Senegal River is one of the major rivers of Western Africa. At Kayes it is about 400 meters wide. The purpose of this conceptual study is to arrive at an approximate construction cost. It was necessary to make various assumptions regarding basic data, such as river cross-section, flow characteristics, existing foundation materials, since very little data was available.

The height of the bridge was selected assuming a 50 year flood frequency with additional clearance for debris to pass under it during flood stage. Spread footings were selected assuming that good rock is available at the bridge site. Solid reinforced concrete piers with rounded ends were selected to provide less obstruction to the flow and minimize scour. Based on the available information, and considering the height of piers, spans of about 28 meters were selected for economy and practicality of construction. For this span length, two major choices for type of superstructure were considered, structural steel and prestressed concrete girders. The technology for the construction of these types does not exist at the present time in Mali. However, the magnitude of the construction would anyway require international contractors. The use of

local materials and labor should be maximized. Thus, considering the availability of cement and low cost of maintenance, post-tensioned prestressed concrete, I-beams are recommended for the superstructure, with a cast-in-place reinforced concrete deck slab. (See Figure 3-5)

Sufficient data is not available to select a particular site for the bridge. Observations made during the field trip showed that the river is narrower, with better defined banks, approximately 500m upstream of the existing Irish bridge. During the field trip, water was flowing over the bridge. The length of the bridge is estimated at 420m, using hydraulic data made available to us by Service d'Hydrologie at Kayes, Mali.

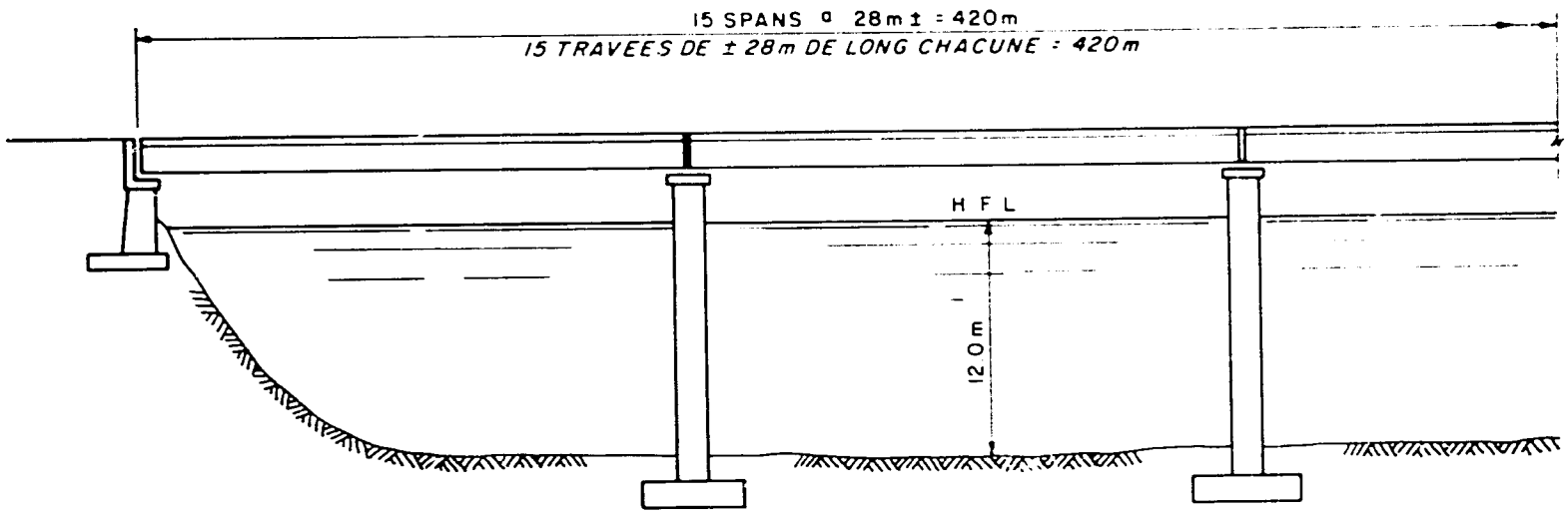
Because of the lack of available data, the cost of the bridge does not include constructing the approach roadways, river training works, slope protection, scour protection, lighting and other incidentals.

Information was not available for computing unit prices. Unit prices for prestressed concrete are estimated on the basis of extrapolation from existing reinforced concrete prices using experience gained on other projects in Africa and the U.S.

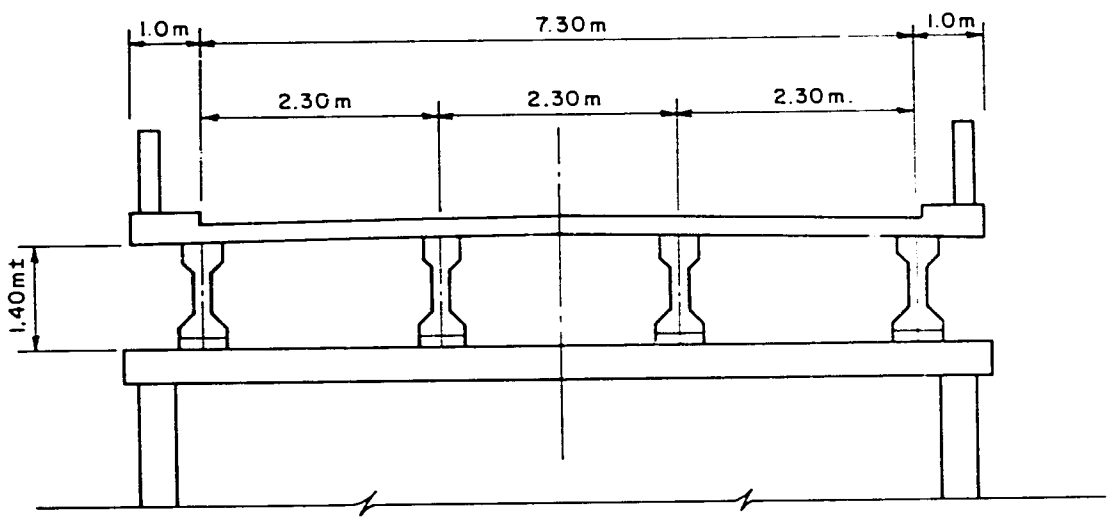
3.4.1.2 CONSTRUCTION CONSIDERATIONS

During the site visit, it was noted that there was moderate bridge construction activity in the Kayes region. There is a certain amount of skilled labor available in some of the required construction specialties. This would include laborers experienced in excavation, concrete formwork and placement, reinforcing steel placement, as well as other general construction labor. However, because of the need for specialized experience in prestressed concrete structures, a contractor with international experience will most likely be required.

Most materials needed for the bridge are available locally. However, prestressing tendons, anchor blocks and other prestressing



LONGITUDINAL SECTION / *COUPE LONGITUDINALE*



CROSS SECTION / *COUPE EN TRAVERS*

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FIGURE 3 – 5
BRIDGE ACROSS SENEGAL RIVER
PONT SUR LE FLEUVE SENEGAL

appurtenances and equipment would have to be imported. Special forms would have to be imported for the post-tensioned prestressed concrete beams. These would most likely be steel forms and be reusable.

Construction of the bridge should require about two years, depending upon the contractor's experience and available equipment. Pier construction should be accomplished within the eight months of "dry season." However, completion of all piers during the dry season would not be required, since the piers would be designed to take the forces due to river flow without the superstructure being erected.

3.4.1.3 BACKWATER COMPUTATIONS FOR BRIDGE DESIGN

The analyses of bridge backwater elevations and scour depths are based on the following data:

1. On-site photographs.
2. Aerial Photographs.
3. Site inspection observations by TAMS' field team.
4. Flood Frequency and Stage-Discharge Relationships.
5. Two velocity measurements.

The accuracy of these analyses would be greatly improved with detailed cross section data, sediment grain size distribution and field measurements of river velocity.

The channel area and shape were estimated from the following velocity and discharge data measured 800m downstream of the existing Irish Bridge on 11 September 1979:

W.S. Elevation	= 4.6 m*
Discharge	= 1200 m^3/s
Velocity	= 0.94 m/s
Channel Width	= 400 m

* W.S. Elevations are measured from the stream bed.

Based on aerial and on-site photographs, the bank slopes above 4.6m were estimated to have a slope of 1 vertical to 2 horizontal. The banks appear to be 8 - 12 meters high. Based on the flood frequency and stage-discharge relationships given in Table 3.4, backwater computations were performed for the 100-year and 10-year floods. Backwater (h) is defined as the rise in water above the normal water surface level upstream of the proposed bridge.

The backwater analysis uses procedures described in Hydraulics of Bridge Waterways, U.S. Department of Transportation, Federal Highway Administration, 1973.

A summary of the backwater and velocity computations for two bridge configurations much more restrictive to flow than the 28 meter span bridge used herein is presented in Table 3.5. The backwater effect is very small. Backwater is primarily a function of flow contraction, due to wingwall effects and/or the natural narrowing of the channel cross section at the bridge site. Bridge piers, particularly across wide channels such as proposed herein, produce a minimal backwater rise.

Scour depths were estimated from the equations presented in Scour at Bridge Waterways, Appendix B, Highway Research Board, 1970. Scour depth is defined as the equilibrium scour measured from the mean bed elevation. As sediment grain size distribution data were not available, those equations requiring the mean grain size were not used.

As shown in Table 3.6, computed scour depths range from no scour to 4m. However, based on the limited data available, the equation that appears most applicable for the conditions under study (general transport case) is the Larras equation. The Larras equation, based on scour data available from rivers following flooding, predicts a scour depth of 1 to 2 meters.

Table 3.4

Flood Frequency And Stage-Discharge Relationships

Frequency (Years)	Volume m^3/s	Height (m)	Height (ft)
100	6600	12.25	40
50	6300	12.00	39
20	5800	11.60	38
10	5400	11.30	37
5	4900	10.30	34
2	4000	9.38	31
1.25	3050	8.02	26
1.05	2150	6.56	22
1.02	1600	5.52	18
1.01	1200	4.68	15

Table 3.5

Summary of Backwater Computations

	Flood Frequency (yr) 100	Flood Frequency (yr) 10
Flood Characteristics		
water elevation (m)	12.25	11.3
volume (m^3/sec)	6,600	5,400
Bridge Characteristics		
height (m)	12.8	11.5
number of spans	21	23
span length (m)	19.8	18.3
bridge length (m)	416	421
wingwall (m)	2 @ 9.6	2 @ 4.7
Total (m)	435	430
Backwater Curve		
height (cm)	1.5	1.2
velocity (m/sec)	1.5	1.3

Table 3.6

Estimated Scour Depths+

Equation	Scour* Depth (m)	Comments
Ahmad	.7 - 11	Alluvial rivers, deep sand fill, Pakistani model and experimental
Breusers	2	Model studies; drilling spuds in waves and currents
Inglis-Poona	no scour	Model tests - India
Chitale	.09	clear-water case
Larras	1 - 2	Scour data French rivers following flood
Neill	3 - 4	Model studies - approach stream bed
Shen	2 - 3	clear water case

3.4.2 PAPARA RIVER BRIDGE

A bridge across the Papara river, under construction by force account was visited on October 4, 1979. This is to be a four span bridge. Work began three years ago, but to date, construction of the piers is still in progress. Lack of financing is reported to be responsible for the delay.

The workmanship of the construction was good and the placement of forms and reinforcing steel was properly done; the quality of concrete work was good and the finish of concrete after removal of forms was smooth.

3.4.3 OTHER BRIDGES IN THE VICINITY OF KAYES

The following three (3) bridges were inspected after consultation with D.N.T.P. officials:

1. Bridge near Bintinguela
2. Bridge across Kamankole River
3. Pipe culvert across the Papara River

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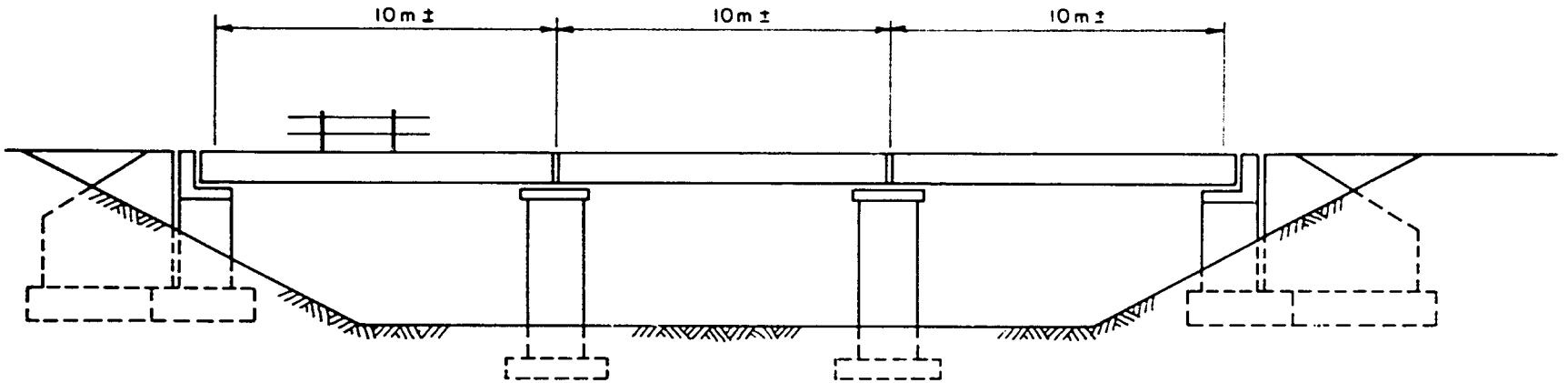
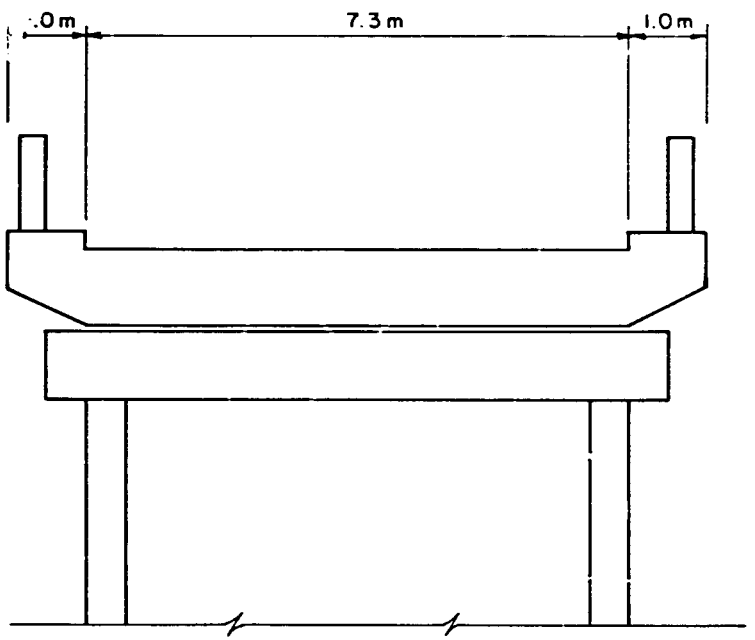
* Scour depth - measured from mean bed elevation

\+ Based on 100-year flood data and pier width - 1.5 m (5 feet)



LONGITUDINAL SECTION/*COUPE LONGITUDINALE*



CROSS SECTION/*COUPE EN TRAVERS*

TAMS

FIGURE 3 – 6
BRIDGE ACROSS PAPARA RIVER
PONT SUR LE FLEUVE PAPARA

For each structure a brief description, evaluation, estimate of quantities and estimate of costs are included in Appendix D. In addition, a conceptual sketch for a proposed bridge across the Papara river is given in Figure 3.6.

CHAPTER 4

CHAPTER 4

PROJECT IMPLEMENTATION PROGRAM

The project as recommended herein includes two options: A) The Kayes-Nioro road including the Yélimané branch plus an agricultural development component in the Yélimané and Ségala areas, and B) the Kayes-Nioro road. The transport components of the project options have been identified in Chapter 3. The definition of the agricultural component, being a by-product of the economic analysis, is defined later in Chapter 10. The inclusion of project implementation at this stage of the report is indicative of the fact that later analyses (i.e. costs of implementation and time series of costs and benefits streams) require critical input prior to their being carried out.

4.1. THE CONSTRUCTION INDUSTRY

Roadway construction in Mali, for various social and economic reasons, has followed the pattern of worldwide trends and has become equipment intensive. Construction programs have been conducted along either of two administrative arrangements, one by government forces using force account procedures and the other by private contractors using construction contract procedures.

4.1.1. FORCE ACCOUNT CONSTRUCTION CAPABILITY

The Ministère des Travaux Publics Et Du Tourisme (MTPT) has developed considerable experience with force account operations.

The Direction Nationale des Travaux Publics (DNTP) is charged with the ministry's responsibility for planning, design, force account construction and force account maintenance of the national road network (14,000 kms). The Directorate is the largest within the ministry; it employs over 1,100 permanent workers, including some 80 engineers and technicians, and seasonal labor of up to 500 persons. The executive arm of the DNTP is it Division Technique which functions through 8 districts and 18 sub-districts. 1/

Within the Division Technique there exists a brigade for bituminous surfacing and a brigade for road rehabilitation. In addition, two specialized brigades have carried out the bulk of recent force account construction which has concentrated on feeder roads.

Several special units have been set up to undertake the construction of specific roads. Presently, four such units are reported by GRM to be in operation and a new unit is reportedly being created to construct Section A of the Sevaré-Gao road from Sevaré to Hombori (328 kilometers). The work of this unit will be limited to earthwork, drainage structures and bridges. The bituminous surfacing of the road will, however, be carried out by private contractors.

During discussions with DNTP officials it was learned that MTPT had in the past made few attempts at feeder road construction by labor intensive means. However, the experiences resulted in failure as problems of logistics and health proved to be insurmountable.

During 1979, the World Bank was engaged in discussion with the Government of Mali regarding a proposed Fourth Highway Program. The results of these discussions are still pending. Proposed plans are presently being updated and would have, at earlier stages, required the force-account

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1/ MTPT formerly was Ministère des Transports et des Travaux Publics. DNTP was formerly Direction National de l'Infrastructure des Transports. Division Technique was Division des Operations Techniques.

construction of 440 kilometers of bituminous seal coats and surface treatments and 260 kilometers of re-graveling by force account within a four year period. In addition, the DNTP professional staff would have had responsibility for the construction supervision of 500 kilometers of road work to be carried out by private contractors. The Division Technique's bituminous brigade, the Service de Renforcement des Routes (previously Unité de Bitumage), and the two feeder roads construction brigades would be committed beyond capacity if the full program were implemented. (See Chapter 6 for further details on the Fourth Highway Program).

Staff members of the Ministry in consultation with TAMS staff reached the consensus that force account construction of the Kayes-Nioro road could not be achieved in the context of present capabilities and programmed activities, unless the effort was minimal, and relied on equipment based construction technologies.

In addition to MTPT, the Government of Mali operates a semi-public construction firm, SONETRA. This firm has in the past competed with private contractors for public works projects in Mali. Due to lack of equipment, this firm has not undertaken road construction work for the past three to four years and most of its activities are at present directed to building construction. There are no plans at present, to rejuvenate its road construction capabilities.

The Malian armed forces, through the Génie Militaire, have some road construction capabilities. In the recent past, this construction branch of the armed forces has participated in a countrywide road betterment program. For example, the Génie Militaire has rehabilitated 20 kilometers of the road between Dialaka and Yelimané. In addition, the military has in-country capabilities for producing hot plant-mix bituminous road surfacing materials. No information was developed as to the condition and serviceability of this equipment, as their participation in this project did not seem likely.

4.1.2. PRIVATE SECTOR CONSTRUCTION CAPABILITY

Four foreign contractors are presently operating in Mali. Three have headquarters in Bamako (S.N.T.P., SATOM, ABU) and one is located in Mopti (Bordin). All are european and presently involved in major public works projects, including road construction. Several other international contractors have carried out projects in Mali in the past few years and would be interested in obtaining new work in the area. A recent international bid for road construction received 10 offers (from the four contractors mentioned above, plus one from Italy, four from France and one from the Ivory Coast). This indicates some international interest in acquiring work in Mali. U.S. contractors have not yet entered the Mali Market, or showed an active interest in doing so.

The three Bamako-based contractors were contacted. They indicated an interest in and capability to construct the Kayes-Nioro road, either in its entirety or in part. The project considerably exceeds the capacity of any one firm in terms of equipment presently in Mali. One firm stated that its in-country heavy equipment pool consisted of approximately 55 units, including thirteen scrapers (mostly small and old), nine bulldozers D-8, eighteen dump trucks, a 60 tons per hour crusher, two aggregate screening plants and surface treatment equipment. The contractors estimated that construction would last up to 5 years, should one single contract be awarded. Their estimates consider that work can only be carried out during the dry season (9-10 months per year) at a rate of about five kilometers per month.

There are no private sector Malian firms with a capability for road construction. This is partly due to the predisposition of MTPT to carry out feeder road construction and road rehabilitation by force account, when at all possible, and to utilize foreign contractors for larger works beyond the capacity of the ministry's manpower. For these reasons and

owing to relatively little road construction undertaken over a long period, non-public Malian firms have had no role in this activity other than vending equipment.

Two Malian building contractors, Aliou Keita and Mali-Travaux, were interviewed. Mali-Travaux expressed interest and indicated capability to undertake minor structural work (small bridges, box culverts, pipes, ditches, etc.) in the capacity of a sub-contractor. Mali-Travaux stated familiarity with the Kayes area where it has previously carried out building construction work. Furthermore, neither firms indicated experience or interest in carrying out labor intensive construction.

The foregoing survey of the construction industry indicates clearly the following:

- The use of several contractors could shorten the construction period;
- Contractors with experience or interest in Mali are likely candidates for constructing the road;
- Force account construction can, to a limited degree, be introduced; and
- Private and public sector experience in labor intensive construction is minimal and interest in this technology is missing.

4.2 IMPLEMENTATION PROGRAM ALTERNATIVES

For each project option, a separate implementation program is proposed. Implementation program-Alternative A is proposed for project option A consisting of the Kayes-Nioro road, including the Yélimané branch plus an agricultural component, and implementation program-Alternative B is proposed for project option B consisting of only the Kayes-Nioro road.

4.2.1. TWO ALTERNATIVE IMPLEMENTATION PROGRAMS

The discussion herein relates to two alternative implementation programs for the design phase of the project. The first alternative relies on technical assistance, the second uses an A/E consultant firm in the usual consulting manner. Each alternative possesses advantages and disadvantages when compared with the other. These two alternatives are assessed as follows in terms of quality of design, project cost, project schedules, other donor participation and technology transfer:

- It is usually accepted that design work, within the context of a technical assistance program, is of somewhat lower quality than design work carried out by a cohesive and experienced A/E consultant team that can bring to bear, on the quality of the work, the resources of an established firm. This does not imply that this is always the case or that technical assistance cannot, per se, provide an adequate product. The technical assistance approach is more sensitive to staffing and therefore greater risks are involved when it comes to the quality of the product, which in this case is a final design for a road.

- Design costs are expected to be higher when an A/E consultant is used. However, due to a more refined product wherein construction quantities are minimized, it is expected that construction costs could be reduced such that total project costs remain equal whichever design approach is used; though, it is more likely that total project costs would be less than if technical assistance is used. For purposes of the economic analysis, costs were kept the same for both approaches.

- The use of an A/E consultant for the design work will reduce the duration of this element. Furthermore, the whole road would be designed and bid documents made ready for all its sections at one single point in time. This will reduce the administrative work required by GOM agencies. As a result of a shorter design period, it is expected that the whole project would be completed in a shorter time; i.e., several months.

- Should the design work be relegated to an A/E consultant, funding for the design services would be easier to make as coordination requirements between different agencies and governments would be lessened. Should the design work be so carried out, the possibilities of attracting joint financing agencies into the project are enhanced, since work would be in progress as a result of a funding commitment.

- Technical assistance will permit a certain degree of technology transfer. The needs in Mali, however, are more acute at the level of construction than at the level of design. Very limited possibilities are available for technology transfer if an A/E consultant is used, unless part of the design package includes the training of Malian engineers as a component.

In conclusion, project costs are expected to remain equal. The use of an A/E consultant for the design work will result in reduced administrative work, in a slightly shorter implementation period and in an increased probability of attracting joint financing. The use of technical assistance for the design work, however, will provide increased technology transfer.

4.2.2. ELEMENTS COMMON TO BOTH ALTERNATIVE IMPLEMENTATION PROGRAMS

It is herein proposed that the Ministry of Public Works and Tourism (MTPT), and specifically the National Directorate of Public Works (DNTP), be selected as the executing agency for either of the project options.

The use of both contractors and a force account brigade, for either of the two project options, is recommended. Following are the major reasons for recommending that some force account construction be undertaken:

- Force account construction requires the purchase of equipment which later could be used for road maintenance, should the Fourth Highway Program be delayed or its success be limited.
- Although construction costs could be somewhat higher, force account construction of the Dialaka-Yélimané section would provide the opportunity of creating and training a construction brigade for the First Region.
- Force account construction could permit experimentation with different construction management techniques whereby the construction brigade would be operated on an independent "Cost Center" basis with expatriate consultant staff in decision making positions, both technically and from an administrative/fiscal point of view. Such a scheme is being used on the Didieni-Goumbou road with UN funding, and could prove less costly than either contractor construction or usual force account construction.

For each of the project options, the road network is partitioned into several sections appropriate for individual construction contracts. Various criteria were utilized towards this end, and these are the following:

- Minimum overall construction period;
- Flexibility for joint financing;
- Size in relation to construction capacity in Mali;
- Topography and availability of materials; and
- Possibility for MTPT force account participation.

The partitioning of the road network into several sections should not preclude the possibility of utilizing one single contractor for all sections slated for contractor construction. It is recommended that contractors be permitted to submit bids on any of the road sections or any combination thereof. The bid evaluation will allow an accurate assessment of whether or not it is less expensive to utilize one contractor versus two or three. The available data is of such a nature as to preclude an accurate assessment at this stage.

The length of the construction period should not be significantly affected by the number of contractors used, as this period is a direct function of the mobilized equipment and not the number of contractors.

The Proposed alternative implementation schedules include a time lag prior to start of implementation. Major among the activities which are required in said period are the preparation and approval of a project paper and discussions relative to the possible acquisition of joint financing. It is estimated that the bulk of this work could be completed early in the fall of 1980 at which time the Terms of Reference could be prepared followed by the selection of a Consultant. It is expected that a Consultant could be brought on board sometime in the spring of 1981.

The additional studies, listed below, could be carried out interchangeably whether a consultant team or technical assistance is used. The additional studies are recommended for both project options, and these are:

- Reduction of construction quantities. It is recommended that studies be carried out on dry compaction and on cement stabilization of silty sands, commonly available along the road alignment, with a view at reducing the pavement thicknesses used in this study; cement is readily available in Mali. The results of these studies could be later used in developing a "least cost" road standard which is sound from an engineering point of view. A demonstration project could be set up at the construction phase of the work, during which experimentation with soil stabilization and dry compaction could be carried out.

- Socio-Economic base data. It is recommended that Socio-economic data be collected with a view at providing a data base. This could be compared with data to be collected after the road is constructed. The comparison would help in assessing the actual impacts of the project and the value added to the region.

- In addition to the above, the needs of the proposed executing agency are such that multidisciplinary assistance is required. This assistance would have to cover the subjects of monitoring of construction costs, administrative support and equipment procurement. Along this line, the feasibility of a GOM construction brigade run on an independent "Cost Center" basis and directed by expatriate staff could be investigated. The Malian experience on the Didieni-Goumbou road should be instructive. Furthermore, additional analyses of road maintenance requirements in the First Region and the project road should be carried out as the issue of road maintenance is critical to the feasibility of the proposed investment options, especially as the Fourth Highway Program is not yet in place.

Construction of the 68 kilometer section of road between Dialaka and Yélimané or the 61 kilometer section between Dialaka and Sandaré, by a Ministry brigade organized specifically for the purpose will require acquisition of new equipment. This is necessary because construction equipment in the First Region is lacking and the present availability and serviceability of the inventory of the Service du Matériel (i.e. the Ministry division responsible for furnishing and repair of equipment) is very limited. New equipment is normally more appropriate for heavier construction operations and would be necessary in any event to supplement the four-year World Bank Fourth Highway Program.

Major items and estimated acquisition costs for equipment considered appropriate for force account construction of the Dialaka-Yélimané or Dialaka-Sandaré road to all-weather standards are identified in Table 4-1. These cost estimates for force account road construction equipment are based on local dealer quotations, when possible, and upon U.S. equipment FOB quotations to which a percentage is added for shipping and insurance costs. As of December 1979, equipment costs were increasing at the rate of 1 1/2 percent of base price per month.

The services of a short-term equipment specialist are advisable to assist the Service du Matériel and Division Technique of the MTPT in final selection, technical specifications and bid document preparation for acquisition of new equipment. The equipment specialist could either be part of the A/E consultant or technical assistance teams.

Origin and specific type of equipment should take into consideration local familiarity with and local availability of maintenance. Caterpillar equipment, Berlier trucks and Landrovers are the most common items in the inventory of the Service du Materiel. Since American trucks are not normally imported into Mali, there is no local dealer support. However, conversations with USAID Mission engineering staff indicated that commercial and dealer

Table 4.1

Force Account Reconstruction Equipment
(Millions of MF, 1979 prices, without taxes)

Item		Quantity	Local Component	Foreign Component	Total
1.	Dozer, 150 kw with ripper	1	10.0	70.0	80.0
2.	Dozer, 48 kw, angle/tilt	1	5.1	35.9	41.0
3.	Wheel loader, 95 kw	1	5.9	41.1	47.0
4.	Motorgrader, 100 kw	1	7.5	52.5	60.0
5.	Dump truck, $5m^3$, low sides	5	9.0	63.0	72.0
6.	Flat bed truck, 2.5 T.	1	1.7	12.1	13.8
7.	Roller, 3-wheel, 12-14 T	1	2.8	19.5	22.3
8.	Backhoe/Loader, $0.75m^3$	1	1.9	13.2	15.1
9.	Farm Tractor, 55 kw	2	1.2	8.3	9.5
10.	Towed Tanker, 5000 l.	4	1.6	11.2	12.8
11.	Towed Tanker, 1500 l.	2	0.3	1.9	2.2
12.	Pickup Truck, 4 x 4	3	2.3	16.3	18.6
13.	Towed Lube/Tire Service Unit	1	0.4	2.8	3.2
14.	Towed Tilt-Trailer, 15 T	1	0.7	5.3	6.0
15.	Concrete Mixer, $0.3m^3$	2	0.4	2.7	3.1
16.	Portable Light Set	1	0.1	0.9	1.0
17.	Water Pump $50m^3/h$	2	0.1	0.7	0.8
18.	Maintenance Truck	1	2.2	15.0	17.2
19.	Motor Bike, 250 cc	2	0.1	0.7	0.8
20.	Miscellaneous Equipment		0.2	1.8	2.0
21.	20% Initial Spare Parts		10.7	75.0	85.7
22.	10% Contingency		5.3	37.5	42.8
	TOTAL		69.5	487.4	556.9

support for limited models of International Harvester trucks is presently under consideration. Delivery times for construction equipment (rollers are in particularly short supply) are protracted. Procurement planning, for new equipment purchases, should anticipate an overall period of not less than 15 months from firm order to useful deployment in Mali. This time lag is due mainly to the remoteness of the site.

Sensitivity to the issue of mobilizing equipment to the site is required due to the landlocked nature of Mali. Several possiblities are available to bring equipment to the site. These are:

- Dakar-Kayes by Railroad
- Abidjan-Bamako by road, then either Bamako-Nioro by road or Bamako-Kayes by railroad

All contractors established in Bamako seem to prefer the option of Abidjan-Bamako and Bamako-Nioro by road because the railroad has a limited capacity, is unreliable and involves long delays. Typical transportation costs are detailed below:

Transportation Costs of Typical Pieces of Heavy Equipment from Abidjan to Bamako by Road (1978 Prices, 1000 MF)

Bulldozer Cat D8	6,300
Cat D7	4,900
Loader Cat 966	4,050
Cat 950	3,500
Cat 930	2,950
Cat 920	2,550
Motorscraper Cat 623	4,400
Cat 621	4,200
Grader Cat 130 G	2,250
Cat 140 G	2,400
Cat 120 B	2,250
Compactor Cat 815	3,100
Electric Generator	950

These include Abidjan port charges and transport to Bamako; all taxes are excluded. Said costs are slightly higher than by rail via Dakar.

4.3 IMPLEMENTATION PROGRAM - ALTERNATIVE A

The below described implementation program is proposed for the purpose of carrying out project option A, consisting of the Kayes-Nioro road, the Yélimané branch and an agricultural development component in the Yélimané and Séqala areas.

4.3.1. STRATEGY

Apportionment of the Kayes-Nioro road, for project option A, would reduce the construction period that would be required under a single contract. This apportionment is considered optimal for a technical assistance approach, given mobilization problems and costs, the desirability of completing final designs in increments and flexibility for joint financing of construction costs. Division into four construction sections also permits contracts to be apportioned according to topography (flat, rolling or flat-sahelian) and among principal categories of construction materials (laterites or shales).

Utilizing the apportionment criteria discussed previously, the following methods and sections are recommended. These represent optimum size construction packages, under a technical assistance program:

Construction Method	Section	Approximate Length (Kilometers)
Contract	Kayes to Dialaka	82
Contract	Dialaka to Sandaré	61
Contract	Sandaré to Nioro	107
Force Account	Dialaka to Yélimané	68
		318

Advertisements for international bids are recommended for those road sections which are slated for contract construction.

The Dialaka-Yélimané road is considered most appropriate for force account construction by a Ministry brigade organized and equipped for this purpose. Force account construction could be achieved for this branch

because construction materials are widely and easily available, the length is short and lower design standards are recommended.

4.3.2 MANAGEMENT

The preferred Technical Assistance program would maximize Malian participation to produce the greatest benefit to Mali, but would also provide the necessary expatriate personnel experienced with procurement regulations, financial methodology and documentation of international lending agencies to prevent implementation delays due to mistiming or inadequacy of procedures.

A team approach using a self contained unit set up within DNTP could prove to be an efficient means of carrying out the implementation of the road project. This unit would be centralized in Bamako, with possibly a field office in Kayes. Although Bamako is quite removed from the site, closer control of work activities can be achieved and higher caliber staff can be attracted. At the late stages of implementation the field office in Kayes would become the hub of activities as the construction phase would have supplanted the design phase.

It is proposed that the design and equipment procurement phases be concentrated in Bamako, while field surveying and soils investigations be coordinated in the field office in Kayes. The level of detail in road design should be limited to the minimum acceptable for bidding purposes. There is no need to over-detail the designs, as flexibility of re-design would prove advisable during construction. In addition, the design of the Dialaka-Yelimané branch (force account construction) could be carried out to a preliminary level of fixing the center line on the ground and directly proceeding to a construct-design phase, provided close control of cost accounting is maintained.

4.3.3. STAFFING

An estimated 50 person-months of expatriate technical advisory assistance is projected for completion of designs and contract bid documents.

An additional 100 person-months for assistance through completion of construction for the entire project is suggested. Although there would be some over-lap in function between design development, procurement and construction management and supervision, advisory team composition and duration of assignments would be approximately as given in Table 4.2. Experience with commensurately-sized design, construction and logistical conditions should be required of technical assistance personnel, in addition to French language capability.

Malian staff requirements are estimated at 950 person-months during the design phase and 1,250 person-months during construction. These figures include estimated requirements for support labor as well as technical and administrative staff. Composition and approximate duration of assignments for Malian Ministry personnel would be as given in Table 4-3.

The average cost per person-month for technical assistance, furnished by a consulting firm, is estimated at U.S. $10,000 (1979 prices). For the Malian staff shown in Table 4-3, the weighted average direct salary cost is 67,600 MF per person-month. Budgetary estimates for per diem and other subsistence costs are 35 percent. When materials and intangibles are also added, the total direct cost is estimated at 100,000 MF per man-month.

Program costs for the Malian counterpart component for design and construction supervision then become:

(2,200 man-months) x (100,000 MF/mm) x (overhead factor of 2)=
440,000,000 MF or U.S. $1,100,000

Technical assistance component costs are calculated as:

(U.S. $10,000/mm) x (150 mm) = U.S. $1,500,000

TOTAL U.S. $2,600,000

This amounts to about 10 percent of construction costs for road improvement alternative 5. As design and construction supervision costs can be directly related to the standard of construction which is eventually selected, it was decided that the above figure would not be used as a fixed value throughout, but would be tied to the level of road improvement.

Table 4.2

Estimated Expatriate Advisory Personnel (Person-Months)

Position	Design Phase	Construction Phase	Total (MM)
Counterpart Coordinator/ Project Manager	20	25	45
Design Engineer	20	--	20
Advisor Kayes-Sandaré	--	24	24
Advisor Sandaré-Nioro	--	24	24
Advisor Dialaka-Yelimané	--	12	12
Short Term Specialists	10	15	25
Total Person-Months	50	100	150

Table 4.3

Estimated Malian Counterpart Staff Requirements (Person-Months)

Position	Design Phase	Construction Phase	Total (MM)
Project Coordinator/ Counterpart Manager	25	30	55
Highway Engineer	20	150	170
Design Engineer	40	5	45
Materials Engineer	10	10	20
Chief of Survey	20	--	20
Accounting	40	80	120
Materials Technician	25	85	110
Drafting/Estimating	260	10	270
Secretarial	60	70	130
Survey	190	250	440
Drivers	150	230	380
Miscellaneous Staff Labor	110	330	440
Total Person-Months	950	1,250	2,200

4.3.4. AGRICULTURAL COMPONENT

This component, recommended in this study for inclusion in this project option, is conceptually defined in Chapter 10 within the context of the economic analysis of the Kayes-Nioro road. Because of the conceptual nature of the subject, an implementation program is proposed at a corresponding rough level of detail.

Additional work is required in further defining the agricultural intervention targeted for the Yelimané and Ségala areas. This work will aim at preparing the details of this intervention. Major among the issues which would be addressed are the following:

- Choice of whether improved production technologies are to be rainfed or would utilize some irrigation (possibly in conjunction with the water resources study presently underway for O.V.S.T.M.);
- Should some level of mechanization be introduced or reliance be placed on animal drawn implements?
- What are the crops to be encouraged? i.e. those for local consumption (cereals), cash crops or livestock forage or a mixture; and
- Where specifically is the intervention to be concentrated? What pilot areas are to be used?

Once the agricultural component of the project has been further defined, a project paper could be prepared. It is assumed herein that the work will be carried out by donor agency staff. The time frame for all said activities is conjectural at this writing. However, it is estimated that an agricultural intervention could start by January, 1982.

A three year program is assumed to be appropriate for an intervention of this magnitude. An agricultural technical assistance team for about 60 person-months would provide the necessary coordination and detailed planning

of the program. Furthermore, equipment procurement, for extension services and other project elements, would be required. It is suggested that this activity be started prior to the arrival of the agricultural technical assistance team, and possibly in conjunction with road equipment acquisition.

Recommendations as to management of the intervention, such as which GRM department is to be the executing agency, will have to await further decisions. However, one can anticipate that the intervention will peak in 1983 and become self-operating by the end of 1984. Furthermore, it is proposed that a certain degree of flexibility be left in the program, such that detailed planning would be carried out during program implementation in the field.

The implementation schedule for project option A, given in Figure 4.1, is based on the following rates of progress derived from an assessment of capabilities likely to be available in Mali:

- Field surveys: about 5 to 6 km per month per survey crew. Two separate survey crews would be required for each road section in order to meet the proposed scheaule. In total, a maximum of four survey crews would be operating at any one time;
- Road design: about 2 km per week per design crew; this is an optimistic rate selected in light of the limited amount of alignment changes and the recommended low level of detail; two design crews would be operating during most of the program; a higher rate of production is estimated for the Dialaka-Yélimané section;
- Document preparation to Contractor mobilization: a period of five to six months is deemed to be the minimum feasible under conditions prevalent in Mali; and

START OF PROJECT/
DEBUT DU PROJET

YEARS/
ANNEES

COMPLETION OF PROJECT/
FIN DU PROJET

	1980 (0)	1981 (1)	1982 (2)	1983 (3)	1984 (4)	1985 (5)
• PROJECT PREPARATION/ *PREPARATION DU PROJET*						
• KAYES – DIALAKA • DESIGN/*ETUDE* • BIDS/*APPEL D'OFFRES* • CONSTRUCTION/*CONSTRUCTION*						
• DIALAKA – SANDARE • DESIGN/*ETUDE* • BIDS/*APPEL D'OFFRES* • CONSTRUCTION/*CONSTRUCTION*						
• SANDARE – NIORO • DESIGN/*ETUDE* • BIDS/*APPEL D'OFFRES* • CONSTRUCTION/*CONSTRUCTION*						
• DIALAKA – YELIMANE • DESIGN/*ETUDE* • EQUIPMENT PROCUREMENT/ *APPROVISIONNEMENT DU MATERIEL* • CONSTRUCTION/*CONSTRUCTION*			DELIVERY OF EQUIPMENT/ *LIVRAISON DU MATERIEL*			
• RURAL DEVELOPMENT/ *DEVELOPPEMENT RURAL* • PROJECT PREPARATION/*PREPARATION DU PROJET* • PROJECT IMPLEMENTATION/ *EXECUTION DU PROJET*						

LEGEND /
LEGENDE

RAINY SEASON /
SAISON PLUVIEUSE

TAMS

FIGURE 4 – 1
ALTERNATIVE A
PROJECT IMPLEMENTATION PROGRAM
ALTERNATIVE A
PROGRAMME D'EXECUTION DU PROJET

- Construction: about 5 km per month for contractor construction and less than 4 km per month for force account construction; it is assumed that construction will proceed on an average of nine months per year and that only a limited number of activities could still be undertaken during the rainy season.

The proposed schedule in Figure 4.1 is predicated on phasing and incremental production being timed for judicious overlapping between the different activities; i.e. design is carried out simultaneously with field surveying which would keep slightly ahead of design.

4.4. IMPLEMENTATION PROGRAM - ALTERNATIVE B

The below described implementation program is proposed for carrying out project option B, consisting of only the Kayes-Nioro road.

4.4.1. STRATEGY

Similar to the previous implementation alternative, the Kayes-Nioro road is apportioned into sections. Utilizing the same apportionment criteria, the following sections and construction methods are recommended:

Construction Method	Section	Approximate Length (km)
Contract	Kayes-Dialaka	82
Force Account	Dialaka-Sandaré	61
Contract	Sandaré-Nioro	107
		250

As the design work on all three sections would be completed simultaneously by one A/E consultant, it would be possible to prepare the bid documents so that one or more contractors is/are selected for the construction work. The option should remain open to construct the Dialaka-Sandaré section using a contractor, though, it is recommended to use force account for reasons of technology transfer, creation of Malian construction capability in the First Region, and the provision of an equipment pool which could be

used for road maintenance. The Dialaka-Sandaré section is selected for force account construction, since it is the shortest and would still be completed at about the same time as the other two sections in spite of a reduced rate of construction progress by force account.

4.4.2. MANAGEMENT AND BUDGETING

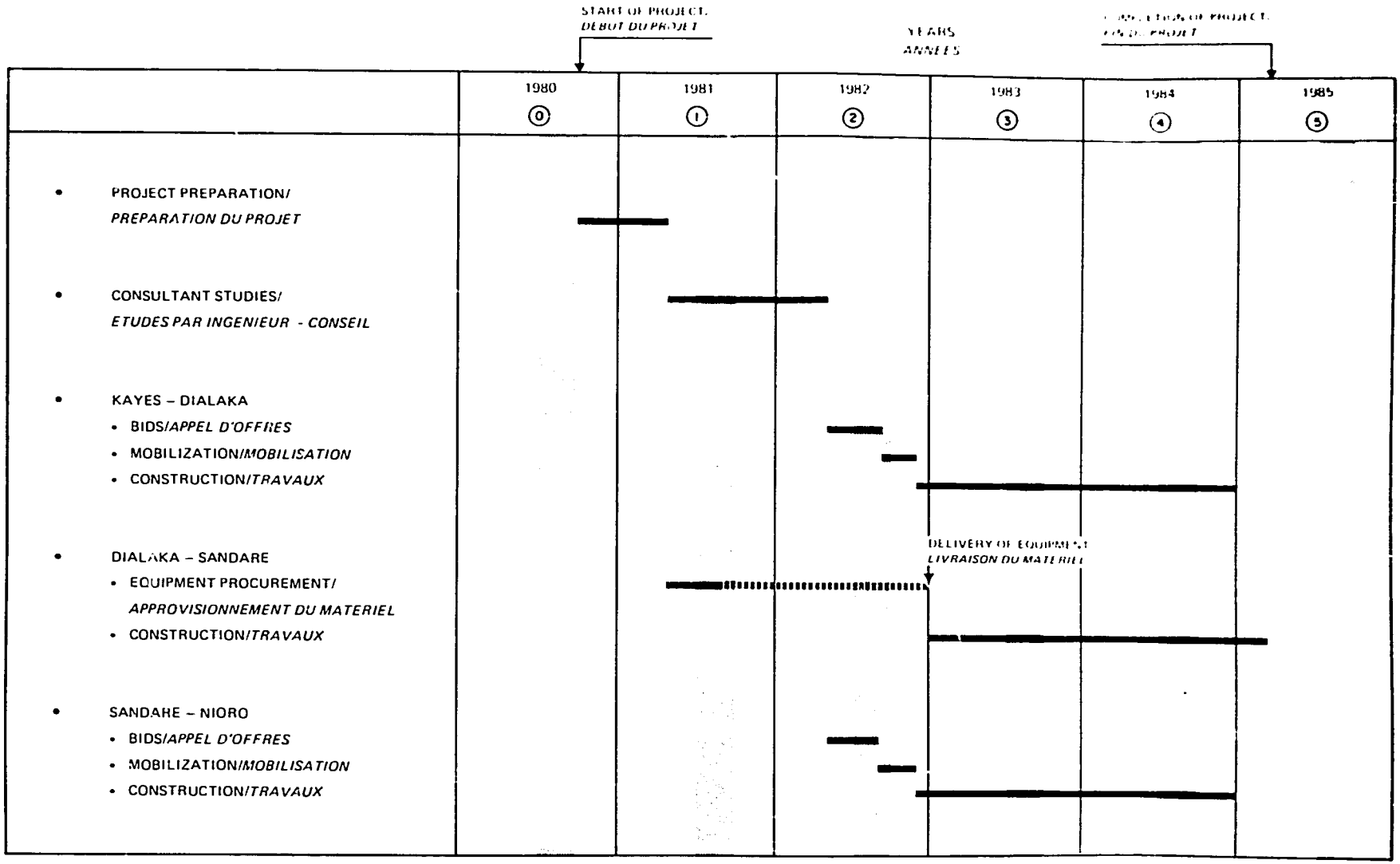
The preferred use of an A/E consultant for the design phase would be in its headquarters with necessary soils and other surveys to be carried out in the field. This would reduce the costs of the design work. Aerial photography would have to be undertaken as it more likely is cheaper and more expeditious. Timing for the aerial photography is critical, and scheduling outside the rainy season is almost mandatory.

The A/E consultant team would also carry out the additional studies listed in 4.2.2. namely with the purpose of minimizing construction quantities, establishing socio-economic base data, developing road maintenance requirements in light of an established Fourth Highway program, investigating better force account management and cost control techniques, and establishing equipment requirements.

The construction supervision and construction management are left open at this stage to provide maximum flexibility for acquiring joint financing for the construction phase of the work. However, a sum of about 90 million MF should be earmarked for an expatriate advisor to help in construction management of force account activities.

Following is the proposed budget for the A/E consultant portion of the work:

Item	Million Malian Francs (1979)
Aerial Photography	140
Final Design (includes soils investigation and testing)	500
Administrative Studies	60
Soils Experimentation	50
Socio-Economic Data	50
	800



LEGEND/
LEGENDE

RAINY SEASON /
SAISON PLUVIEUSE

TAMS

FIGURE 4 – 2
ALTERNATIVE B
PROJECT IMPLEMENTATION PROGRAM
ALTERNATIVE B
PROGRAMME D'EXECUTION DU PROJET

4.4.3. PROPOSED SCHEDULE

The implementation schedule for project option B, given in Figure 4.2, is based on the following rates of progress:

- Consultant design work: over 20 km per month, using aerial photography, provided the flying of the road is accomplished by the start of the rainy season of 1981.
- The period from end of design to start of construction is estimated at 7 months. This period includes bid advertisement, bid evaluation and contractor mobilization.
- Construction: at 4 and 5 km per month for paved and gravel roads by contractor, and at 3 km per month for gravel roads by force account.

CHAPTER 5

CHAPTER 5
CONSTRUCTION COSTS

5.1 UNIT COSTS

5.1.1 PRIVATE SECTOR CONSTRUCTION

Unit cost estimates for the various construction items of the project were established by means of a review and analysis of the following:

- Unit road construction costs available from existing reports;
- Recent bids and engineer's estimates of other road projects similar to the Kayes-Nioro Road, provided by D.N.T.P.; and
- Unit costs provided by the major, locally established European private construction firms.

All costs were brought to a "without-tax", 1979 basis. To that effect, an annual inflation rate of 15% was used, which appears to be within the range indicated by D.N.T.P. staff, private contractors and the National Bureau of Statistics. Average unit costs were thus obtained and compared with similar costs from the Consultant's present and recent experience in other developing countries (particularly in Africa), as well as the U.S.A.

Unit costs which showed great variation from one source to the other (possibly because of differences in the definition of construction work tasks included in each item), were computed directly on the basis of the costs of the components constituting each item. This was particularly so in the case of structural work items.

Unit costs for private contractor construction are presented in Tables 5.1 and 5.2.

5.1.2 FORCE ACCOUNT CONSTRUCTION

A number of construction cost studies have been made by D.N.T.P. However, it was not possible to draw the required firm conclusions, since each study was dependent upon the nature of assumed work crews, equipment fleet and rates of productivity. Furthermore, as cost accounting histories of construction by Government forces were not available, unit costs of selected operations which could be carried out by force account were estimated on the basis of input costs, such as labor, equipment and materials combined with estimates of productivities.

The consultant examined costs per kilometer of road construction for different serviceability levels (D through B), in mountainous, rolling and flat terrain, for both private sector contracts and D.N.T.P. force account studies. If a 30 percent overhead factor is applied for centralized supervision, the costs of force account construction would be equal to the costs incurred by private contract. However, the data base is small, variations from the average too high and the credibility of the basic assumptions too unsure for a reliable conclusion on force account construction costs. For analysis purposes, force account construction costs were therefore assumed to be equal to those derived for private sector construction.

During discussions with D.N.T.P. officials it was strongly indicated that public sector construction capabilities are being over-extended due to a shortage of management, supervisory and engineering staff as a result of the amount of present participation in several road and bridge construction programs. Malian officials considered that it would be preferable to construct the Kayes-Nioro road by private contractors.

The consultant's recommendation (refer to Chapter 4) is that most of the Kayes-Nioro road be constructed by private contractors. Selected

Table 5.1

Unit Construction Costs In Malian Francs - 1979[1] (Local Taxes Not Included)[2]

ITEM	UNIT	UNIT COSTS							
Source		Transport Study-Bamako Kayes[3]	Average Unit Costs[4]	SNTP[5]	SATOM[6]	Data Provided by DNTP[7]	Koutiala-Sikasso Road[8]	Average	Adopted
Clearing & Grubbing	m^2	60	45	15	58	55	69	50	60
Topsoil Removal	m^2	70	310	355	370	-	305	280	200
Subgrade Preparation	m^2	210	275	220	190	-	205	220	220
Excavation (Wasted)	m^3	850	780	485	1120	740	1020	830	850
Embankment (Excavated Material)	m^3	1845	1485	1030	1620	1270	1580	1470	1600
Embankment (Borrow Material)	m^3	2840	1520	1120	1760	1050	1650	1660	2000
Ditching	lm	1005	1610	285	785	500	650	805	900
Subbase Course	m^3	2840	1650	2300	4810	2110	3900	2935	3000
Base Course	m^3	3550	2155	2300	5000	2680	3900	3265	3300
Prime Coating	m^2	440	400	430	390	450	310	405	400
Double Bituminous Surface Treatment	m^2	1600	1300	1035	1800	1260	1375	1400	1500
Transportation of Materials	m^3/km	250	160	150	200	185	160	185	200
Additional Cost of Rock Excavation	m^3	3550	-	4485	5300		3400	4185	4200

Table 5.1 (Continued)

Unit Construction Costs In Malian Francs - 1979[1] (Local Taxes Not Included)[2]

ITEM	UNIT	UNIT COSTS							
Source		Transport Study - Bamako Kayes[3]	Average Unit Costs[4]	SNTP[5]	SATOM[6]	Data Provided by DNTP[7]	Koutiala-Sikasso Road	Average	Adopted
Additional Cost of Ditch Excavation in Rock	lm	7,275	--	--	--	1,685	--	4,480	4,500
Concrete Pipe ø 80	lm	--	53,960	40,250	--	53,870	--	49,360	55,000
Concrete Pipe ø 100	lm	--	97,125	57,500	--	--	--	77,315	80,000
Gabions	m^3	--	--	33,550	43,700	34,400	--	37,070	40,000
Concrete (B350)	m^3	--	--	138,000	174,000	131,650	--	147,885	170,000
Steel	kg	--	--	500	580	--	--	540	650

1 - In order to bring all unit costs to a 1979 basis, the consultant adopted an average construction cost inflation rate of 15% for the last 3 years. All costs shown are 1979-based.
2 - Taxes were deducted on the basis of information provided in the source data.
3 - Values are based on unit costs for 1976 in the First Region, including taxes.
4 - Values are based on average 1978 costs including taxes, from a survey of recent bids.
5 - Values are based on estimated 1978 costs, excluding taxes.
6 - Values are based on estimated 1979 costs, excluding taxes.
7 - Values are based on estimated 1978 Engineer's estimate for a major road, excluding taxes.
8 - Values are based on 1978 Lowest Bid prices, tax-free contract.

Table 5.2

Unit Costs Estimated By Consultant

1. Drainage & Structures

Ford, 5m wide (Per linear m)

Concrete 300 (incl. reinforcement)	3.35 m^3 at 175,000	586,250FM
Rip-rap (not grouted)	4.25 m^3 at 11,000	46,750
Gabions	2 m^3 at 40,000	80,000
Miscellaneous		87,000
		800,000FM

Gravity Retaining Wall, 2m high (Per linear m)

Concrete 300 (incl. reinforcement)	1.03 m^3 at 175,000	180,250FM
Excavation, Backfill & Misc.		19,750
		200,000FM

Box Culvert 1x 2m, 7m long, including headwalls (Each)

Concrete 350	1.18 m^3/1m x 7 x 170,000	1,404,200FM
Steel	160 kg/1m x 7 x 650	728,000
Headwalls		300,000
Excavation, Backfill & Misc.		67,800
		2,500,000FM

ø80cm RC Pipe Culvert, 7m long (Each)

Pipe Culvert @ ø80 cm	7 m at 55,000	385,000FM
Headwalls		45,000
		430,000FM

ø100cm RC Pipe Culvert, 7m long (Each)

Pipe Culvert @ ø100 cm	7 m at 80,000	560,000FM
Headwalls		60,000
		620,000FM

2. Miscellaneous Items

Erosion protection: m^2	11,000FM
Rip-rap (not grouted): m^3	11,000FM
Metal railings: 1m	55,000FM
Removal of existing pipe culverts: each	80,000FM
Removal of other structures: m^3	40,000FM

sections of average construction difficulty (Yélimané branch road or Dialaka-Sandaré section) would be accomplished by force account. This will develop sufficient equipment and expertise for roadway and equipment maintenance. The extent of such needs is dependent upon the pending World Bank funding highway maintenance program which is discussed in Chapter 6. Rigorous cost accounting for such force account work will make future comparisons of public versus private construction possible.

5.2 CONSTRUCTION COSTS

5.2.1 GENERAL

Construction costs for the various levels of road improvements were computed on the basis of estimated quantities and adopted unit costs. These quantities and costs are summarized in Table 5.3 (level CC), Table 5.4 (level BB) and Table 5.5 (level AA). The Kayes-Nioro road was sub-divided into four sections: Kayes-Dialaka, Dialaka-Sandaré, Sandaré-Nioro and Dialaka-Yélimané. Improvements in alignment (levels BB and AA) will result in the total road length being reduced by about 1%. However, the cost estimates are based on original road lengths, as the reduction in road length will be compensated by an increase in the number of small drainage structures.

Construction costs, reasonably estimated therein, are to a ±20 percent accuracy, as would be expected at a preliminary design level. Table 5.6 summarizes the total capital investment costs for each of the seven alternative road improvements.

5.2.2 MOBILIZATION DESIGN, AND SUPERVISION COSTS

Mobilization Costs are estimated to be 15%, based on averaging various estimates given by local European contractors, and taking into account the remoteness of the project site and the general lack of adequate supplies of water for construction. Chapter 4 illustrates the remoteness of the area by listing the costs of transporting construction equipment to the site.

Table 5.3

Construction Costs (1,000 MF, 1979)
Design Standard CC

ITEM	UNIT	UNIT COST (M.F.)	KAYES - DIALAKA Quantity	KAYES - DIALAKA Cost	DIALAKA - SANDARE Quantity	DIALAKA - SANDARE Cost	SANDARE - NIORO Quantity	SANDARE - NIORO Cost	DIALAKA - YELIMANE Quantity	DIALAKA - YELIMANE Cost
Clearing & Grubbing	m^2	60	738,000	44,280	640,000	38,400	1,123,000	67,380	816,000	48,960
Removal of Topsoil	m^2	200	164,000	3,280	157,000	33,400	294,000	58,800	238,000	47,600
Preparation of Sub-grade	m^2	220	656,000	144,320	488,000	107,360	856,000	188,320	544,000	119,680
Cut (wasted)	m^3	850	-	-	3,000	2,550	1,300	1,105	-	-
Fill (excavation materials)	m^3	1,600	-	-	12,000	19,200	1,700	2,720	-	-
Fill (borrow materials)	m^3	2,000	43,800	87,600	80,300	160,600	81,000	162,000	40,800	81,600
Ditching (shallow)	lm	450	73,800	33,210	54,900	24,705	96,300	43,335	61,200	27,540
Sub-base	m^3	3,000	-	-	-	-	-	-	-	-
Base	m^3	3,300	71,340	235,422	53,070	175,131	93,090	307,197	59,160	195,228
Transportation of Base Materials	m^3/km	200	535,050	107,010	291,885	58,377	605,085	121,017	236,640	47,328
Transportation of Sub-base Materials	m^3/km	200	-	-	-	-	-	-	-	-
Addl. Cost - Rock Excav.	m^3	4,200	-	-	15,000	63,000	3,000	12,600	-	-
Addl. Cost - Ditch Excav. in Rock	lm	2,200	-	-	4,500	9,900	900	1,980	-	-
Retaining Walls	lm	200,000	-	-	400	80,000	100	20,000	-	-
Sub-Total				655,122		772,623		986,454		567,936
Removal of Existing Pipes	ea	80,000	26	2,080	5	400	28	2,240	-	-
Removal of Other Structures	m^3	40,000	24	960	31	1,240	57	2,280	-	-
Drainage Pipe Ø80-7m long	ea	430,000	65	27,950	25	10,750	55	23,650	15	6,450
Drainage Pipe Ø100-7m long	ea	620,000	20	12,400	16	9,920	35	21,700	-	-
Box Culverts 1x2 - 7m long (or equivalent)	ea	2,500,000	6	15,000	25	62,500	19	47,500	15	37,500
Fords	lm	800,000	-	-	40	32,000	80	64,000	850	680,000
Riprap Erosion Protection Bridges	m^2	11,000	2,400	26,400	800	8,800	3,600	39,600	-	-
Embankment	m^2	11,000	250	2,750	1,000	11,000	750	8,250	3,500	38,500
Gabions	m^3	40,000	-	-	-	-	270	10,800	-	-
Bridge Repairs	-	-	-	28,620	-	2,820	-	14,120	-	-
Sub-Total			-	116,160	-	139,430	-	234,140	-	762,450
TOTAL				771,282	-	912,053	-	1,220,594	-	1,330,386

Table 5.4
Construction Costs (1,000 MF, 1979)
Design Standard BB

ITEM	UNIT	UNIT COST (M.F.)	KAYES - DIALAKA Quantity	KAYES - DIALAKA Cost	DIALAKA - SANDARE Quantity	DIALAKA - SANDARE Cost	SANDARE - NIORO Quantity	SANDARE - NIORO Cost	DIALAKA - YELIMANE Quantity	DIALAKA - YELIMANE Cost
Clearing & Grubbing	m^2	60	965,000	57,900	830,000	49,800	1,455,000	87,300	1,020,000	61,200
Removal of Topsoil	m^2	200	458,000	91,600	246,000	49,200	767,000	153,400	680,000	136,000
Preparation of Sub-grade	m^2	220	891,000	196,020	671,000	147,620	1,177,000	258,940	748,000	164,560
Cut (wasted)	m^3	850	14,650	12,450	12,750	10,840	17,200	14,620	10,200	8,670
Fill (excavation materials)	m^3	1,600	27,000	43,200	56,600	90,560	5,900	9,440	10,200	16,320
Fill (borrow materials)	m^3	2,000	225,200	450,400	292,500	585,000	267,500	535,000	91,800	183,600
Ditching	lm	900	72,900	65,610	54,900	49,410	96,300	86,670	61,200	55,080
Sub-base	m^3	3,000	147,600	442,800	120,420	361,260	15,940	47,820	95,200	285,600
Base	m^3	3,300	129,600	427,680	97,600	322,080	171,200	564,960	108,800	359,040
Transportation of Base Materials	m^3/km	200	958,500	191,700	488,800	97,760	1,123,200	224,640	443,200	88,640
Transportation of Sub-base Materials	m^3/km	200	638,500	127,700	115,300	23,060	10,500	2,100	47,600	9,520
Addl. Cost - Rock Excav.	m^3	4,200	-	-	33,000	138,600	6,600	27,720	-	-
Addl. Cost - Ditch Excav. in Rock	lm	4,500	-	-	5,000	22,500	1,000	4,500	-	-
Retaining Walls	lm	200,000	-	-	1,000	200,000	200	40,000	-	-
Sub-Total			-	2,107,060	-	2,147,690	-	2,057,110	-	1,368,230
Removal of Existing Pipes	ea	80,000	26	2,080	5	400	28	2,240	-	-
Removal of Other Structures	m^3	40,000	24	960	31	1,240	57	2,280	-	-
Drainage Pipe Ø80-7m long	ea	430,000	125	53,750	72	30,960	136	58,480	68	29,240
Drainage Pipe Ø100-7m long	ea	620,000	20	12,400	16	9,920	35	21,700	-	-
Box Culverts 1x2-7m long (or equivalent)	ea	2,500,000	6	15,000	25	62,500	19	47,500	15	37,500
Fords	lm	800,000	-	-	60	48,000	120	96,000	1,300	1,040,000
Riprap Erosion Protection Bridges	m^2	11,000	2,400	26,400	800	8,800	3,600	39,600	-	-
Embankment	m^2	11,000	500	5,500	2,000	22,000	1,500	16,500	7,000	77,000
Gabions	m^3	40,000	-	-	-	-	270	10,800	-	-
Bridge Repairs			-	28,620	-	3,820	-	14,120	-	-
Sub-Total			-	144,710	-	187,640	-	309,220	-	1,183,740
TOTAL				2,251,770		2,335,330		2,366,330		2,551,970

Table 5.5

Construction Costs (1,000 MF, 1979)

Design Standard AA

ITEM	UNIT	UNIT COST (M.F.)	KAYES - DIALAKA Quantity	KAYES - DIALAKA Cost	DIALAKA - SANDARE Quantity	DIALAKA - SANDARE Cost	SANDARE - NIORO Quantity	SANDARE - NIORO Cost	DIALAKA-YELIMANE Quantity	DIALAKA-YELIMANE Cost
Clearing & Grubbing	m^2	60	965,000	57,900	830,000	49,800	1,455,000	87,300	1,020,000	61,200
Removal of Topsoil	m^2	200	458,000	91,600	246,000	49,200	767,000	153,400	680,000	136,000
Preparation of Sub-grade	m^2	220	891,000	196,020	671,000	147,620	1,177,000	258,940	748,000	164,560
Cut (wasted)	m^3	850	14,650	12,450	12,750	10,840	17,200	14,620	10,200	8,670
Fill (excavation materials)	m^3	1,600	27,000	43,200	56,600	90,560	5,900	9,440	10,200	16,320
Fill (borrow materials)	m^3	2,000	225,200	450,400	292,500	585,000	267,500	535,000	91,800	183,600
Ditching	lm	900	72,900	65,610	54,900	49,410	96,300	86,670	61,200	55,080
Sub-base	m^3	3,000	147,600	442,800	120,420	361,260	15,940	47,820	95,200	285,600
Base	m^3	3,300	129,600	427,680	97,600	322,080	171,200	564,960	108,800	359,040
Transportation of Base Materials	m^3/km	200	958,500	191,700	488,800	97,760	1,123,200	224,640	443,200	88,640
Transportation of Sub-base Materials	m^3/km	200	638,500	127,700	115,300	23,060	10,500	2,100	47,600	9,520
Addl. Cost - Rock Excav.	m^3	4,200	-	-	33,000	138,600	6,600	27,720	-	-
Addl. Cost - Ditch Excav. in Rock	lm	4,500	-	-	5,000	22,500	1,000	4,500	-	-
Retaining Walls	lm	200,000	-	-	1,000	200,000	200	40,000	-	-
Sub-Total			-	2,107,060	-	2,147,690	-	2,057,110	-	1,368,230
Prime Coating	m^2	400	421,200	168,480	317,200	126,880	556,400	222,560	-	-
DBST	m^2	1,500	405,000	607,500	305,000	457,500	535,000	802,500	-	-
Transportation of Aggregates	m^3/km	200	132,000	26,400	61,300	12,260	312,800	62,560	-	-
Sub-Total			-	802,380	-	596,640	-	1,087,620	-	-
Removal of Existing Pipes	ea	80,000	26	2,080	5	400	28	2,240	-	-
Removal of Other Structures	m^3	40,000	24	960	31	1,240	57	2,280	-	-
Drainage Pipe Ø80-7m long	ea	430,000	125	53,750	72	30,960	136	58,480	68	29,240
Drainage Pipe Ø100-7m long	ea	620,000	20	12,400	16	9,920	35	21,700	-	-
Box Culverts 1x2-7m long (or equivalent)	ea	2,500,000	6	15,000	25	62,500	19	47,500	15	37,500
Fords	lm	800,000	-	-	60	48,000	120	96,000	1,300	1,040,000
Riprap Erosion Protection Bridges	m^2	11,000	2,400	26,400	800	8,800	3,600	39,600	-	-
Embankment	m^2	11,000	500	5,500	2,000	22,000	1,500	16,500	7,000	77,000
Gabions	m^3	40,000	-	-	-	-	270	10,800	-	-
Bridge Repairs			-	28,620	-	3,820	-	14,120	-	-
Sub-Total			-	144,710	-	187,640	-	309,220	-	1,183,740
TOTAL				3,054,150		2,931,970		3,453,950		2,551,970

Table 5.6

Summary of Capital Investment Costs (1,000 MF, 1979)

ROAD IMPROVEMENT ALTERNATIVES	CONSTRUCTION COST				SUBTOTAL	TOTAL COST*
	KAYES-DIALAKA	DIALAKA-SANDARE	SANDARE-NIORO	DIALAKA-YELIMANE		
1	CC 771,282	CC 912,053	CC 1,220,594	-	2,903,929	3,673,470
2	CC 771,282	CC 912,053	CC 1,220,594	CC 1,330,386	4,234,315	5,356,408
3	BB 2,251,770	CC 912,053	CC 1,220,594	CC 1,330,386	5,714,803	7,229,225
4	BB 2,251,770	BB 2,335,330	BB 2,366,330	CC 1,330,386	8,283,816	10,479,027
5	AA 3,054,150	BB 2,335,330	BB 2,366,330	CC 1,330,386	9,086,196	11,494,037
6	AA 3,054,150	AA 2,931,970	AA 3,453,950	CC 1,330,386	10,770,456	13,624,626
7	AA 3,054,150	AA 2,931,970	AA 3,453,950	BB 2,551,970	11,992,040	15,169,930

* Total cost includes mobilization, construction, design and supervision.

In the case of a technical assistance implementation program, the design and supervision costs have been estimated at 10% of total construction and mobilization costs. When an A/E consultant is used, the design cost is estimated at 9%, including additional studies, and expatriate construction management at 1% of total construction and mobilization costs. Supervision of contractor construction and local construction management of force account work are estimated, in this later case, to be covered within the construction and mobilization costs. This is possible, due to a more economical design as provided by an A/E consultant.

5.2.3 COST COMPONENTS

Construction costs were allocated between the foreign and local currency components. In addition, costs were separated into equipment, materials and labor components.

Based on information obtained from private contractors in Mali, an analysis of recent bids and data provided in existing reports available with D.N.T.P., the total construction costs, excluding most local taxes, have been broken down as follows:

A) Sources of funds

Foreign Currency	75%
Local Currency	25%
Total	100%

B) Application of funds

Equipment	55%
Materials	25%
Expatriate Salaries	10%
Local Salaries	10%
Total	100%

In practice, it is very difficult to exclude all taxes since in many "tax-free" contracts taxes are still paid on fuel and salaries and social contributions are made. Table 5.7 summarizes these breakdowns for all seven alternative road improvements.

5.3 COMPARISON WITH OTHER MALIAN ROADS

Unit costs for the Kayes-Nioro road, including Mobilization but excluding Design & Supervision, are as follows:

Road Improvement Level	Cost (1,000 MF/km; 1979)
CC	13,358
BB	31,986
AA	43.424

The above costs are compatible with recent experience when they are compared with those given below for other roads in Mali:

Road	Total Cost (1,000MF)	Length-km	Unit Cost (1,000FM/km)	Date
Access to Selingue Dam	2,198,700	35 (1)	62,820 (2)	Current
Sikasso-Koutiala	7,473,000	132	56,613 (2)	"
Didieni-Goumbou	3,000,000	180	16,666 (3) (6)	"
Ansongo-Anderambou-Kane	4,312,400	310	13,911 (3)	"
Sevare-Hombori	9,514,000	328	29,000 (4)	"
Sevare-Kersedougou	1,237,000	100	12,370 (5)	"
Markala-Nioro	6,875,000	71	96,830 (2)	Near Future

(1) Actual completed
(2) Bituminous surface
(3) Feeder Roads
(4) Cost does not include bridges and bituminous surfacing
(5) Road improvement consists of only bituminous surfacing
(6) Force account construction with "Cost Center" approach using technical assistance. Close to level CC, but with somewhat thicker pavement.

Table 5.7

Breakdown Of Costs Summary (1,000 MF, 1979)

Road Improvement Alternatives	Source of Funds		Application of Funds	
	Foreign Cost	Local Cost	Local Salaries	Other Costs
1	2,755,102	918,367	367,347	3,306,123
2	4,017,306	1,339,102	535,640	4,820,767
3	5,421,918	1,807,306	722,922	6,506,302
4	7,859,270	2,619,756	1,047,902	9,431,124
5	8,620,527	2,873,509	1,149,403	10,344,633
6	10,218,469	3,406,156	1,362.462	12,262,163
7	11,377,447	3,792,482	1,516,993	13,652,937

5.4 BRIDGES ON KAYES-NIORO ROAD

As discussed in Chapter 3, all bridges on the Kayes-Nioro road were inspected and found to be in sufficiently good condition that only minor rehabilitation is warranted. Much of the needed work is for rebuilt approaches allowing faster and safer traffic use, erosion protection, and parapet and railing work. Estimated rehabilitation costs are presented in Table 5-8 for all bridges. These costs have already been included in the Construction Cost estimates given in Tables 5.3 through 5.7.

Table 5-8

Rehabilitation Costs of Bridges on Kayes-Nioro Road

Station	Estimated Cost (1,000 MF)
11+41	1,406
19+34	3,028
29+77	5,292
30+20	950
57+67	16,154
60+11	1,790
93+67	1,000
103+31	2,820
144+43	1,327
149+92	666
156+78	1,826
177+80	1,066
177+89	3,170
214+20	1,510
217+08	1,613
222+40	971
250+25	1,970
Total	46,559
Foreign Component	34,919
Local Component - Material	8,148
Labor	3,492

5.5 SPECIAL BRIDGE STUDIES

As already discussed, USAID/Mali requested the consultant to assess the needs for bridges in the vicinity of Kayes, in consultation with First Region GOM officials. Following are order of magnitude cost estimates for those bridges which were selected and investigated. These estimates should be considered as very tentative. In addition, it will be noted that the costs for these bridges are not included in any of the later analyses as they do not relate directly to the study road.

5.5.1 SENEGAL RIVER BRIDGE

Based on the preliminary design given in Chapter 3, the following quantities and costs were estimated:

No.	Item	Unit	Price (1,000 MF)	Quantity	Cost (1,000 MF)
1	Concrete (350 kg) - Superstructure	m^3	170,000	1,050	180,600
2	Concrete (350 kg) - Substructure	m^3	138,000	2,400	330,240
3	Prestress Concrete	m^3	270,000	860	228,760
4	Reinforcing Steel	kg	650	470,000	293,750
5	Other Items	--	--	--	67,230
				Subtotal	1,100,580
Add 30% for Mobilization, clearance, wingwalls, etc.					330,174
				Total	1,430,754
Foreign Component					1,073,000
Local Component		-	Material		250,000
		-	Labor		108,000

5.5.2 OTHER BRIDGES IN THE VICINITY OF KAYES

Based on preliminary analyses given in Appendix D, the following costs are estimated:

Type of Work	Bridge	Cost (1,000 MF)
Construction	New bridge across Papara River on Kayes-Keniéba Road, Near Bintiguela	112,000
Rehabilitation	Bridge near Bintiguela, 14 km from Kayes	2,130
Rehabilitation	Bridge across Kamankolé River on Keniéba Road	13,224
	Total	127,354
	Foreign Component	95,515
	Local Component - Materials	22,287
	- Labor	9,552

CHAPTER 6

CHAPTER 6

ROAD MAINTENANCE PROGRAM

6.1 EXISTING ROAD MAINTENANCE SYSTEM

6.1.1 ADMINISTRATION, STAFFING AND FINANCE

6.1.1.1 ADMINISTRATION

A principal division of the Ministère des Travaux Publics et du Tourisme (MTPT), the Direction Nationale des Travaux Publics (DNTP), has overall responsibility for road maintenance. In addition, it is responsible for studies, plans, designs, supervision and execution of road construction and for technical studies of railways, ports and airports. Periodic maintenance by force account (seal coating and regraveling) is usually carried out by specially organized mobile brigades functioning under the Division Technique of the DNTP. Routine and emergency maintenance is normally the responsibility of eight Regional Directorates located throughout the country. Regional Directorates administer a present total of eighteen subdivision depots which support local maintenance workforces and equipment.

Within the DNTP, the Division des Etudes Générales et des Programmes prepares investment and maintenance programs, budgets and does expenditure control; the Division des Etudes Techniques et de Recherches studies projects and supervises works; the Division Technique executes road construction and periodic maintenance. Five other principal divisions of the Ministry of Public Works all interact with and support the DNTP. Chief among these are the Service du Matériel (equipment services) which purchases,

maintains and repairs road equipment; the Centre de Perfectionnement du Personnel (training center); the surveying institute; and the Centre National de Recherches et d'Experimentation (soils and materials laboratory).

Equipment is rented by the Service du Matériel to the regions and to the Division Technique (the bituminous brigades, for instance). A sample of these rates is shown in Table 6-1. The equipment can also be rented to private companies and corporations but at higher rates.

6.1.1.2 STAFFING

The operational staff directly involved in planning, supervising and executing road and equipment maintenance numbers in excess of 1,300 engineers, technicians and skilled workers. There is a permanent workforce in excess of 1,100 engineers, technicians and skilled workers in the Direction Nationale des Travaux Publics (DNTP); in excess of 200 personnel responsible for mechanical maintenance are employed by the Service du Matériel. Total permanent personnel is considered sufficient for the operation and maintenance of the present Mali road network. The ongoing Third and proposed Fourth Highway Projects of the World Bank contain provisions for training which would reach almost all personnel in the DNTP and Service du Materiel.

The ratio of permanent road maintenance and equipment maintenance personnel to the road network and equipment fleet is high and would be judged excessive in a developed country. Considering the extremely dispersed road network (0.01 km of roads of all types per square km of land area), plus difficulties in communications and transport between maintenance centers, and present levels of skills and efficiency, this ratio may not be excessive for conditions in Mali.

Approximately 20% of the total DNTP staff is assigned to the First Region (Kayes). This level of staffing is approximately equal to the First

Table 6-1

Equipment Rental Rates (1979), Applicable to Ministry Divisions[1]

Type	Value[2] (Million FM)	Rate Charged to Regional Divisions		Rate Charged to Division Technique	
		Daily	Hour/Kilometer	Daily	Hour/Kilometer
Bulldozer	88.5	142,400	17,800	160,600	20,100
Loader	33.0	61,300	7,700	66,200	8,300
Grader	44.1	75,800	9,500	82,500	10,300
Roller	43.8	42,100	5,300	48,700	6,100
Pneumatic Roller	68.1	117,000	14,600	127,000	15,900
Tractor	7.3	10,700	1,300	11,800	1,500
Tracled Roller	10.0	9,200	1,100	10,300	1,300
Truck (5T)	9.8	17,500	55	19,000	60
Truck (13T)	16.0	28,500	90	30,900	95
Water Truck	28.2	40,300	125	44,600	140
Low Boy	18.3	23,100	70	25,200	80
Light Vehicle	3.4	5,500	15	6,000	20
Pick-up	6.5	10,500	30	11,500	35

1/ Source: Service du Materiel, Ministry of Public Works and Tourism, 1979.

2/ All taxes included.

Table 6.2

First Region Staff (1978)

Designation	Direction Regionale	Subdivision Kayes	Subdivision Nioro	Subdivision Kita	Total General
Ingenieur 2° degre	1	-	-	-	1
Ingenieur 1° degre	-	1	1	-	2
Techniciens	-	1	-	2	3
Comptable	1	3	1	1	6
Secretaires Dactylo	3	2	2	2	9
Plantons	2	3	2	1	8
Gardiens	1	1	2	2	6
Magasiniens	-	3	2	-	5
Pointeau-Facturier	-	1	1	2	4
Surveillant chantier	-	-	3	-	3
Pointeurs	-	2	2	1	5
Contre-maitre T. P.	-	4	-	-	4
Contre-maitre mecanique	-	6	4	7	17
Mecaniciens	-	9	5	-	14
Aide-mecaniciens	-	5	1	2	8
Ajusteur et chandronnier	-	2	-	-	2
Soudeurs	-	1	-	1	2
Forgerons-Ferrailleurs	-	4	-	-	4
Menuisiers-charpentiers	-	5	3	2	10
Mason	-	6	4	2	12
Aides-Masons	-	4	1	4	9
Peintres	-	1	-	2	3
Chauffeurs et Chauff. mecanic	1	10	15	7	33
Conducteur	-	8	3	2	13
Aides-Conducteurs	-	4	-	1	5
Graisseurs	-	2	-	-	2
Manoeuvres	2	15	12	1	30
TOTAL	11	103	64	42	220

Region's proportion (23%) of classified and unclassified roads in the national network. Table 6-2 lists classifications of First Region personnel and distribution of staff between regional directorate and smaller administrative units. The number of engineering personnel is relatively small in comparison to the total permanent workforce.

6.1.1.3 FINANCES

Road user charges in the form of taxes on petroleum products, vehicle and parts imports and vehicle registrations are the principal sources of revenue (95%) for the Road Fund. The fund finances expenditures for road maintenance and equipment procurement, road studies and investments, the soils and materials laboratory, street improvements, and road loan debt service. The national budget, in addition, finances some administrative costs and occasionally urgent investment work. Revenues from user charges during the period 1973-77 exceeded actual road outlays as indicated by the comparison given in Table 6-3; however, only about 30% of the user charges are allocated to the road fund.

Table 6-3

User Charge Revenue and Road Outlay (in Million FM)[1]

	1973	1974	1975	1976	1977
User Charge Revenue	5,200	5,261	6,904	6,679	7,594
Road Fund Outlay[2]	3,159	4,738	6,127	5,616	6,146
User Charge Revenue expended by Road Fund	1,430	2,388	1,882	1,883	2,446

The International Development Association (IDA) states that due to severe inflation: "allocations for road maintenance in real terms have decreased over this period as Road Fund revenues have been increasingly used to finance Malian contributions to road investments." In addition,

1/ Source: GRM documents

2/ External source financing constituted about 56% of actual outlays during this period.

the actual status of the Road Fund is problematic since many road user fees are paid into the Postal Checking System upon which the Road User Fund must draw checks for much of its revenue. Because the Postal Checking System experiences problems in remaining liquid, the Road Fund is affected. Overall, the road fund, as presently funded, is not capable of handling road maintenance requirements for the country as a whole.

6.1.2 EQUIPMENT AND WORKSHOPS

6.1.2.1 REGIONAL FACILITIES

Facilities in the First Region, for equipment maintenance and repair, parking and storage of maintenance materials are situated at Kayes, Nioro and Kita. Additionally, there is a small depot for storing fuel in drums at Sandare. Detailed inspections of district and sub-district facilities at Kayes and Nioro by TAMS personnel indicated that these are only minimally functional. Statements by various ministry personnel indicated that the Kita facility is in a similar status.

Geographical distribution of the three facilities is good, since they are well-spaced within the First Region, but each facility is 200 kilometers distant from the other. In the future, should an additional sub-district facility be established at Keneiba, travel to the most distant portions of the entire First Region road network would seldom exceed 100 kilometers from the nearest maintenance facility. Land areas and buildings for equipment repair, storage and offices are adequate at both Kayes and Nioro. If supplied with electricity and water, they could support increased maintenance loads.

Shop equipment and supplies for proper fueling, preventive maintenance and light contact mechanical repair are lacking. These functions are presently inadequately performed or not performed at all at Kayes and Nioro, because of missing or inoperative equipment or lack of parts and

supplies. For example, 90 percent or more of the heavy equipment inspected--trucks, graders, dozers, loaders and tankers--has been out of commission for periods of six months to several years. On much of the inoperative equipment, tires or tracks were relatively new and in some instances appeared to be original.

One result of these conditions is that the small amount of road maintenance presently carried out is inordinately expensive due to rental costs for deadlined equipment and salaries of idle or underutilized staff. Another result is short life-expectancy of equipment. Throughout Mali, a widely quoted rule of thumb is that light vehicles have a four year life expectancy and heavy equipment lasts five years. Although road conditions diminish vehicle life, absence of proper mechanical maintenance is also a significant factor.

The following factors require improvement in order to upgrade the low level of facility support for road maintenance:

- Funding. Adequate operating funds must be available to district and sub-district workshops to permit purchase of off-the-shelf consumable supplies,and parts must be promptly received.

- Preventive Maintenance Equipment (Regional Workshop). To remedy conditions in First Region workshops, complete re-equipping will be necessary to support even minimal mechanized maintenance activity. The first priority is portable service equipment for daily repairs of equipment at the workshops and/or at work sites. Second stage improvements should concentrate on stationary equipment for workshops, in the event both objectives cannot be realized simultaneously. Absence of power and water at the Nioro workshop and inadequacy thereof at Kayes makes portable equipment a first priority.

6.1.2.2 CENTRAL WORKSHOPS

Bamako is the headquarters for the Service du Matériel. Buildings and yards for equipment repair and overhaul are extensive and well planned. Interior layouts and infrastructure of the machine shop and heavy and light equipment repair shops are well designed for large scale equipment maintenance, as are many of the out-buildings and speciality shops.

Despite these good facilities, the Central Workshop was barely functioning during the period of the TAMS' team inspection. Obvious were shortages of electricity, spare parts and consumable supplies necessary for equipment repair. Conspicuously lacking in the spare parts warehouse were supplies of welding rods, gasket materials, hoses, belts, hydraulic fluids and stocks of nuts and bolts, without which there can be little efficient equipment repair. Spare parts in warehouses appeared to consist largely of "dead stock", i.e., seldom required parts.

The machine shop contained an impressive amount of equipment but, for example, only one lathe was in operation. There was a noticeable lack of equipment and tools in specialty workshops, i.e., diagnostic equipment, battery chargers, engine starters, welding equipment, etc. Only one air compressor (of five) in the facility was in working condition. There is no steam cleaning equipment and high pressure water cleaning equipment was inoperative. Available tools cannot always be located. In the engine rebuilding shop there was a large accumulation of truck and heavy equipment engines (about 40) awaiting repair.

These observations are indicative of a largely ineffective facility due to a critical lack of operating funds and experience.

6.1.2.3 ROAD MAINTENANCE EQUIPMENT INVENTORY

Service du Matériel or equipment division has an inventory of approximately 625 units of road equipment and vehicles to support maintenance of some 14,000 kilometers of roads and tracks. As of July 1979, the status of this fleet was officially described as given in Table 6-4.

Table 6-4

Status of Equipment Fleet

Number	Percent of Fleet	Condition or Comment
56	9	Good Operating Condition
232	37	In Service But Needs Repair
125	20	Needs Major Repair
212	34	Should be Scrapped
625	100	

The amount of out-of-service or limited-service equipment can be expected to increase rapidly until such time as technical assistance intervention, parts procurement and operator and mechanics training programs combine to improve significantly the overall proficiency within the Service du Matériel and hence in Mali.

6.2 PLANNED IMPROVEMENTS (FOURTH HIGHWAY PROGRAM)

The Fourth Highway Program of the International Development Association (IDA) contemplates financial, administrative and technical improvements to the road maintenance system. This project is still in the appraisal/negotiation stage at this writing. The information herein included, is unofficial, of an interim nature, subject to modifications, and based on an exchange of views with GRM and World Bank staff in Mali. The program is estimated to start within the year, if approved by GRM and the World Bank.

6.2.1 PLANNED FINANCING MECHANISM

Under the Fourth Highway Program, the control division of the Ministry of Finance would propose increases on current fuel taxes in the order of 10 MF per litre to provide usable, ongoing revenues to finance GRM contributions to the planned extensive road maintenance work. The proposed changes would also raise the proportion of these taxes that would be allocated to the Road Fund. On the basis of the increased fuel taxes, it is estimated that the Road Fund would be able to meet the requirements of countrywide, limited routine maintenance, periodic maintenance for selected roads, local components of IDA projects, ongoinging and other priority road investments, and the amortization of debt service of past road projects. In addition, there would be a projected Road Fund surplus at the end of 1983.

6.2.2 PLANNED TRAINING AND TECHNICAL ASSISTANCE

Under the GRM/IDA 1980-83 program, no technical assistance is being provided directly to the DNTP. For the Service du Matériel, IDA intends to provide expert mechanical technical assistance during the on-going Third Highway Program and the proposed follow-up Fourth Highway Program. Technical assistance to the Ministry's accounting office would be provided, should the need be identified during periodic program audits. The possibility for an accounting office training fellowship is included. Technical assistance for establishing a transport data collection unit in the Ministry is also contemplated.

The 1980-83 Program (in its present unofficial stage) is designed to complete the training of Ministry road and equipment maintenance personnel, both at the center and in the regions. The center for training ministry personnel is located in Bamako. This center, designated the Centre de Perfectionnment du Personnel des Travaux Publics (CPPTP), was established under the Second and Third Highway Programs and began limited training operations in late 1978. The training staff will be increased from its

present level. Also, funding will be made available for additional CPPTP facilities, teaching materials, equipment tools and vehicles and field equipment.

6.2.3 PLANNED IMPROVEMENTS TO WORKSHOP AND ROAD MAINTENANCE EQUIPMENT

The Fourth Highway Program presently includes planning and external funding for improvements to workshops, including equipment and tooling. These improvements are to be centered on the central facility in Bamako as the keystone to an ambitious road equipment rehabilitation and road maintenance program. IDA proposes to fund a significant portion of the costs for shop improvements, new shop tools and spare parts in existing road equipment. However, direct IDA funding identified for improvements in workshops would not significantly affect capabilities of the 18 district and sub-district workshops, once the needs of the central facility were satisfied.

The Fourth Highway Program anticipates repairing about 200 of the 300 items of road maintenance equipment in the present inventory that are contemplated for use in the 1980-83 Program. A period of at least three years is estimated for the repair of this portion of the fleet. Much of the remaining and operational equipment will, however, reach the end of its scheduled physical life prior to completion of the Fourth Highway Program. Rehabilitated road maintenance equipment is to be reinforced with new acquisitions to remedy deficiencies in type and number. Some of the new acquisitions would be used for force account brigades to increase capacity for carrying out deferred periodic maintenance planned for execution under the 1980-83 Highway Program. Overall, the Program is designed to be self sustaining at a level adequate for meeting country wide routine maintenance requirements.

Programs for equipment rehabilitation and for new equipment acquisition, if fully realized, might produce a combined fleet amounting to

some 350 units of all types in service at any one time, assuming a relatively low equipment availability factor of 60%. This amount of equipment should be sufficient to support the amount of road maintenance planned during the Fourth Highway Program.

6.3 MAINTENANCE PROGRAM PROPOSED UNDER KAYES-NIORO PROJECT

The analyses made for the maintenance program proposed herein have examined maintenance requirements from two vantage points: recommendations for the First Region in general and recommendations specific for the Kayes-Nioro Road. The program is discussed by type of program element. Where pertinent, each of these two vantage points is addressed.

As the Fourth Highway Program is, as of this writing, still in the appraisal/negotiation stage, the maintenance program proposed as part of this study is discussed for two conditions: 1) the Fourth Highway Program is implemented successfully and 2) said program is not implemented. Proposals are made for both possibilities.

6.3.1 ADMINISTRATION

No administrative changes are recommended to carry out the required road maintenance in the First Region and on the Kayes-Nioro Road. This also is the point of view of GRM officials.

6.3.2 MANPOWER REQUIREMENTS

As indicated in Section 6.1.1, the present overall total permanent staff of more than 1,300 engineers, technicians and skilled workers (DNTP plus Service du Materiel) is considered adequate to maintain the National Road Network, augmented as appropriate with seasonal laborers. The staffing level of the First Region, now approximately 220 in the Directorate and subdivisions, is also considered adequate for road maintenance purposes. Adjustments in the distribution of personnel among classifications might be necessary to meet changing maintenance requirements. For example, the existance of a paved road will necessitate a different personnel mix. It is assumed that this can be accomplished by drawing upon the reservoir of personnel in DNTP and Service du Matériel.

6.3.3 TECHNICAL ASSISTANCE AND TRAINING

No requirements for technical assistance in maintaining the Kayes-Nioro Road in the immediate post-construction period can be identified at this time. Longer term requirements for technical assistance will depend upon the success of the training program conducted by the permanent training center in Bamako and the ability of the Ministry to retain trained and experienced personnel. The turnover rate in DNTP personnel during the proposed IDA 1980-83 program period, estimated at 5% per year, is not considered excessive and has been taken into consideration in formulating training plans.

In view of the extensive training plans for the Fourth Highway Program period, no supplementary program is recommended for the same time frame. It is advisable that the IDA and GRM be consulted prior to the end of the program to determine whether or not additional financial assistance for the continued operation of the Centre de Perfectionnement du Personnel des Travaux Publics might be desirable.

6.3.4 ROAD MAINTENANCE AND WORKSHOP EQUIPMENT REQUIREMENTS

As discussed in Section 6.2.3, the equipment situation at the end of road construction in 1985 cannot be easily projected. Without the Fourth Highway Program a very serious deficit is most likely for both road maintenance and workshop equipment. With the Fourth Highway Program, however, a significant amount of change can be anticipated for the First Region, since routine annual maintenance is planned for all national and regional routes. In addition, the projected surplus in the Road Fund, if partially allocated for periodic maintenance, would further improve the maintenance situation in the First Region. If the Fourth Highway Program is implemented successfully as planned, most future First Region requirements for road maintenance equipment would most likely be met at a somewhat adequate level without further assistance. However, it is not anticipated that the Fourth Highway

Program will be able to meet in a timely manner the requirements for workshop equipment.

6.3.4.1 REGIONAL REQUIREMENTS FOR WORKSHOP EQUIPMENT

Preventive maintenance and general workshop equipment is almost non-existent at present in sub-district facilities. In addition, it is not anticipated that the Fourth Highway Program will change significantly this situation prior to the end of its IDA funding phase in 1983. Most likely, the lack of workshop equipment in the First Region will persist beyond the latter date well into the post construction period of the Kayes-Nioro Road. In order to insure the availability of workshop equipment for repair of road maintenance equipment in the First Region, minimum requirements have been estimated. Table 6-5 gives a preliminary list of the minimum preventive maintenance and daily service equipment for First Region Workshops. The drafting of a final list could be carried out at the design phase of the Kayes-Nioro Road, in conjunction with the ordering of road construction equipment recommended in Chapter 4. This would permit further refinement and more appropriateness to actual future needs.

Table 6.5 has been developed on the basis of field visits to the Kayes and Nioro facilities. These visits indicated that, expecially at Nioro, facilities for adequate fuel and water storage and power generation must be improved. Water is only available by tanker and there is no means for permanent water storage. Fuel storage is inadequate, considering the difficulty of re-supply and tanks cannot be utilized due to the absence of power. Additional tanks and new metering pumps for diesel and gasoline will be necessary, Two electric generators should be installed for reliability of service, but do not need to be of very large capacity. In addition, shop manuals or parts catalogs for equipment on hand must be made available. Lack of these, as at present, can generate protracted lost time in diagnosing problems, ordering correct parts and in making proper adjustments to road

Table 6-5

Recommended First Region Workshop Equipment
(MF million, 1979)

Item	Quantity	Local Cost	Foreign Cost	Total
Lubrication Equipment, Power and Hand	3 sets	1.8	12.6	14.4
Tire Service Equipment	3 sets	0.6	4.2	4.8
Refueling Equipment	3 units	1.5	10.5	12.0
Cleaning Equipment, Steam or H.P. Water	3 units	0.2	1.3	1.5
Battery Charger and Circuit Testor	3 sets	0.1	0.5	0.6
Welding Machine, 300A	3 ea.	1.0	6.8	7.8
Power Set	3 ea.	0.4	2.9	3.3
Hand Tools	3 sets	0.1	0.8	0.9
Building Improvements	sum	5.4	24.6	30.0
SUBTOTALS		11.1	64.2	75.3
20% Spare Parts		2.2	12.9	15.1
10% Contingencies		1.1	6.4	7.5
TOTALS		14.4	83.5	97.9

maintenance equipment. In the long run, a fourth district workshop at Keneiba would reduce the relatively long travel distance now necessary to serve the region's roads.

6.3.4.2 KAYES-NIORO ROAD EQUIPMENT REQUIREMENTS

In order to insure maintenance of the Kayes-Nioro road in the first post construction period, should the Fourth Highway Program fail for a number of reasons to affect road maintenance levels in the First Region, it is recommended to reconstruct one section of the road by force account. Reconstruction of a road section by force account, utilizing new equipment acquired for the work, would make relatively new equipment available for maintenance purposes in the First Region in 1985. Equipment recommendations and estimated costs, totalling MF 557 million, have been itemized in Table 4-1. The Kayes-Nioro Technical advisory staff, or the A/E consultant retained for the design phase, would assist in final selection and procurement of the equipment.

Priority for use of this equipment if given to the Kayes-Nioro Road, will insure adequate levels of maintenance on said road during the first post construction period, even if the Fourth Highway Program fails to mature as presently anticipated. A contract condition precedent to maintain on a priority basis, i.e., priority allocation of maintenance funds and equipment to the Kayes-Nioro Road, could be considered by donor agencies.

6.4 ROAD MAINTENANCE BUDGETING REQUIREMENTS

6.4.1 GENERAL

The road maintenance costs, presented hereafter, are the total costs required for properly maintaining the Kayes-Nioro Road network, and that for the First Region. These would include costs to be incurred by the Fourth Highway program and costs to be incurred for maintenance activities not covered under said program. As this World Bank program is still

not finalized, it is not possible at this stage to allocate the total costs between said program and additional needed activities. Appendix H presents the total required costs for maintaining the Kayes-Nioro road network.

If said World Bank program is not implemented, the budgeting requirements would be for the total costs. Should the Fourth Highway program materialize, then the budgeting requirements would be reduced by as much.

6.4.1.1 STRATEGY

Road maintenance involves a multitude of field operations each appropriately carried out using a specific technology. The recommended strategy for employment of labor-based, equipment-based and appropriate labor/equipment mixes for road maintenance in Mali is based upon previous studies of Mali's human resources, and economic and field conditions. In broad terms, the recommended strategy is identified as follows:

- Heavy maintenance should be carried out by equipment intensive means. This category of field operations includes resealing pavement, grading, regraveling, compacting and anti-corrugation dragging (tôle ondulée) of aggregate roadways.
- Light maintenance should be carried out by labor intensive means. This category includes clearing shoulders, cleaning drainage, hand loading trucks, pot-hole repair, etc. involving minimum skill and direction.
- Routine maintenance is appropriately carried out using a mix of equipment and labor. These operations include patching, spot emergency repair, regraveling shoulders and drainage maintenance other than simple clearance of debris.

6.4.1.2 ROAD MAINTENANCE SCHEDULES

Road maintenance schedules recommended for the First Region also apply to the Kayes-Nioro Road. Recommended frequencies for road maintenance operations are reasonably consistent with GRM standards and maintenance strategies anticipated by the Fourth Highway Program. Actual frequencies should be determined for individual facilities after careful consideration of a number of strongly influential variables, including quality of initial design and construction, topography, climate and user traffic.

Maintenance requirements for engineered gravel and paved (with a double surface treatment) roads would be as indicated in Table 6-6 and 6-7 for routine and periodic maintenance.

6.4.1.3 ESTIMATE OF UNIT MAINTENANCE COSTS

Unit maintenance costs adopted for estimating maintenance expenditures are shown in Table 6-8. These costs have been developed using GRM and IDA sources in conjunction with the adopted road maintenance strategy, presented in the previous section. These costs are without taxes and include costs of labor, materials, equipment amortization and operation and overhead.

6.4.2 ESTIMATE OF BUDGETING REQUIREMENTS FOR FIRST REGION

To develop First Region annualized maintenance expenditures (both periodic and routine), simplifying assumptions for road characteristics and bridges were adopted. Bridge estimates were assumed for the region based on the number of bridges per kilometer for the Kayes-Nioro road since no regional bridge inventory was available. Requirements for annualized expenditures were estimated by accounting for the following factors:

- Maintenance strategy
- Maintenance requirements and schedules
- Unit maintenance costs
- Extent of road network

Table 6-6

Routine Annual Road Maintenance Requirements

Road Type	Traffic (vpd)	Operation	Estimated Quantity (per km per year)
Paved (DBST)	100-150	- clear shoulders and clean drainage	1,000 m
		- patch 1.5% of surface area	75 sq. m.
Gravel Surface	50-80	- clear shoulders and clean drainage	1,000 m
		- drag surface (anti-corrugation) average 30 times per year	30,000 m
		- spot repair 8% of surface area	65 cu. m.
		- dry grading average 2 times per year	2,000 m
Feeder Road	10-30	- control vegetation and clean drainage	1,000 m
		- spot repair 10% of surface	40 cu. m.
		- dry grading once annually	1,000 m
Seasonal Track	minimal	- control vegetation	1,000 m
		- spot repair 15% of surface area	30 cu. m.
		- dry grading average 0.5 times per year	500 m

Table 6-7

Periodic Road Maintenance Requirements

Road Type	Traffic (vpd)	Operation and Frequency	Estimated Quantity (per km)	Frequency (years)
Paved (DBST)	100-150	- regravel shoulders (5cm) and reshape ditches	1,000 m	5
		- seal coat	1,000 m	8
Gravel Surface	50-80	- regrade and compact	1,000 m	3
		- regravel surface (10 cm)	1,000 m	6
		- reshape ditches	1,000 m	5
Feeder Road	10-30	- regravel (5 cm) half length	500 m	8
		- reshape ditches	1,000 m	5
Tracks	minimal	- no periodic schedule	--	--
Bridges		- inspect and maintain as necessary		5

Table 6-8

Estimated Unit Maintenance Costs (1,000 MF, 1979)

Operation	Unit	Cost (w/o Tax)
Light Maintenance	km	157,000
Spot Repair	m^3	3,000
Dragging Surface	km	2,200
Dry Grading Surface	km	46,000
Grading/Compacting	km	125,000
Ditch Shaping	km	56,000
Regraveling	m^3	2,800
Bituminous Patch	m^2	1,900
Bituminous Seal	m^2	1,400
Regravel Shoulders	m^3	2,800
Maintain Bridges	lm	16,400

The road network in the First Region is summarized in Table 6-9. Presently, the total network consists of about 3,300 km of national and local routes, feeder roads and seasonal tracks. In addition, there are no paved roads in the First Region.

Table 6-9

First Region Road Network

Type	Traffic (Vpd)	Length (km)	Width (m)	Thickness of Pavement (m)
Gravel	35	862	5.5	.15
Feeder or Improved Track	10	1775	4	.10
Seasonal Track	5	693	4	.05
		3.330		

Table 6-10 summarizes the computed estimates for required annualized maintenance expenditures in the First Region. It should be noted that the annual routine maintenance expenditures, estimated at 1,120 million MF, would make up about 78 percent of the annualized total for the First Region.

Audit of the financial accounts, made by others, indicates an expenditure level of over 200 million MF per year, during the 1976-78 period, for road maintenance in the First Region. A comparison with estimated requirements shows clearly the need for substantial additional funds.

6.4.3 ESTIMATE OF BUDGETING REQUIREMENTS FOR KAYES-NIORO ROAD

Required expenditures for maintenance of the Kayes-Nioro road have been estimated for three road standards. These have been defined in Chapter 3 and compared to existing Malian standards. In addition, estimates of costs for maintaining the road at its present level (i.e. status quo; vehicle operation costs are constant) have been made. Table 6.11 summarizes said estimates on a kilometer basis. The bases for these estimates are those used to determine required expenditures for maintaining the whole road network of the First Region.

Table 6-10

Estimate of First Region Requirements for Annualized Maintenance Expenditures
(W/O Taxes, Million MF, 1979)

Road Class	Network Length (km)	Cost per Kilometer			Total Annualized Expenditures
		Routine Annual	Annualized Periodic	Annualized Total	
Gravel	862	0.510	0.285	0.795	685.6
Feeder Road/ Improved Track	1,775	0.323	0.037	0.360	639.4
Seasonal Track	693	0.152	--	0.152	105.5
	3,330				1,430.5
Bridges	1.1				3.6
TOTAL					1,434.1

Table 6-11

Kayes-Nioro Road Maintenance Costs (1,000 MF/km, 1979, W/O Taxes)

Maintenance Operation	Status Quo	Reconstruction Standard		
		CC	BB	AA
Routine light maintenance	100 (annual) 1/	174 (annual)	174 (annual)	77 (annual)
Rehabilitation	100 (annual)	327 (annual)	n.a. 2/	n.a.
Patching		n.a.	n.a.	171
Ditch Shaping		(included in rehab.)	56 (5 years)	(included in shoulder maintenance)
Resealing		n.a.	n.a.	7,000 (8 years)
Regraveling Roadway		1,145 (3 years)	2,450 (6 years)	n.a.
Regraveling Shoulders		n.a.	n.a.	200 (5 years)
Grading/Compaction		(included in rehab.)	125 (3 years)	n.a.
ANNUALIZED	200	883	635	1,163

1/ Notation in brackets refers to the frequency of corresponding maintenance operation.

2/ Not applicable.

It will be noted at this stage that there exists a radical difference between a road constructed to a minimum cost standard (CC) when compared with an engineered road to either standards BB (laterite/gravel surface) or AA (DBST surfacing). As the Kayes-Nioro road is intended for all-weather use, a minimum cost construction will require constant rehabilitation on an annual and periodic basis. The rehabilitation effort is oriented towards the repair of pavement failure due to inadequate pavement thickness and to pavement deterioration subsidence and significant erosion resulting from attendant substandard drainage. The estimate for rehabilitation needs are based on subgrade CBR values; the lower the CBR the more frequent and more extensive is the rehabilitation effort which is required.

6.4.4 MAINTENANCE NEEDS AND AVAILABLE MEANS

The anticipated costs of maintenance in the First Region and for the Kayes-Nioro road merit comparison with revenues projected to be available for road maintenance. While future expenditures can be estimated based upon likely predictions about maintenance needs, future revenues are contingent upon a number of unpredictable factors regarding the Road Fund and its use, including the implementation and success of changes under consideration by the IDA and GRM. This section, therefore, outlines some alternative scenarios for means and compares each situation to estimated needs.

- If the proposed increases in fuel taxes and the increased share of these to the Road Fund are not implemented (i.e., there is no Fourth Highway Program), then no change in existing road maintenance levels can be assumed. In the first post-construction period of the Kayes-Nioro road (1985-1990), the equipment purchased for force account construction would still be available for maintenance. This equipment (including workshop equipment), plus priority allocation of existing funds, would permit adequate maintenance of the road until about 1990*.

* It is assumed that, with the recommended acquisition of workshop equipment, the physical life of road maintenance equipment would last until 1990.

Beyond the life of the force account equipment, however, no road maintenance would be likely. To cover this possibility, the sensitivity analyses included the case wherein the Kayes-Nioro road would not be maintained adequately beyond 1990 (i.e., revenues and equipment could be lacking or that revenues and equipment would not be directed to maintaining the Kayes-Nioro road).

Under this scenario, First Region maintenance requirements will remain unfilled as is presently the case.

- If the Fourth Highway Program were successfully implemented, the prospects for road maintenance will be radically changed. Funds for routine annual maintenance (a goal of the IDA program) would be available to meet the requirements of the First Region and the Kayes-Nioro road. In addition, some funds would be available for a modest level of periodic maintenance. These funds would be forthcoming from a probable surplus in revenues after the routine maintenance requirements have been met.

  The force account equipment, purchased for road construction, would fill any gap that could develop during the first post-construction period in the periodic maintenance on the Kayes-Nioro road. Beyond this period, periodic maintenance will not be adequately met on the Kayes-Nioro road and in the First Region in general unless the projected surplus of revenue is allocated with a high priority to periodic maintenance needs. There are a number of optimistic conditions in this scenario (e.g., use of force account equipment, existence of a surplus of revenues, and priority allocation of the projected surplus to periodic maintenance). However, should these conditions mature, future road maintenance requirements in the First Region and for the Kayes-Nioro road will be somewhat adequately met.

The more likely projection for the future is a scenario somewhat in between the two extremes discussed above. More realistic conjectures as to road maintenance in the First Region could be made once the Fourth Highway program is finalized. However, as regards the Kayes-Nioro road, recommendations have been made to insure its maintenance at an adequate level until about 1990. It is somewhat reasonable to assume that a maintenance program, similar to that which is being discussed between the World Bank and GRM, will be forthcoming prior to 1990. If so, the Kayes-Nioro road will still be maintained beyond 1990 but most likely at a level less than required.

Still, the economic analysis has included a sensitivity test to consider the possibility that no improvements in maintenance levels, over what is presently the case, would occur except during the post-construction period through 1990. This is defined as a "limited maintenance" possibility.

CHAPTER 7

CHAPTER 7

APPROACH TO THE ECONOMIC ANALYSIS

This chapter describes the conceptual approach and procedures for the economic analysis that were adopted in this study. In Chapter 8, existing economic conditions within the study area are described; in Chapters 9 and 10 which follow, the economic calculations that were made pertaining to the transportation, and agricultural and livestock sectors, respectively, are presented; finally, in Chapter 11 the agricultural, livestock and transportation sector results are combined into a comprehensive regional economic analysis.

7.1 THE CONCEPTUAL APPROACH

There are two basic approaches that may be adopted in the economic analysis of road projects: (1) the "traditional" approach, which essentially consists of estimating the road user and maintenance cost savings that will be realized through the proposed road construction, and (2) a "producer-surplus" or "value-added" approach, which views the road as but one part of the economic system of a region requiring an estimate of the costs and benefits associated with all impacted sectors within the region.

The decision to employ one approach or the other is largely dependent upon the nature of future economic activity and the resulting demand for transportation. The road-user cost approach is generally appropriate for roads with relatively high traffic volumes and for which long-term regional growth will not involve significant change in the character of the area of influence of the road. If major changes in land use, production and traffic patterns are expected, as

is the case for the Kayes-Nioro project, a "value-added" analysis is called for.

In the road-user cost approach, the feasibility of the road is evaluated on the basis of benefits realized in the transport sector by the user; in a value-added analysis, the feasibility of the road is determined on the basis of benefits realized in all affected sectors within the area of influence, including the benefits to the user. Therefore, the value-added approach permits the analysis of a total development package by incorporating all costs and revenues involved in achieving the projected developmental impacts.

For the adopted value-added analysis, the feasibility of the proposed improvements was determined by comparing total costs with the improvements less total costs without improvements to total revenues with the improvement less total revenues without improvements.

Implicit in a comprehensive approach of this nature is the need to assess at least three crucial aspects of development, listed below and described in the economic analysis chapters that follow:

- the distribution of benefits among farmers, truckers and consumers;
- the linkages between transport cost savings and development, i.e., how will producers respond to lower transport costs?, and
- non-transport constraints to development.

7.2 ALTERNATIVE ROAD IMPROVEMENTS

The object of a road feasibility study is to optimize capital investment in road improvement. This investment is a direct result of the level to which the road is improved.

Road projects, for a variety of reasons, must be sectionalized. In addition, each road section can be improved to different standards. The

combination of both factors defines several possible road improvements. Seven such alternative road improvements were selected for analysis herein, as indicated in Chapter 2. The selection was made in order to meet the following objectives:

- Study the feasibility of each road section separately;
- Study the marginal feasibility of sequential road improvement levels; and
- Select an optimum road system, for each of two investment options.

The adopted economic criterion for selecting the optimum investment (i.e. the optimum road system) is the maximization of regional income, or, in technical terms, the present worth of the regional value-added, provided all sequential investments for road improvement to higher levels are marginally feasible.

7.3 THE TRANSPORTATION SECTOR

Within the transportation sector there are two general types of costs and benefits: (1) those that pertain to the road itself, i.e., the construction and maintenance costs, and (2) those that pertain to the vehicles operating along the road.

Construction costs and maintenance costs without and with the seven improvement alternatives under consideration were estimated and presented in Chapters 5 and 6, respectively, and Appendix H.

For non-agricultural vehicles, operating costs were calculated for the existing road and for each of the road improvement alternatives. The difference in annual vehicle operating costs without and with the various improvements constitutes the savings or benefits for these vehicles.

For agricultural vehicles, care was exercised to avoid a "double-counting" of transportation savings for agricultural vehicles and the increase in production value for agricultural produce. An evaluation was made of the

distribution of transport cost savings made possible by the road between the agricultural and transport sectors. (It has been assumed for purposes of these analyses that the market prices for the produce will remain constant, which implies that consumers will not be direct beneficiaries of the road improvement.) The portion of savings passed on to the agricultural sector (i.e., the farmers) would increase the ex-farm price of the produce, and therefore both the incentive for and overall value of production. The portion of savings retained by the truckers would increase revenues for the truckers resulting from that portion of the agricultural production moving on the road. In Chapter 9, a description of the procedures involved in calculating unit transportation costs and revenues is presented. Chapter 10 presents a discussion of the above assumptions.

7.4 THE AGRICULTURAL SECTOR

The principal impact of the road, in addition to the transport sector, is on the agricultural sector. The direct impact of road improvement investments is the realization by the farmers of additional revenue. This is termed an "incremental unit surplus", i.e., incremental unit revenues from higher ex-farm prices less incremental unit costs. This incremental unit surplus, when reinvested and combined with ongoing and/or planned agricultural programs, results in increased areas of cultivation and the adoption of higher production technology. The reduction in transport costs induces cropping pattern changes as the marketing of some cash crops is enhanced. As mentioned previously, it has been assumed herein that the market price for agricultural produce will remain constant; this assumption implies that the transport cost savings will be distributed between the farmers and truckers/middlemen, and none to the consumer.

The costs to the farmer involved in agricultural production include both operating and investment or overhead costs. These costs include expenditures for farmer's time, hired labor, seeds, fertilizers, insecticides, implements and facilities. When the development package includes an agricultural development component in addition to road investment, all costs

relating to the agricultural development component must be included. These costs would include such items as feeder roads, storage facilities, management and economic costs of services and credits, and all other capital and overhead costs of the agricultural development component of the overall investment program.

Revenues to the farmer are calculated by multiplying the projected tonnages of agricultural production destined for domestic, local or export consumption by the appropriate ex-farm price. The ex-farm prices are calculated by taking market prices less transport costs to the farmgate. The proportion of transport cost savings that is passed on to the farmers is reflected in a higher ex-farm price.

These agricultural costs and revenues to the farmer are calculated without and with the proposed road improvements and agricultural investments, if any. Incremental production costs are the costs with the road improvements, and agricultural investments, less the costs without; incremental revenues or production values are the revenues with, less the revenues without.

Important factors in projecting future impacts are: (1) the farmers' response to the incentives resulting from the higher ex-farm prices, and (2) non-transport constraints that might exist. In other words, will the increases in ex-farm prices be of sufficient magnitude to provide a real incentive for production, and further, what will the farmers do with the additional revenue? Will there be market limitations in terms of marketing practices or adequate demand for the produce? These issues and the calculations involved in the economic evaluation of the agricultural services are described in Chapter 10.

It will be noted at this stage that due to consideration of the above issues, the project impacts on the livestock sector are judged to be only a marginal possibility. Therefore, the economic analysis did not incorporate the livestock sector in the basic computations but included it at the level of the subsequent sensitivity analyses.

The present agricultural marketing system within Mali involves fixed tariffs that are established by the Government. These tariffs are sometimes too low to offer production incentives for the farmers and are, in effect, a form of subsidy for urban dwellers within Mali. A significant portion of the agricultural produce in Mali is marketed, therefore, in a "parallel" market at tariffs higher than the official ones. These parallel-market tariffs are considered in the analyses herein to reflect the free-market prices and are considered representative of the economic values of the produce; they have been used in calculating farmer revenues. Discussions of marketing constraints are included in Chapters 8 and 10.

7.5 THE COMPREHENSIVE ECONOMIC ANALYSIS

A computer package was developed specifically to model the agricultural and transport sectors of the Kayes-Nioro road zone of influence on the basis of the above said approach. Two basic comprehensive economic analyses were performed using this model, one for each of the following investment options:

- For the development projects that are firmly programmed for implementation, as described in Chapter 8, net income of the farmers and transporters with and without the proposed road improvements was determined, and economic feasibility indices were calculated. Each of the seven alternatives was compared to the base "without improvement" condition; in addition, marginal analyses were performed which involved comparison of each alternative with the lower standard alternative preceding it.

- The additional agricultural investment (over and above those projects firmly programmed) needed to realize economically feasible projects for some of those alternatives that were not found to be feasible in (1) above, was determined.

7.6 SENSITIVITY ANALYSES

In order to perform a value-added analysis, it was necessary to make numerous assumptions regarding short and long-term development prospects within Mali as well as estimates concerning base data in cases for which they were not available. It is likely that many of the developments and basic asumptions will not materialize as projected herein. For this reason, several sensitivity analyses were performed to determine how the study results and conclusions would change if certain fundamental elements of the analysis were modified. The sensitivity tests reflect the following conditions:

- Investment and maintenance costs are modified by ± 20 percent;
- Regional net revenues to the farmer are modified by ± 20 percent;
- The Kayes-Nioro Road is not properly maintained;
- The livestock sector is impacted by the road project; and
- The opportunity cost of capital is 12 percent.

The sensitivity tests were selected to cover possible, if not probable, changes in projected conditions. The limits set for the changes in the basic assumptions are considered sufficient to ensure reasonable measurement of the conclusions' reliability; i.e. a ± 20% variation in cost is sufficient to ensure reasonable measurement of the cost side of the economic analysis. The results of the sensitivity tests are described in Chapter 11.

7.7 SOCIO-ECONOMIC PARAMETERS

The following three elements are an integral part of the economic analysis:

- social price of benefits;
- shadow-pricing of costs; and
- the opportunity cost of capital.

The concept underlying social pricing is that benefits to different socio-economic groups within society may be weighed differently, with priority given to projects which benefit lower income groups; the value of an extra dollar to the "poorest of the poor" is considered to be of more value than an extra dollar to higher income groups.

As indicated earlier, the beneficiaries for the project under study may be grouped in three broad categories: (1) the farmers or producers; (2) the truckers or middlemen, and (3) the urban populace. Each of these groups has a vital role in the Malian economy. Clearly, benefits to the farmers are very important; no production or development will occur without incentives for the producers. On the other hand, without adequate benefits for the truckers, the transportation industry will not prosper, and consumers and suppliers will not be brought together in an efficient manner. In addition, the agricultural pricing policy in Mali indicates that the Government attaches high priority to the urban populace inasmuch as the official agricultural tariffs are often significantly lower than the "parallel-market" tariffs, thereby providing a subsidy for urban consumers. Differential social pricing of benefits has not been applied in this study since the validity of the concept is questionable, as the social weight of the benefits to the three beneficiary groups is about equal.

In developing project economic costs and benefits, adjustments are sometimes required for those costs (often foreign exchange and local labor) that do not represent what may be termed "real" economic value. In some countries, the official currency exchange rates do not reflect the scarcity of foreign exchange and the costs of imports are held artificially low. The Malian Franc, however, is fixed in relation to the French Franc and the demand and supply for foreign exchange are not imbalanced due to subsidies by France. Unemployment is not a problem in the study area inasmuch as essentially all available labor is employed in agricultural production during a significant portion of the year. In Mali, therefore, it is judged that both unskilled labor and foreign exchange do not differ sufficiently from their economic value to society as a resource to warrant shadow-pricing, and have not been adjusted herein.

The opportunity cost of capital is the economic, as opposed to the financial, cost of capital and is the interest rate at or above which projects are considered economically feasible. In the absence of a free market and a comprehensive evaluation of the economic goals and investment

opportunities in Mali, it is difficult to determine the opportunity cost of capital with precision. It is judged, however, that the opportunity cost of capital for combined agricultural and road transportation projects in Mali is relatively low and has been estimated at 10 percent in this study.

The choice of a 10 percent rate for the opportunity cost of capital is a compromise between extremes which could have been used (6 and 14 percent). In light of capital scarcity, the use of the lower extreme would imply a societal commitment for developing the infrastructure of a depressed region, at the expense, possibly, of economically more viable projects in more developed regions and in more productive sectors. The use of the upper extreme would imply a societal commitment for only those projects with higher economic returns, irrespective of developmental objectives to "prime" depressed economies. As Mali and most funding agencies are ambivalent as to how and where capital is to be allocated, the compromise of a 10 percent opportunity cost of capital has been adopted herein.

CHAPTER 8

CHAPTER 8
EXISTING ECONOMIC CONDITIONS

8.1 INTRODUCTION

For its entire length of approximately 318 kilometers, the Kayes-Nioro road, including the Yélimané branch, lies within the administrative limits of Mali's First Region. This northwestern area of the country, wedged between Mauritania, Sénégal and Guinea, accounts for approximately 10 percent of Mali's total area and 14 percent of its total population. With an all-weather road there would be a year-round link between Kayes (45,000 inhabitants), the Region's chief town, and both Nioro du Sahel (15,000 inhabitants), and Yélimané (10,000 inhabitants). At present these centers are practically cut off from each other throughout most of the rainy season (June through September).

8.2 EXISTING DEVELOPMENT PROJECTS

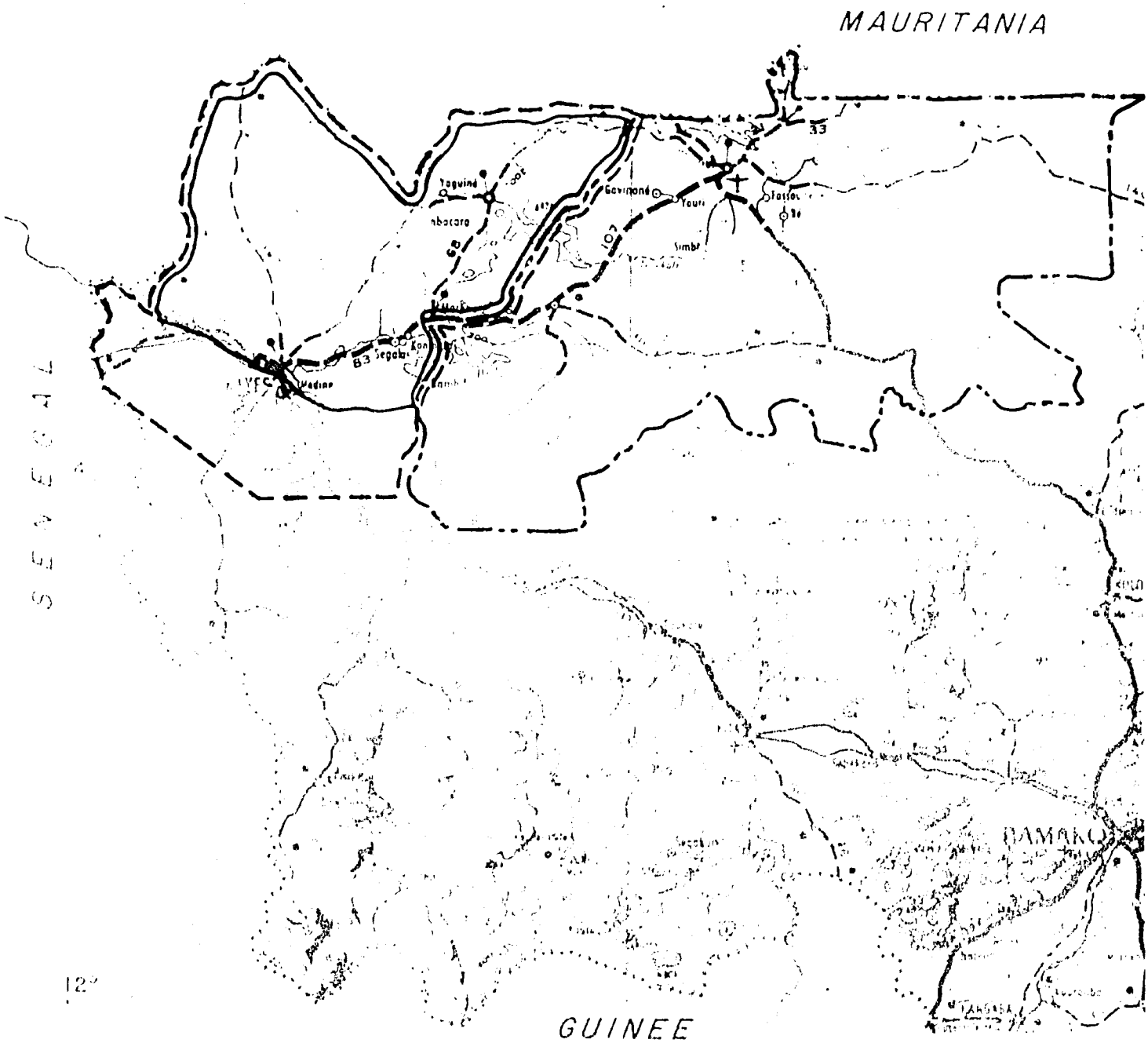
The Government of Mali has currently under execution in the First Region two large-scale, long-term development projects. One is entrusted to the Kaarta Integrated Development Organization (ODIK) and the other, to a small group of public sector agencies coordinated by the Malian Livestock and Meat Organization (OMBEVI). Canadian financial assistance through the Canadian International Development Agency (CIDA) and covering the Kaarta project's first five years of implementation totals some $21,000,000 for a global area of 35,210 square kilometers and a population of 301,500. The Malian Government's other large-scale investment in the First Region along

similar lines is the Kayes Nord (Guidimaka) Pastoral Area Livestock Development Project, currently being implemented under a $15,000,000 agreement with the Government of Saudi Arabia. It covers 15,000 square kilometers with a population of about 200,000. Figure 8-1 shows the relationship of these projects to the zone of influence.

The improvement of the Kayes-Nioro road and the development projects within the First Region are closely interrelated. The achievement of development project goals will be greatly aided by the presence of an all-weather transportation link. On the other hand, the impact of road improvements is magnified by the presence of development projects. In general and although road improvements create specific directly traceable impacts, it is the "spread effects" which the road improvement creates which are the more important impacts of the road improvement.

8.2.1 KAARTA DEVELOPMENT PROJECT

This project has multiple economic, social and environmental objectives. In the short term, the specific targets include increases in staple agricultural production during a five-year horizon, overcoming the area's grain deficit, placing greater emphasis on cash crops (peanuts) and forage, a near tripling of beef production and a similar increase in amount of beef marketed. In the long run, the project aims to have modernized the agricultural sector, improved pasture use, protected and replanted forests, built feeder roads, carried out an adult literacy program and improved health through provision of medicine. Assistance to crop and livestock producers will be supplemented by applied agronomic and livestock research, studies of hydrology, digging of wells and programs of training and community organization. The project has a life of 20 years during which Canadian assistance is available for the first five years. This assistance will probably be extended to cover the second five years with additional funding. The program began in 1978 and the principal short-term interventions are scheduled for completion in 1983.



---- LIMIT OF KAARTA/*LIMITE DE KAARTA*

—— LIMIT OF KAYES - NORD/ *LIMITE DE KAYES - NORD*

---- LIMIT OF OVSTM/*LIMITE DE OVSTM*

ZONE OF INFLUENCE/*ZONE D'INFLUENCE*

TAMS

FIGURE 8 – 1
DEVELOPMENT PROJECTS
IN ZONE OF INFLUENCE
PROJETS DE DEVELOPPEMENT

For the first five years, agricultural investments from Mali and CIDA total 1785 million FM and livestock investments total 1225 million FM. About 1120 million FM will be spent for well-digging and hydrology and 1295 million FM is slated for feeder roads improvement. In the agricultural sector, interventions include fungicidal treatment of seeds, improved seed selection, fertilizer, better equipment (plows, seeders, cultivators), agricultural credit, and organization of rural farmers. In the livestock sector, interventions will include better selection of stock, encouraging sale of young stock, new wells in areas with richer pasture, veterinary services, feed supplements and establishing group rights to property around wells.

The main objectives of the Kaarta project, in the agricultural sector, are to increase production by introducing improved agricultural practices to change crop patterns and to increase the area under cultivation. The goal is to reach about 20 percent of the population in five years (i.e. change traditional cultivation to improved cultivation on 20% of the family farms). Improved cultivation is estimated to about double present yields. Furthermore, the goal is to direct cultivation towards cash crops, such as peanuts, and towards regional self sufficiency in staple cereals.

The project's goals for increases in crop production and livestock marketing are ambitious, especially if the Kayes-Nioro road link is not constructed. The current managers of ODIK have indicated that the programs they are carrying out are not contingent on the construction or reconstruction of the Kayes-Nioro road, in the sense that the minimum benefits projected from their proposed investments will be achieved whether or not the road is built. This program does, however, emphasize the First Region's poor internal transportation network and its isolation from the rest of the country (what they call its fenced-in-condition or "enclavement") as a major constraint on all development efforts. Some 16% of ODIK's total five-year investment will go for a feeder roads construction program designed to correct this situation, with most of the trails radiating from a main trunk which is the Kayes-Nioro route.

It is noteworthy that in ODIK's projections, the yearly rate of increase in the number of family farms (or production units, PU) to be progressively converted from hand cultivation to the use of animal traction, more advanced agricultural production practices, and a closer integration of cropping and livestock activities, decreases from 31% in Project Year 2 to 16% in (project year) PY3, 14% in PY4, and 10% in PY5. It seems likely that other things remaining equal, better transportation resulting from the construction of the Kayes-Nioro road would reverse the dampening trend in development impact and assist the development programs in maintaining their initial momentum. The transportation cost savings that are effected by the road improvements will tend to increase the ex-farm prices of agricultural produce and, therefore, overall farmer revenue. A portion of the additional revenue may be re-invested in farming and will help generate additional production. Further discussion of this issue is provided in Chapter 10.

8.2.2 KAYES-NORD LIVESTOCK DEVELOPMENT

This project has a primary focus on livestock production and its objectives have been articulated within the framework of the overall strategy for livestock development in the Sahel. That strategy would concentrate on the breeding of livestock in the northern Sahel where rainfall is less, and the growing and fattening of livestock in zones further south (closer to Kayes) where rainfall is greater. Specifically, the Kayes-Nord project aims to increase livestock productivity through more rational use of rangeland and water resources, to provide herdsmen with greater income and to supply meat for the Bamako market and the Sénégal export market. The project has a projected life of 25 years with initial funding by Saudi Arabia for five years. The project is now in progress and the interventions funded for the first five years should be complete by 1984.

Interventions which are contemplated include development of water resources and redistribution of cattle over the rangeland, extension of veterinary services and animal health care, better cattle feeding practices (mineral

and protein supplements), training of herdsmen, a credit system, creation of feedlots and fattening ranches, and better slaughtering and marketing facilities as part of the finishing and fattening program for animals. To reduce overgrazing, the program will enforce exclusive use of pasture through herdsmen associations, create new watering points, undertake reforestation and establish fire-breaks to control spread of fires.

The Kayes-Nord project has earmarked 6% of the total five-year investment for the construction of 430 kilometers of fire-breaks (tracks) or fire trails. These are also intended to increase internal mobility. The opening of year-round safe and low-cost road communication between Kayes, Yelimané and Nioro would help in making possible the programmed objectives of this project.

8.2.3 OTHER DEVELOPMENT PROJECTS

A number of other projects sponsored by various international donors in cooperation with the Government of Mali, are presently at various stages of progress within the northern portion of the First Region.

- USAID project to improve rural health services in Yélimané;
- An irrigation study of the Lake Magui-Terekolé, Kolombiné Valleys within the framework of the Opération Vallée Sénégal Terekolé-Magui (OVSTM), for which a three-year agreement was entered into with a West German firm with a provision for assessing the cost of constructing three small dams and carrying out an anti-schistosomiasis campaign;
- USAID assistance in the development of irrigated perimeters in the Kayes area;
- Various studies sponsored by the Organisation pour la mise en valeur du fleuve Sénégal (OMVS) for aerial mapping in the "cercles" of Kayes and Yélimané.

- USAID First Region Pilot Development Project, proposed but not yet finalized in late 1979. This project would have multiple directions including agricultural development and would have a center of activity at Ségala.

8.2.4 SOCIO-ECONOMIC DATA BASE

Although many studies and references were consulted and reviewed, and although numerous interviews were conducted, the data base for this study relies heavily on the studies carried out for ODIK and the Kayes-Nord project. A complete list of references and interviews is provided in Appendix A of this report.

Several remarks are warranted reference the data base, the manner in which it was used, and the use to which it was put. These remarks, essential to properly assess the value and reliability of further analyses, are as follows:

- The data prepared for ODIK and the Kayes-Nord project is derived from field surveys, general GOM statistics, and aerial photo interpretation. Discrepancies and inconsistencies, which are present in the data, are attributable to differing field surveys being taken for different areas for different years. However, the inconsistencies are mostly of a minor nature.

- Data derived from field surveys ought to be looked at with some apprehension, as the rural inhabitant of the First Region tends to respond within a social context that is apprehensive of the motivation of governmental agents, or any other agent for that matter. The responses of the rural inhabitant are negotiable. All surveys in the area have accounted for this fact of life in the region.

- The fact that the different studies, conducted independently, show only minor inconsistencies in the base data, lends credence to the belief that the reported conditions represent a reliable portrayal of the area.

- Notwithstanding the general reliability of the data, all information which was used was assessed for its reasonableness by carrying out comparisons with similar areas and other sources of information, mainly GOM statistics Furthermore, whenever discrepancies were found, averages were taken or the unreasonable information was discarded.

- For projection purposes, the source data was manipulated to account for the following: 1) the assessment by the study team of the area, 2) the prospects for success of both the ODIK program and the Kayes-Nord project in light of more recent developments, 3) the results of interviews, and 4) the experience of the consultant with similar studies in comparable settings.

- In general, projections provided by previous studies were found to be ambitious. The projections which are later used in this study are significantly less ambitious. Mainly, they either were reduced in half or projected to take twice as long, or both.

The data base and projections, as used in this study, are considered to be reliable representations of the most likely conditions. However, it is probable they are not. For this likelihood two measures were taken: 1) Sensitivity tests, pertaining to the variability in the agriculture and livestock sectors, were carried out and 2) it is recommended that socio-economic base data be systematically collected during the design phase of the project

(see Chapter 4) to corroborate the base data used and for later possible uses.

8.3 OVERVIEW OF POPULATION AND RESOURCES

The area of influence of the projected road has a basic homogeneity, despite local differences. The backbone of economic life, as in most of Mali's First Region, is primary production revolving around agriculture and livestock, although the lack of water is a limiting factor to both. Livestock accounts for a major proportion of regional GDP, possibly as much as 55 percent. Agriculture, however, employs a higher proportion of the active rural population and about 25 percent of all the farmers are also cattle raisers.

The area's endowment of natural resources is generally unfavorable. The soils are generally of poor quality; and average annual rainfall is low (see Appendix F) with sharp year to year variations, while the high amount of potential evapotranspiration leaves little margin for aquifer recharging. As a result, both agriculture and cattle-raising are of the extensive type.

Total population within the zone of influence is approximately 246,000 of which 190,000 are rural (outside Kayes urban area). The zone's area is about 15,600 hectares, making the man-to-land ratio in the rural portion of the zone of influence relatively low, about 12 persons per 100 hectares. The critical constraints in this relationship are lack of water and fertile soils rather than land area.

Farms are "owned" by a family unit. Little emphasis, however, as far as rural land is concerned, has been placed on formalities for title cession or transmission, deed recording, or the surveying of agricultural real estate. This goes hand in hand with a rotating system of cultivation. While the same approximate proportion of the total hectareage is cultivated and the rest is left fallow, the fields under cultivation can change from year to year. Grazing

land is treated as a free, communal resource and the best range lands, that is, those closest to the seasonal streams, wells or ponds, are thus subject to overuse.

Local consumption of food staples is estimated at 175/kg/person/year of produce and 15 kg/person/year of meat. Presently, most agricultural production is for local consumption with the exception of peanuts and miscellaneous other cash crops.

8.4 EMPLOYMENT AND INCOME

Poverty is a way of life for the rural farm families. Average per capita income in the regions is reported at about $50 per year and is probably less in the rural areas. An important supplementary source of income in the region is the savings sent by postal mandat from wage-earners abroad who have migrated to seek employment.

The proportion of economically active males in the population ranges from 13 percent to 33 percent in Kaarta arrondissements. This wide disparity reflects the varying impact of heavy emigration in search of better economic opportunities, which takes away for several years the younger and often more enterprising elements of the labor force. When women are included and the 14 to 59 year group is considered, the economically active population ratio ranged from 39.7 percent to 58.9 percent in one of Kaarta's arrondissements. The relationship between employment and emigration is more fully covered in Appendix F.

Nationwide, Mali in 1977 had 113,900 wage-earners, representing only 5.7 percent of the active population; of these, 45 percent were government employees. Taking into account the state enterprises, it was estimated that in the country at large, one salaried person out of two was employed by the public sector. Within this context of few salaried workers, standard concepts of employment, unemployment and underemployment can be applied to the area of influence only with greater circumspection than that typically warranted in areas of predominantly rural production.

The area's basic agricultural and livestock activities are essentially seasonal. Moreover, they are carried out by many ethnic groups of which the Sarakolé are the majority and the others include Bambara, Peul, Moor and Khassonké. Crop production and stock rearing are a way of life as much as an economic pursuit. Social mobility is limited and the typical production unit is the family farm. Therefore, analyses based on reference to a competitive labor market or a common man-power pool would be misleading. As pointed out by the World Bank, comparisons of real incomes between farmers and herdsmen are near impossible because of the different life styles and sets of social values. From the fact that few nomads have settled in the post-drought years, it may be deduced that they regard their present quality of life to be equally as desirable as that of traditional farmers in areas of possible settlement.

From the above it may be inferred that the area of influence has no unemployment problem, if one accepts emigration as a fact of regional life. As long as people continue to emigrate, one would not find in the area people who are able to work and are looking for jobs. It is difficult to disagree with the conclusion of OMBEVI (1976): "what is felt in that sub-region (western Sahel) ... is a shortage of labor power..." Limited availability of labor implies, among other things, the following:

- the growth of the region is dampened; and
- shadow pricing of labor cost has limited applicability.

8.5 AGRICULTURAL ECONOMY

8.5.1 TYPES OF FARMS

The road's zone of influence is generally an area of small family farms, whose respective sizes reflect tradition as much as purely economic considerations such as current marketing opportunities and constraints, factor availability and entrepreneurial risk-weighing.

For the Kaarta project area, about 37 percent of all the production units recorded in a 1976-77 sample survey were farms of 4.5 hectares each, often cultivated with ox-drawn plows by Sarakolé families with an average size of 12. This group combines stock rearing with agriculture and practices both division of labor and some specialization.

Some 21 percent of the Kaarta production units in 1976-1977 were farms of 3.85 hectares cultivated by families of the Bambara and Khassonké tribes composed of, on the average, 8 members. These farms were usually tilled by hand (chiefly with the traditional short-handled hoe or "daba").

About 42 percent of the Kaarta production units consisted of typical plots of 1.85 hectares, also hand-farmed by the Peul/Moor groups. Production units averaged 6 members each. Only a part of the family is fully engaged in agriculture. The other members are full-time herdsmen for their own cattle or for other groups. They may take animals to graze on the outskirts of their village beyond the crop fields or shepherd cattle farther away for days or weeks in semi-nomadic search for the best pastures around the watering points. The latter become scarcer and scarcer as the dry season advances. The majority of Peuls are cattle breeders, while the Moors generally tend sheep and goats.

8.5.2 AGRICULTURAL PRODUCTIVITY

Based on Kaarta's cropping survey, the smaller farms in the hands of the Peul/Moor families show a higher gross tonnage productivity, 1.17 tons per hectare, than either the Bambara/Khassonké farms (0.59 tons/hectare) or the Sarakolé farms (0.50 tons/hectares). This may be due in part to the use of cattle manure to fertilize fields and in part to more careful tilling concentrated on a limited area. Average yields are given in Table 8-1, indicating that the area's yields are substantially below those of the whole of the First Region.

Table 8-1

Average Gross Yields (kg/hectare)

	First Region[1]	Area of Influence[2] Traditional Cultivation (present)	Area of Influence[2] Improved Cultivation (future)
Sorghum	943	650	1,000
Millet	840	500	770
Maize	1,234	750	1,500
Groundnuts	1,234	660	1,300

1/ Source: Ministry of Rural Development and OVSTM (Opération Vallé Sénégal - Terekolé-Lac Magui). 1977-1978 yields.

2/ Developed from a review of statistics reported for the Kaarta Project (ODIK 1979 and ITC 1977).

Table 8-2

Estimated Cropping Pattern of the Area of Influence

	Percent	
Beans	1.1	plus 19.9 in simultaneous cropping
Sorghum	33.0	
Millet	24.0	
Maize	7.5	
Groundnuts	21.2	
Miscellaneous	13.2	
	100.0	

Source: Ministry of Rural Development.

The cropping pattern for the area was synthesized from statistical sources of GRM and the Kaarta project. Table 8-2 gives the estimates adopted for subsequent analyses. Miscellaneous crops include such items as: rice, pulses, tobacco, cotton, pepper, niebe, voanjazou and other types of kidney beans.

8.5.3 CROP PRODUCTION PRACTICES

Crop fields are cultivated in rotation, with fallow cycles of 2, 3, 5 and even 15 years succeeding each period of active exploitation lasting from 2 to 5 years; at any given time, land under cultivation represents only some 3.5 to 4 percent of the total area. Cultivatable land, through one form or another in rainfed farming, is estimated at 16 percent of gross area.

There are several reasons for this low overall productivity in the area of influence of the road, of which variable and uncertain rainfall is only the first. Land preparation starts in May, towards the end of the dry season, with the first seeding usually in May. Harvesting takes place from October to January, depending on crop variety and the need for frequent late seeding or mixed cropping to take advantage of above normal rainfall in a given year. The limiting factors to a greater volume of production are: the use year after year, without renewal, of the same low-yield seeds; the primitive level of agricultural tools and implements which make possible only casual land-clearing and minimal weeding; and the limited use of fertilizers, pesticides, and herbicides,the costs of which are prohibitive for the poorer farmers despite a subsidy program by the Government. Even the producers anxious to experiment with modern inputs are likely to misuse them in the beginning; agricultural extension services, as well as health and education facilities, are either nonexistent or very limited, and the few agents actually in place are hampered by very bad roads and the wide dispersion of the farms to be reached. It is also estimated that as much as 30 percent of total crop volume is lost in some years through the action of birds, rodents, termites and locusts and from infestations in inadequate silos.

It is noteworthy in this context to note that as early as 1975 sorghum and millet yields on the order of 1,000 kg/ha in Chad and Sénégal and peanuts yields on the order of 1,300 kg/ha in Mali itself were achieved. These yields were accomplished through cultivation using draft animals for thorough weeding, with fairly simple agricultural implements (plows, seeders, carts and versatile tool-bars), and with some modern inputs (CILSS 1977). In Mali also, the use of animal traction with a full line of tested improved practices, under conditions roughly similar to those of the best parts of the zone of influence, has resulted in yields of 1,100 to 1,000 kg/ha for millet-sorghum and 1,000 to 1,500 kg/ha for peanuts (USAID 1976).

8.6 LIVESTOCK PRODUCTION

The division of the study area's livestock activities between sedentary and nomadic rearing is sharper in theory than in practice, as a number of herds can be considered as either semi-sedentary or semi-nomadic; the major difference is often only in the distance, duration and periodicity of their migration, spurred by seasonal cycles.

In the area of influence as a whole, current use is on the average 8.3 hectares of land per unit of tropical cattle (UBT)[1]. Total UBT estimated in the zone of influence were 192,800 for 1980. Estimates made for development projects indicate that with changes in management practices and redistribution of cattle plus provision of new watering points, overall carrying capacity (now close to or less than use) can be increased. The variation in current carrying capacity is great according to soil type, yearly rainfall and dry season versus rainy season (for Kaarta from 1 hectare per UBT to 12).

1/ UBT: Unit of tropical livestock, corresponding to a liveweight of about 250 kilograms. In accordance with the generally accepted equivalence table:

60% of cattle, 1 head	-	1.0 UBT
40% of cattle, 1 head	-	0.5 UBT
1 sheep or goat	-	0.1 UBT

As one moves northward away from the wetter Sudanian climate, the rangelands become less able to support year-around grazing, except around permanent lakes and streams, hand-dug wells or slowly drying ponds. Here the local, genuinely sedentary herds, must compete for the yellowing forage with migratory cattle sometimes coming from far away. This way almost all the well-watered pastures are plagued with overstocking and are threatened with gradual impoverishment. Each year in the last days of June, on the eve of the dries months, the shepherds start their slow migration north towards the Mauritanian border. The movement is reversed from November to January, as they time their return with grain harvesting in the southern part of the First Region. As they progress farther south, they keep bartering or selling their animals on the hoof in various market towns, to resupply themselves in cereals for the rest of the year.

This laissez-faire approach to animal husbandry is, on the whole, highly inefficient. While it relies entirely on natural forage, it does not protect range lands and water resources. In some sectors 40 percent of the pastures are ruined each year by brush fires; since there has been no reforestation program, destruction of the land cover is usually followed by soil erosion.

There is no systematic herd management, with planned gelding, fattening and slaughtering at the optimum liveweight of the male animals not needed for reproduction. The bulls lose during the dry months a large part of the weight gained during the rainy season and it takes 7 years or more, instead of 3 to 4, to bring an ox to full maturity. Over most of this prolonged life, growth in potential meat value is uneconomic in proportion to real feeding cost. The cows' economic potential is also underutilized; the average calving interval is 22 months and the calves are not weaned before 10 months. With proper care, the suckling period could be limited to 6 months. At the same time calf mortality is high, due to lack of shelter, complementary feeding or veterinary care.

Improvements in herd structure and corresponding changes in liveweight per head of cattle could result from technical inputs (better post-natal health care, sheltering, early weaning, and complementary feeding of calves, together with early destocking of male animals). The following computer-assisted livestock development analysis, carried out in 1976 in the Karakoro sector of the First Region for the Kayes-Nord project, is representative of existing conditions and planned improvements (Table 8-3).

Table 8-3

Technically Feasible Improvements
in Herd Composition and Cattle Head Liveweight
First Region, Karakoro Sector, 1976 3/

	Head Composition (percent)		Average Liveweight per Head of Cattle (kg/head)	
	Present	Projected 1/	Present	Projected 2/
Males	29.2	20.7	--	--
Bulls	10.6	01.4	280	280
Calves, age 0-1	07.6	10.7	36	36
Steers, age 1-2	06.0	05.3	150	163
Steers, age 2-3	05.0	03.3	200	217
Females	70.8	79.3	--	--
Cows	44.6	44.1	250	269
Calves, age 0-1	07.6	10.7	36	36
Heifers, age 1-2	06.6	09.1	148	161
Heifers, age 2-3	06.1	08.1	190	202
Heifers, age 3+	05.9	07.3	230	242

As a result of these improvements, over the next 18 years, the culling rate for males could rise from a present 19.6 percent to 50.7 percent. For the females, it would likely decrease from 7.3 percent to 7.1 percent.

1/ Projected for Year 15 of Kayes-Nord Project
2/ Projected for Year 18 of Kayes-Nord Project
3/ Source: OMBEVI (Office Malien du Betail et de la Viande)
Western Sahel Livestock Development Project in Mali, 1976

Thus, the weighted average offtake could advance from a current 10.9 percent to 15.8 percent. These projections are substantially in line with the experience of a livestock development project presently in execution in neighboring Sénégal with partial financing by a loan from the World Bank. Over the project's first 14 years of implementation, the calving rate would rise from 56 percent to 62 percent, the calves' mortality rate would decline from 35 percent to 25 percent, while total offtake would jump from 10.6 percent to 14.4 percent.

Although there are less data available for smaller animals, it is believed that exploitation of sheep and goat herds in the zone of influence is as inefficient as that of cattle. Parasitical infestation is probably heavier, and there is a higher proportion of overage males and sterile females, 29 percent altogether. It is therefore safe to assume that a program similar to the one contemplated for cattle, with emphasis on better veterinary care, systematic destocking before the dry season and a sharper demarcation between lamb breeding and fattening activities, could increase productivity and bring about improvements with the order of magnitude given in Table 8-4.

Table 8-4

Present Conditions and Programmed Improvements, Sheep and Goats *

	Present	Programmed
Fertility rate	85%	95%
Mortality rate	22%	4%
Offtake rate	27%	47%

8.7 REGULATORY SYSTEMS AND MARKETING

8.7.1 REGULATORY SYSTEMS

The ending of physical isolation is not likely to yield its full benefits unless it goes hand in hand with a lowering of the barriers to integrated and self-sustaining development presented by certain of the existing marketing

* Source: OMBEVI, Western Sahel Livestock Development Project in Mali, 1976

and economic regulation systems. Those pertinent to the area's major products, cereals, peanuts and meats, are particularly relevant.

From the viewpoint of cereal (coarse grains and rice) production and consumption, the First Region is a deficit area at present. Through 1974-1976 it accounted for, on the average, 3 percent of the regional purchases of OPAM (Office des Produits Agricoles du Mali), the government agency exclusively responsible for cereals' purchase and distribution, including imports and exports. Private trade in those commodities has been illegal for a number of years. But as the prohibition is flexibly enforced, there has developed from year to year a "parallel" or "clandestine" market which is tolerated as long as it remains within certain bounds. (These bounds are quite extensive: 60 to 80% of total market.)

Each year an official price schedule or "bareme" applicable throughout the year to the whole country is promulgated after formalized inter-ministry and inter-agency consultations; these price schedules take into account political, social and economic considerations. The rationale for the "bareme" is to guarantee adequate supplies at equitable prices to Mali's urban population as well as to remote areas such as most of the First Region. Producer, wholesale and retail prices, as well as collection and all intermediary charges, are specified. The system also provides for subsidies to agricultural inputs, to avoid excessive penalization of the farming sector.

In June 1979, the official price for millet, sorghum and maize was raised from 40.00 FM to 50.00 FM per kilogram, that of peanuts (unshelled), from 60.00 FM to 80.00 FM and that of rice (paddy) from 50.00 FM to 60.00 FM. While the issue has always been controversial and had a number of ramifications, the fact is that, at these levels, the official prices amounted to about half what the Malian products could command once they had crossed the country borders or if marketed unofficially. In many instances, official

prices are similar to or even less than the estimated production costs of farmers in a position to react to market incentives.

In analyses of future development potential, it must be acknowledged that even if development programs make available to cereal and peanut producers the possibility of achieving higher yields, their response to these new opportunities is likely to be related to their perception of the flow of real benefits which will accrue to them, rather than to the State, the transporters or other intermediaries. The official policy is a disincentive to production. However, the existence and significance of the parallel market is the agent which hopefully will insure a positive perception on the part of the farmer for increased production.

The provision of an improved road network in the region, it could be argued, would make it easier for the regulatory agencies to further penetrate the area and therefore to control a larger share of the production. Should this happen, it would distinctly reduce the anticipated beneficial impacts due to road improvements. However, it is not expected that this increased penetration would occur to a significant degree as to jeopardize the incentives for increased production. The reasons for this are:

- The quotas set by OPAM are more the result of a political decision rather than being a function of accessibility. Nevertheless, for purposes of later economic analyses, it has been assured that this quota will somewhat increase. This fact is accounted for in the projection of road improvement impacts.
- The ongoing development projects have the distinct intention of entering the chain of marketing to provide the necessary incentives to those farmers that would be reached through their intervention.

- There are too many socio-political pressures within the region to ensure that OPAM's share of the production is not increased by a margin significant enough to affect the created economic incentives of increased income.
- The position of OPAM, as well as other semi-public agencies, is already precarious due to the fact that it is operating with a deficit which is subsidized yearly by GOM, when the latter is experiencing extreme fiscal problems not likely to abate in the near future.

Although the region is deficient in the production of cereals, the official regulatory system still results in some regional exportation of millet, sorghum and maize. This forced exportation implies an increase in the needed amount of imports, at higher prices, for regional consumption.

The trading of meat,as well as livestock on the hoof, is subject to numerous formalities including seven taxes totalling 6,279 FM in 1977 on an average animal with a liveweight value of 30,000 to 100,000 FM plus five slaughtering, marketing, licensing and other dues which vary according to the locality. These taxes are charged in spite of the fact that in most cases the cattle markets are nothing more than a place in the open where sellers and buyers get together. Here again, the uncertainties surrounding the net gains to be expected from production will continue to be a deterrent to higher efficiency, even if investments in development and transportation are successful in eliminating some obstacles to the realization of larger profits.

8.7.2 MARKETING

Most of the regional export production is funneled towards Kayes. However, some of the export production destined for Mauritania does not use the Kayes-Nioro road. Generally, Kayes acts as the regional marketing

center where products are exported either for domestic consumption within the other regions of Mali or to foreign destinations, mostly Sénégal.

For the purposes of this study, the demand for products exported from the region was assumed to be much larger than any increase in the supply from the region. Thus, product prices were assumed to be inelastic in response to increases in supply.

This assumption of constant market prices was based on a review of Mali's needs and market potential in staple cereals. The production of the First Region is only a small proportion of Mali's production. The anticipated production increase in the area of influence would not account but for a small percentage of the supply. The assumed inelasticity of price to a marginal increase in supply is therefore justified.

In the case of cash crops, i.e., peanuts, potential market prices were investigated. Prices in Sénégal, the focal marketing point for peanuts, were reviewed over the recent past. World Bank projections of market prices were taken into account to determine future cash crop prices. The use of a constant peanuts market price over the life of the project is a somewhat conservative assumption, as slight increases in price are anticipated and increased production of the area of influence is marginal in comparison with the total supply in the Sénégal market.

Merchants and transporters are middlemen between the rural farmer and the marketplace. Merchants from urban areas and farmer merchants from rural areas both play a role in a relatively active trading network for agricultural produce. Livestock merchants are a specialized group who collect cattle on the hoof in livestock markets or who gather from shepherds taking cattle on transhumance. Details of existing marketing conditions are provided in Appendix F, Sections F.8.2, F 8.3, and F.8.4). Chapters 9, 12 and 13 also provide discussions of the social and regulatory forces on the

marketing conditions and the probable road improvement impacts on those conditions. Following are the main conclusions pertaining to Marketing:

- Transporters are part of a cooperative whose tariffs are regulated. They nevertheless operate at a profit through the parallel market. This will endure irrespective of any action by GOM to the contrary, actions which should not be expected to occur.

- The parallel market should be expected to maintain its relative importance within the marketing system. Relative changes, with respect to the official market, should be of a slight nature and should not affect the premise that economic incentives for added production will be created through investments in road improvements.

- Transporters are an important link in the marketing chain; they, however, do not have a stranglehold on this chain. The merchants and the inhabitants of the area are too entrepreneurial to permit such a state of nature to occur. In addition, ongoing development projects in the area intend to enter the marketing chain, as an alternative to the transporters. The provision of an adequate all-weather road will increase the competitiveness in the system.

- Due to the competitiveness, though still limited but expected to increase as a result of road improvements, in the marketing chain, benefits from reduction of transport costs should be expected to filter down to the producer in significant proportions. The exact proportions of benefit split between transporters and producers are not critical to the economic analysis, as the social value of benefits

to transporter and to producer is considered equal. This is true as long as the benefit split provides the adequate incentives for increased production.

Chapter 10 provides a further discussion of this subject and other basic concepts used in the modeling of the regional production system. Details on data usage are given in Appendix H.

CHAPTER 9

CHAPTER 9
THE TRANSPORTATION SECTOR

9.1 EXISTING TRAFFIC

In order to define existing traffic along the Kayes-Nioro road, all available traffic data were reviewed, and traffic counts and origin-destination surveys were conducted by the study team. Annual average daily traffic (A.A.D.T.) volumes were established for 1979 and projected throughout the study period as described in the following sections.

9.1.1 EXISTING TRAFFIC DATA

There are two principal sources of traffic data for the First Region: (1) the semi-annual traffic counts conducted by the Ministry of Public Works, and (2) the traffic counts and origin-destination survey data collected in 1975 by the firm of Louis Berger International, Inc., in preparation of the "Etude des Transports Bamako-Kayes."

The semi-annual traffic counts are carried out in January and June for a two-week period, 24-hours per day. Vehicles are classified as either light or heavy vehicles and the number of tons and passengers carried are recorded at six stations along the Kayes-Nioro road. In some cases, the count stations are located near small villages and the counts, therefore, include some local "urban" traffic. Traffic levels have fluctuated significantly from 1972 through 1979, but there has been no net growth during this period. In 1979, volumes varied from a high of 30 vehicles per day near Kayes to 8 vehicles per day at Youri.

In the Louis Berger study, two of the origin-destination survey stations were located along the Kayes-Nioro road. The surveys were carried out for a one week period, 24-hours per day. Annual average daily traffic volumes were estimated in this study to vary from a high of 32 vehicles per day near Kayes to 11 vehicles per day between Dialaka and Youri. The origin-destination surveys revealed that about 90 percent of the total traffic was traveling between Kayes and either Nioro or Yelimané.

9.1.2 TRAFFIC SURVEYS CONDUCTED BY THE STUDY TEAM

Both origin-destination surveys and manual classification counts were carried out by the study team during October 1979.

9.1.2.1 ORIGIN-DESTINATION SURVEYS

The two origin-destination stations were located on the Kayes-Nioro road, one near Kayes with the second near Nioro. At each station, the survey was conducted for a one week period, 24-hours per day; a 100 percent sample was obtained. For each vehicle, the following information was recorded: (1) type of vehicle (passenger car, pick-up truck, light truck, or heavy truck); (2) the brand of vehicle; (3) country of registration; (4) origin of trip; (5) final destination of trip; (6) intermediate stops; (7) purpose of trip (official, private, tourism, other); (8) number of passengers; (9) carrying capacity of the vehicle, and (10) type of cargo and number of tons carried. (See Appendix E for a copy of survey form used.)

Of the vehicles surveyed at the Kayes survey station, it was found that about 24 percent of all vehicles were traveling between Kayes and Yelimané, and that 50 percent were moving between Kayes and Ségala or intermediary locations. Only 13 percent of all vehicles surveyed were traveling between Kayes and Nioro.

Of the vehicles surveyed at the Nioro survey station, some 36 percent were traveling between Nioro and Kayes. The majority of vehicles

were moving between Nioro and small villages within about 40 kilometers of Nioro. Appendix E presents origin-destination tables for the two survey stations, and an origin-destination figure combining the traffic data collected at both stations.

Average truck carrying capacity was found to be in the range of 10 tons for the larger trucks and about three tons for the smaller trucks. Inasmuch as the surveys were conducted prior to the harvest season, the trucks were loaded at about 30 percent of capacity. Average vehicle occupancy was about six passengers per vehicle for light vehicles and slightly more than ten passengers per vehicle for trucks.

The timing of the origin-destination survey, being October where little agricultural evacuation of crops is taking place, was not ideally suited such that a study of commodity and passenger flows could be of value in understanding the area's interactions. Unfortunately, October was not a good month to study the size, composition and direction of principal merchandise flows. Any tabulation of available data would be nonrepresentative. For this reason, the analysis of the data was limited to assessing the zone of influence of the road, to determining traffic volumes by road section, and corroborating subjective impressions of traffic conditions such as truck load factors, the proportion of non-agricultural truck traffic and travel purposes.

9.1.2.2 MANUAL CLASSIFICATION COUNTS

Manual classification counts were conducted at three locations: (1) between Marena and Koniakari; between Sandaré and Diema; and between Dialaka and Yélimané. The counts were made for two or three days at each location, 24-hours per day.

The average daily traffic volumes recorded at the traffic count and at the origin-destination stations are summarized in Table 9-1.

Table 9-1

Recorded Average Daily Traffic (A.D.T.)

	Kayes-Ségala	Koniakari-Marena	Sandaré-Diema	Gavinane-Nioro	Dialaka-Yelimané
Camionette (Pick-up truck)	12	2	1	8	3
Camion-faible tonnage (Light truck)	5	2	2	1	3
Camion-poids lourd (Heavy truck)	8	1	3	3	2
TOTAL	25	5	6	12	8

9.1.3 ESTIMATED ANNUAL AVERAGE DAILY TRAFFIC (A.A.D.T.)

Estimating annual average daily traffic volumes for the various road sections that comprise the Kayes-Nioro road and the branch road to Yélimané, involved a review of previous traffic counts and the counts conducted by the TAMS study team, as well as an assessment of seasonal variations in traffic. Limited data are available concerning seasonal traffic variations but it is known that the fluctuations are significant due to the agricultural nature of the area and the effects of the rainy season upon transportation.

The latest monthly traffic statistics published by the Office National des Transports (1973 and 1974) revealed that traffic volumes in October (the month during which the study team surveys were conducted) were only marginally lower than the yearly average volumes. In addition, three interviews were conducted with the transporters' cooperative in Kayes, corroborating the fact that traffic volumes in October (very early in the agricultural evacuation season, and a month when merchants start replenishing their stocks) are slightly below the annual average. Conversations with gas station owners and the police in Kayes indicated a similar finding. A review

of gasoline consumption, by month as reported in a previous transport study of the area, was used as the basis for translating the traffic counts undertaken in October to an average annual daily traffic (AADT). Similar ratios between October and AADT were used, as these ratios tend to change slightly with time.

For this study, 1979 annual average daily traffic volumes were estimated as shown in Table 9-2.

Table 9-2

Estimated 1979 Annual Average Daily Traffic (A.A.D.T.)

Road Section	Light Vehicles	Heavy Vehicles	Total
Kayes-Ségala	15	20	35
Ségala-Dialaka	10	15	25
Dialaka-Sandaré-Nioro	7	8	15
Dialaka-Yelimané	4	6	10

9.2 TRAFFIC FORECASTS

Annual average daily traffic volumes and traffic mix for 1979 were estimated for each of the road segments under consideration. Traffic volumes were projected to the year 2005 for three basic types of traffic as described in the following sections:

(a) normal traffic;

(b) generated traffic; and

(c) diverted traffic.

Since "development" traffic estimates were presented in terms of projections of tonnages of agricultural produce, as described in Chapter 10, the traffic forecasts described herein relate to the light vehicle or non-agricultural traffic.

9.2.1 NORMAL TRAFFIC

Normal traffic is the traffic that will occur in the study area under present road conditions; this component of traffic is considered to be the same on the existing road segments and on the improved roads proposed to replace them.

Historical growth in traffic levels, vehicle registration and study area population are vuluable indicators of normal traffic growth. As indicated in a previous section of this chapter describing historical traffic data collected by Ministry of Public Works, traffic volumes have fluctuated over the past five years but there hasn't been any net growth. A comprehensive survey has never been made of the vehicle fleet in Mali, although some limited data are available. The "1977 Rapport Annuel de l'O.N.T." indicates that the commercial vehicle fleet in the First Region amounted to 219 vehicles in 1977. The Depouillement des Cartes de Transport in 1978 showed a total of 182 commercial vehicles in the First Region.

Available population data (see Chapter 12) indicate that rural population growth in the First Region amounted to about 1.9 percent per year between 1967 and 1976, with the urban population growth in the First Region amounting to about 5.7 percent per year during the same period.

If a road improvement project is not undertaken in the study area, it is unlikely that traffic volumes would increase by more than token amounts, based on recent experience and the limited data available. Normal annual traffic growth rates have been estimated at two percent per year through the year 2005.

9.2.2 GENERATED TRAFFIC

Generated traffic results from the stimulative effect of easier, more pleasant, or cheaper travel or transportation, and usually occurs in the first year or two after completion of a highway improvement project. In the absence of specific experience in Mali showing the relationship between road improvements and resulting volumes of generated traffic, it has been estimated that the generated traffic immediately subsequent to completion of the roads under study would equal a percentage of the traffic volume in the opening year.

This percentage was estimated as one-half the percentage savings in road-user costs for light vehicles made possible by the improvement. For example, if road-user costs for such vehicles were reduced by 18 percent, then generated traffic would be estimated at 9 percent of the forecast normal light vehicle traffic volume in the operning year. It was assumed that no truck traffic would be generated. Due to the poor condition of the existing road, road-user cost savings for all proposed road improvements would be very significant (see the section of this chapter which follows on Transport Costs and Prices). Based on past experience in similar areas, however, generated traffic was limited to 25 percent of normal traffic, and was assumed to grow at the same rate as normal traffic.

9.2.3 DIVERTED TRAFFIC

Diverted traffic is that traffic which could be attracted to an improved route from existing routes because of distance, time or cost savings. The only possibilities for diverted traffic involve international traffic but this potential diversion would not occur until very late in the study period and would likely involve only a few vehicles per day. Road user cost savings for diverted traffic are considered to be negligible and have not been included in the analyses presented herein.

9.2.4 TRAFFIC FORECAST SUMMARY

Table 9-3 summarizes the projected levels of light vehicle (non-agricultural) traffic (A.A.D.T.) expected during the years 1985, 1995, and the year 2005, for each of the road sections under study.

Table 9-3

Projected Light Vehicle Traffic (A.A.D.T.)*

Year	Kayes-Ségala	Ségala-Dialaka	Dialaka-Sandaré-Nioro	Dialaka-Yelimané
1985	17	11	8	5
1995	21	14	10	6
2005	26	17	12	7

9.3 ORGANIZATION OF THE TRANSPORT SECTOR IN MALI

There are several institutions within the transport sector in Mali that impact transportation within the First Region: (1) Union Nationale des Cooperatives des Transports Routiers du Mali (U.N.C.T.R.); (2) O.P.A.M.; and, (3) individual private truckers.

The U.N.C.T.R. functions at national and regional levels as well as at the level of "cercles". The cooperatives organize the vast majority of private trucking companies, and control almost half of the cargo carrying vehicles within Mali. Most of the private transporters have less than five trucks within their fleet. Those private companies that do not belong to the U.N.C.T.R. are located in Bamako. The transportation of produce is but one of the functions of O.P.A.M. (Office Des Products Agricoles du Mali). As a public enterprise responsible for the purchase and distribution of cereals, O.P.A.M. presently has about 40 vehicles in operation.

* Only light vehicle traffic was projected as no hard data was available on non-agricultural truck traffic. Furthermore, non-agricultural commodities are mostly transported in conjunction with agricultural produce, with the exception of liquid commodities. The purely non-agricultural truck traffic is estimated to be small enough not to warrant its inclusion in the analysis. Besides, its non-inclusion is a rather conservative assumption which lends more confidence to the conclusion of feasibility.

In section 9.5.4 of this chapter, the truck tariff structure that exists for the movement of all cargo and agricultural produce in Mali is described.

9.4 CHANGES IN THE HIGHWAY NETWORK OF THE FIRST REGION

By the end of the study period in 2005, there will have been many changes in the transportation network of the First Region. Within a five-year time span it is expected that it will be possible to travel by road from Kayes to Sénegal via the proposed road in Sénegal through Tombacounda, which will be essentially parallel to the railway line. By about 1990, a southern route from Bamako through Kita and then on to Kayes may be completed if projected road construction is completed. For the long-term, by about 1995, the Malian Government is planning to complete a direct link between Nioro and Bamako via Kolokani.

Each of these road projects will help to reduce the relative isolation and help integrate the First Region into the mainstream of the Malian economy. It is not expected, however, that these road improvements will have a significant impact upon the traffic levels along the Kayes-Nioro road and this effect has not been quantified herein.

9.5 TRANSPORT COSTS AND REVENUES

9.5.1 INTRODUCTION

Vehicle operating costs were calculated for the various types of agricultural and non-agricultural vehicles expected to use the Kayes-Nioro road. The transportation savings for each of these categories of vehicles were calculated in a different manner.

For non-agricultural vehicles, vehicle operating cost savings were calculated in the traditional manner; operating costs were calculated for the existing road and for each of the road improvement alternatives under consideration. The difference in annual vehicle operating costs without and with the various improvements constitutes the savings or benefits for these vehicles.

For agricultural vehicles, care was exercised to avoid a "double-counting" of transportation savings for agricultural vehicles and the increase in production value for agricultural produce. An evaluation was made of the distribution of transport cost savings made possible by the road between the agricultural and transport sectors*. The portion of savings passed on to the agricultural sector (i.e., the farmers) would increase the ex-farm price of the produce, and therefore both the incentive for and the value of production. The portion of savings retained by the truckers would reduce trucking costs and increase revenues for the truckers. This chapter presents a description of the procedures involved in calculating agricultural transportation costs and revenues, while increases in production value are described in Chapter 10.

9.5.2 UNIT VEHICLE OPERATING COSTS

Sufficient empirical data on vehicle performance are not available in Mali to prepare a comprehensive set of vehicle operating costs. Consumption data, (e.g., liters per kilometer for gasoline and oil), presented in the "Kenya Road Transport Cost Study: Research on Vehicle Operating Costs", by H. Hide, S. W. Abaynayaka, I. Sayer, and R. J. Wyatt, and in the World Bank occasional paper, "Quantification of Road User Savings", by Jan de Weille, were used as a basis for the vehicle operating cost analysis.

Interviews with local truck and light vehicle operators in Mali, along with experience of the study team during the field investigations, revealed that the consumption figures for fuel, oil, tire wear, depreciation and maintenance, as shown in those studies, are significantly lower than the values that were obtained in Mali. Based upon this field experience, therefore, it was estimated that fuel and oil consumption is about 10 percent higher on paved roads, 50 to 100 percent higher on gravel roads and about 150 percent higher on poor earth roads in Mali than the values indicated in

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* The implicit assumption herein is that the market price for the produce will remain unchanged, i.e., that consumers will not be directly affected.

either the "Kenya Road Transport Cost Study" or the "Quantification of Road User Savings"; in addition, the other vehicle operating cost components were estimated to be about 10 percent, 20 percent and 50 percent higher on paved, gravel and poor earth surfaces, respectively. Local unit costs were used for the various vehicle types analyzed, for fuels, tires and lubricants, and local wages for vehicle maintenance (Table 9-4).

Table 9-4

Unit Economic Values Incorporated in Vehicle Operating Costs

(10^3 1979 MF)

Vehicles (without tires)	Unit	Price
1. Berliet GLR 200 (10 ton-Diesel)	each	16,100.00
2. Land Rover 109		7,100.00
Tires for:		
1. Berliet GLR 200 (10 ton-Diesel)	each	176.00
2. Land Rover 109		63.00
Fuels and Lubricants:		
1. Gasoline	liter	0.161
2. Diesel		0.120
3. Oil		0.672
Maintenance:	hour	4.00

The Berliet GLR 200, with a 10-ton carrying capacity was selected as representative of heavy vehicles, and the Land Rover 109 Station Wagon was considered the representative light vehicle; there are no buses in operation at the present time nor is it expected that there will be a significant number in the future. Table 9-4 indicates the unit economic prices used in calculating the unit operating costs. These unit values were developed from a survey of automotive dealers in Mali. Note that these are economic values - all taxes have been removed.

Unit vehicle operating costs per kilometer were developed for the representative vehicles on paved, gravel and earth surfaces in good condition and along the existing road for a full range of running speeds. Benchmark speeds refer to average running speeds on level tangent roads in good condition. Benchmark speeds for light and heavy vehicles for paved, gravel and improved earth surfaces as well as for the existing Kayes-Nioro road are summarized in Table 9-5.

Table 9-5

Benchmark Speeds

(Kph)

	Paved Surface	Gravel Surface	Improved Earth Surface	Existing Kayes-Nioro Road
Light vehicle	70	70	55	35
Trucks	60	60	47	25

The calculated vehicle operating costs at benchmark speeds are summarized in Table 9-6. In addition to these vehicle operating costs and the resulting savings with and without the proposed improvements,there would be savings in time value for vehicle passengers. Inasmuch as the economic impact of time savings is difficult to define, this element was not incorporated in the analyses presented herein.

Table 9-6

Unit Vehicle Operating Costs

(10^3 MF per KM)

	Paved Surface	Gravel Surface	Improved Earth Surface	Existing Kayes-Nioro Road*
Light vehicle	0.0971	0.1410	0.1523	0.2792
Heavy vehicle	0.1759	0.2425	0.2635	0.4692

9.5.3 NON-AGRICULTURAL VEHICLE OPERATING COST SAVINGS

Using the anticipated levels of non-agricultural traffic presented earlier in this chapter, savings in vehicle operating costs were calculated for all road network improvement alternatives for the period 1985-2005. The full difference in vehicle operating costs with and without the road improvements under consideration was taken for normal non-agricultural traffic and one-half the difference was taken for generated non-agricultural traffic. The resulting savings for each of the seven alternatives are shown in Table 9-7.

9.5.4 AGRICULTURAL TRANSPORTERS' COSTS AND REVENUES

Transporters (truckers costs and revenues were calculated without road improvement and with all road improvement alternatives.

Transporters' costs were derived from the heavy vehicle operating costs described earlier and summarized in Table 9-6. It was assumed that a 10-ton truck would be used for transportation of produce and that it would be filled while traveling in one direction and empty in the other (i.e.,

* The unit vehicle operating costs for the existing road were derived by considering it as a poor earth road. The unit costs were thus computed by applying the modified consumption and wear rates (Section 9.5.2) to the unit economic values given in Table 9.4.

Table 9-7

Non-Agricultural Vehicle Operating Cost Savings*

(10^3 1979 MF)

Alternatives**	Year 1985	1990	1995	2000	2005
Alt. 1	131,230	144,860	164,490	180,550	197,600
Alt. 2	146,150	159,740	183,360	202,210	219,130
Alt. 3	153,250	167,480	192,020	211,910	229,820
Alt. 4	160,410	175,600	201,200	222,050	240,670
Alt. 5	184,930	202,610	231,220	255,330	277,940
Alt. 6	208,740	229,090	261,690	288,440	313,760
Alt. 7	210,570	230,850	264,020	290,910	316,400
Alt. 1M	131,230	144,860	164,490	180,550	197,600
Alt. 2M	131,230	144,860	164,490	180,550	197,600
Alt. 3M	138,330	152,600	173,150	190,250	208,290
Alt. 4M	145,490	160,720	182,230	200,390	219,140
Alt. 5M	170,010	187,730	212,350	233,670	256,410
Alt. 6M	193,820	214,140	242,820	266,780	292,230
Alt. 7M	193,820	214,140	242,820	266,780	292,230

* Derived from results of computerized regional production system model; applied to that option when investment is made in road improvements only.

** Alternatives 1M through 7M are the same as 1 through 7, except that the Yélimané branch is taken out of the road network (See Chapter 11).

equivalent to a load factor of 50 percent).* This would result in an average cost per ton-km along the existing Kayes-Nioro road of about 94 MF/ton-km, and on the "minimum-cost" improved road of about 53 MF/ton-km.

In Mali, official truck tariffs exist for the movement of all cargo and agricultural produce; these tariffs were established in inter-ministerial act number 2960/MFC-MTTP of October 14, 1977. For the harvesting of crops, the official tariffs are established by region of the country involved and, therefore, are independent of the category of routes involved. The tariffs are based upon an empty trip in one direction, and are as follows:

1.	-1st, 6th and 7th Regions	:	104 MF/t-km
	-2nd Region	:	84.5 MF/t-km
	-3rd, 4th and 5th Regions	:	71.5 MF/t-km
2.	Paddy:		
	Throughout the country	:	84.5 MF/t-km
3.	Cotton (coton)		
	Throughout the country	:	106.6 MF/t-km
4.	Cereals (Cereales)		
	-In "normal" Regions	:	52.00 MF/t-km
	-In "difficult" Regions	:	61.24 MF/t-km

These tariffs are applied for all transactions undertaken by the Government of Mali. In many cases of private trucking, however, truckers find that these tariffs are too low and demand higher rates. For traffic along

* Although trucks could actually end up being more loaded than assumed above, due to the picking up of more cargo either during the trip or additional cargo during the return portion, the computation of costs and tariffs per ton-km should be made on the basis of a reliable and consistent load factor. If truckers pick up additional cargo, the tariffs that are charged will amount to additional profit over and above that which is made on the transport of agricultural commodities.

the better roads in Mali, the tariffs that are actually applied are generally quite close to the official tariffs. For travel along very poor roads, such as in the First Region, the tariffs are often 50 to 100 percent higher than the official rates; these applied rates vary considerably and cannot be precisely defined. For purposes of the analyses presented herein, it has been estimated that average truck tariffs on the existing Kayes-Nioro road are about 40 percent higher than the economic cost per ton-kilometer previously estimated, or about 133 MF/ton-km.

For each of the seven road improvement alternatives under consideration, it was estimated that the transport cost savings that will result will be distributed between trucker and farmer in such a manner that the absolute difference between the trucking tariff charged and the cost of operation per ton-kilometer would be about 20 to 25 percent higher than along the existing road; the remainder of the cost savings would go to the farmer in the form of a higher ex-farm price for the produce. The difference between the estimated truck tariff and cost along the existing road is 132 MF/ton-km less 94 MF/ton-km, or 38 MF/ton-km. The tariffs for the study alternatives were derived by adding 45 MF/ton-km to the estimated costs per ton-km.

The rationale for splitting the savings in transport costs 20% and 80% between the truckers and the producers,respectively, is as follows:

- Although the transporters' cooperative is a monolethic organization, adherence to its ranks is open to any and all. In addition, some few truckers do not belong to it. Therefore, competition within its ranks will increase when the road is improved, resulting in the transmittal of some transport savings to the farmer.

- The farmer is entrepreneurial by nature and would, in a communal society, pool resources to enter the marketing chain if the road is improved (less vehicle maintenance costs) and if he feels he is not getting a fair shake from the trucker.

- The split of 20% to the trucker and 80% to the farmer, under reduced transport costs condition due to road improvements, represents a set of conditions whereby: 1) the trucker is operating at about a profit rate of 100% compared to costs of operations, instead of about 40%, 2) the truckers' profits are increased by 20% for a constant tonnage moved and 3) the tonnage moved is expected to increase several folds, thus accommodating enough room for competition in the market since total profits to truckers would be expected to about double.

- The 20-80% split is not sacrosanct. It was used to represent the fact that the major share of the benefits derived from reduced transport costs will filter down to the farmer and result in increased ex-farm prices, thus providing the necessary incentives for increased production and the means for reinvestments to be made in the agricultural sector by the farmer. The fact that the social price of benefits to both farmers and truckers was taken as equal, the findings of the economic analysis to follow would not have changed had a different split been used, provided the split was not radically different. A different split would only change the split between agri-transport revenues and agri-value added, but not the sum which is used to represent the benefit side of the economic analysis.

Table 9-8 shows the estimated average costs and prices per ton-kilometer for the existing road and the seven road improvement alternatives.

Table 9-8

Estimated Average Truck Operating Costs and Prices *
(1979 MF/ton-km)

Alternatives **	Average Transport Price	Average Transport Cost
Without Improvement	132	95
With Improvement		
Alt. 1	99	54
Alt. 2	97	52
Alt. 3	95	50
Alt. 4	93	48
Alt. 5	86	41
Alt. 6	81	31
Alt. 7	81	31
Alt. 1M	99	54
Alt. 2M	99	54
Alt. 3M	97	52
Alt. 4M	95	50
Alt. 5M	88	43
Alt. 6M	83	33
Alt. 7M	83	33

* Derived from results of computerized regional production system model; applies to that option where investment is made in road improvements only.

** Alternatives 1M through 7M are the same as 1 through 7, except that the Yélimané branch is taken out of the road network (See Chapter 11).

Table 9-9

Total Agricultural Transport Costs and Revenues *

(10^3 1979 MT)

Alternatives **	Year 1985	1990	1995	2000	2005
Without Improvements					
Costs	257,376	303,878	323,477	345,813	357,525
Revenues	360,531	425,476	452,920	484,138	500,536
With Improvements					
Alt. 1 - Costs	257,376	206,873	220,429	237,130	247,232
- Revenues	360,531	381,785	406,806	437,263	455,892
Alt. 2 - Costs	257,376	203,437	222,446	241,039	252,984
- Revenues	360,551	380,438	415,987	451,415	473,784
Alt. 3 - Costs	257,376	198,331	215,330	233,760	245,406
- Revenues	360,531	378,713	411,171	446,390	468,633
Alt. 4 - Costs	257,376	195,557	210,952	228,048	239,592
- Revenues	360,531	380,217	410,146	443,123	465,553
Alt. 5 - Costs	257,376	170,346	183,734	198,403	207,681
- Revenues	360,531	358,252	386,407	417,273	436,785
Alt. 6 - Costs	257,376	148,816	160,651	173,478	181,159
- Revenues	360,531	339,528	366,575	395,970	413,500
Alt. 7 - Costs	257,376	148,813	160,674	173,568	181,322
- Revenues	360,531	339,605	366,674	396,275	413,973
Alt. 1M-Costs	257,376	206,873	220,429	237,130	247,232
-Revenues	360,531	381,785	406,806	437,263	455,892
Alt. 2M-Costs	257,376	206,873	220,429	237,130	247,232
-Revenues	360,531	381,785	406,806	437,263	455,892
Alt. 3M-Costs	257,376	201,767	213,313	229,851	239,654
-Revenues	360,531	380,060	401,990	432,238	450,741
Alt. 4M-Costs	257,376	198,993	208,935	224,139	233,840
-Revenues	360,531	381,564	400,965	428,971	447,661
Alt. 5M-Costs	257,376	173,782	181,717	194,494	201,929
-Revenues	360,531	359,599	377,226	403,121	418,893
Alt. 6M-Costs	257,376	152,252	158,634	169,569	175,407
-Revenues	360,531	340,875	357,394	381,818	395,608
Alt. 7M-Costs	257,376	152,252	158,634	169,569	175,407
-Revenues	360,531	340,875	357,394	318,818	395,608

* Derived from results of computerized regional production system model; applies to that option when investment is made in road improvements only.

** Alternatives 1M through 7M are the same as 1 through 7, except that the Yéllmané branch is taken out of the road network (See Chapter 11).

With the projected levels of produce expected to move along the road, both without and with road improvements, total agricultural transport prices and costs were calculated for each year from 1985 through 2005* for each of the road improvement alternatives and for the without improvement case. The results of the calculations are summarized in Table 9-9 for the years 1985, 1990, 1995, 2000 and 2005.

* The projected tonnages of cargo are presented in Chapter 10 - Regional Production.

CHAPTER 10

CHAPTER 10

MODELING OF REGIONAL PRODUCTION SYSTEM

10.1 GENERAL

The overall approach to the economic analysis was outlined in Chapter 7. Later in Chapter 8, the existing economic conditions within the zone of influence were described as well as the ongoing development projects. Chapter 9 discussed the transport sector and the expected impact of alternative road improvements on transport costs and prices in the zone of influence. Herein, the impacted economic sectors of the regional economy are quantified.

10.1.1 THE PROCESS

A computer model was devised specifically to determine the impacts of road improvements on the region's economy. The model deals with the agricultural sector as well as the transport sector in an integrated manner. The modeling of regional production was carried out for application under two base situations:

- Capital investment in road improvements only; and
- Capital investment in integrated rural development, i.e. in road improvement and in the agricultural sector.

The capital investment in integrated rural development includes an agricultural component, the scope and magnitude of which is described in Section 10.4.

The model for regional production is made up of three successive parts. These are:

- Crop by crop analysis;
- Regional production summary for a given alternative road network; and
- Regional added value (i.e., overall impact), comparing one alternative road network with another.

The model deals with the combination of six agricultural crops, eight alternative road networks and thirteen comparisons between seven improved road networks and the status quo condition. As stated earlier, the model was applied under two base situations relating to whether or not an added capital investment is made in the agricultural sector in addition to road construction. Furthermore, sensitivity analyses were later carried out for each of the two base conditions, each sensitivity analysis involving one additional run of the computerized regional production model.

The base information for modeling the regional production system is derived mostly from the Kaarta and Kayes Nord Projects. It should be noted that the information was used after review, but the results of the economic analysis are nevertheless contingent upon the data sources. A discussion has been made in Chapter 8 on the data base and its uses. The data used and the projections made therefrom are given in Appendix H.

The aim behind computerizing the regional production system model is to provide the necessary flexibility for analyzing numerous options and alternatives. For this reason, the model was developed so that:

- Analyses can be made for different investment options
- Analyses can be made for different road design standards
- Analyses can be made for the road network, one road section at a time.

- Several economic sectors could be analyzed conjointly to account for inter-sectoral relationships; i.e., agriculture and transportation sectors
- Analyses can be made for different project implementation programs
- Future conditions could be analyzed on a yearly basis or in a series of time periods
- Sensitivity of the findings can be assessed with a minimal amount of data manipulation for either one factor at a time or a combination of factors all at once.

10.1.2 MAIN CONCEPTS

The economic studies are based on the real economic value of products and services to society as determined by the market place. All taxes, subsidies or governmental pricing schemes are disregarded in such a case since none of these factors affect the economic value of a product or service.

Since taxes, subsidies and pricing schemes are a reality, they do affect the market place in that these factors create incentives and disincentives to production and to the provision of services and competition therein. The modeling of the regional production system takes account of these market place realities.

Two basic concepts are adopted for assessing the impacts of road improvement on the region's economy. These are:

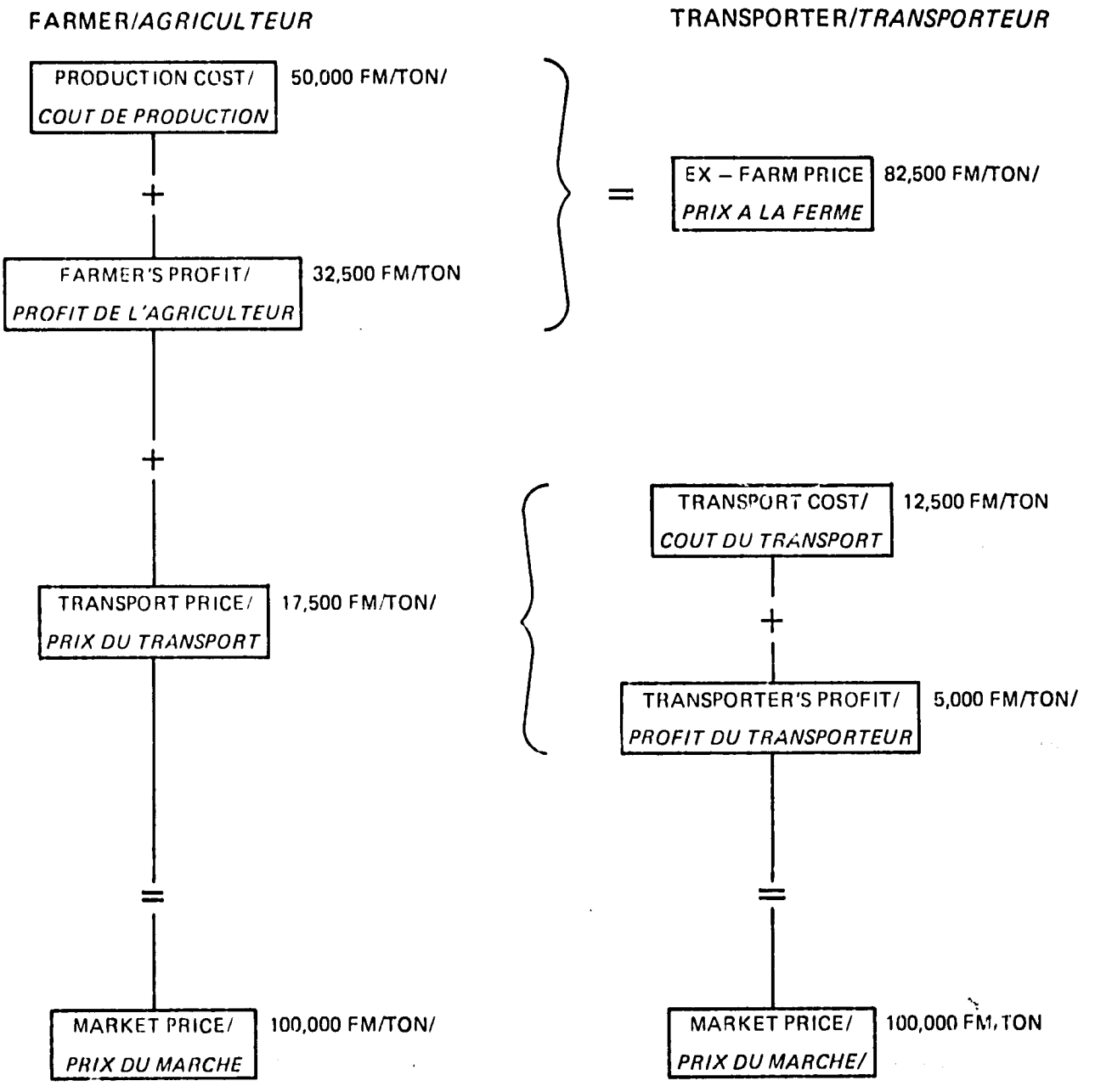
- The savings in transport costs due to road improvement will be split between the trucker and the producer; and will reach the farmer through the parallel market; and

- The benefits derived by the producer will be partially reinvested in additional production.

In Chapter 8, a discussion was presented wherein it was argued that competition in the marketing chain exists at present and that the degree of competition should increase with improved access to the region. As a result of this competition, a major portion of the transport cost savings will filter down to the producer. Chapter 9 presented the rationale for estimating that portion which is expected to reach the producer. A graphic representation of this process is given in Figure 10-1.

What are the effects on the findings of this study if the assumed split of transport cost savings between trucker and farmer does not materialize as expected? If none of the savings are transmitted to the farmer, then there will be no incentive for him to produce any differently than at present. Should a small portion of the savings reach the farmer, the created incentive would be insignificant for changing existing production patterns. Under these conditions, impacts due to road improvements are marginal, at best; the project would not be feasible. However, these conditions are not expected to be a realistic projection of the future. What possibly could happen is that the assumed split of transport cost savings between trucker and farmer would be slightly different.

Once it is accepted that the major portion of transport cost savings is transmitted to the farmer, and therefore an economic incentive for increased production has been put in place, then the findings of the economic analysis are not affected by what actual value is placed on "major portion" of savings. This is true, provided the social prices



LEGEND/*LEGENDE*

FM/TON BEFORE ROAD IMPROVEMENT

1.000 FM/TON AVANT AMELORATION DE LA ROUTE

[illegible]

1.000 FM/TON APRES AMELIORATION DE LA ROUTE

TAMS

FIGURE 10 – 1
BENEFIT DISTRIBUTION
REPARTITION DES BENEFICES

of benefits to trucker are taken as equal (See Chapter 7).

The issue of economic advantage (i.e., higher ex-farm prices) and resultant production incentives is contingent upon the existence of a parallel free market of a significant nature in comparison to the total market. This study assumes that the existing inter-relationship between parallel and government controlled markets will remain somewhat unchanged (See Chapter 8). As long as this is the case, then the economic advantage to the farmer is real. Should the government controlled market be the only market, the economic advantage to the farmer would be fictitious as government controlled prices are at or below costs of production. In this case, no increased production should be expected and the project would not be feasible. This case, however, is not realistic given the recent past in Mali; nevertheless, it could be possible that government agencies (OPAM) would market a slightly greater portion of the production in the region due to improved access. As long as the change is slight (actually assumed in this study), the findings of the economic analysis should remain unchanged. This is true as long as one is dealing in terms of economic value and not prices; the first being the proper method.

For decision making purposes, a sensitivity test of the economic analyses to follow was established to assess in part possible changes in the: 1) split of transport cost savings and 2) split between free and controlled markets. When less savings are transmitted to the farmer and the controlled market increases, the economic incentives to the farmer are reduced; when the opposite happens, the incentives to the farmer are increased. The result is that regional production grows at either a lower or a higher rate--i.e., net value of production is lower or higher than projected.

The second main concept in assessing the impacts of road improvements on the region's economy relates to the reinvestments to

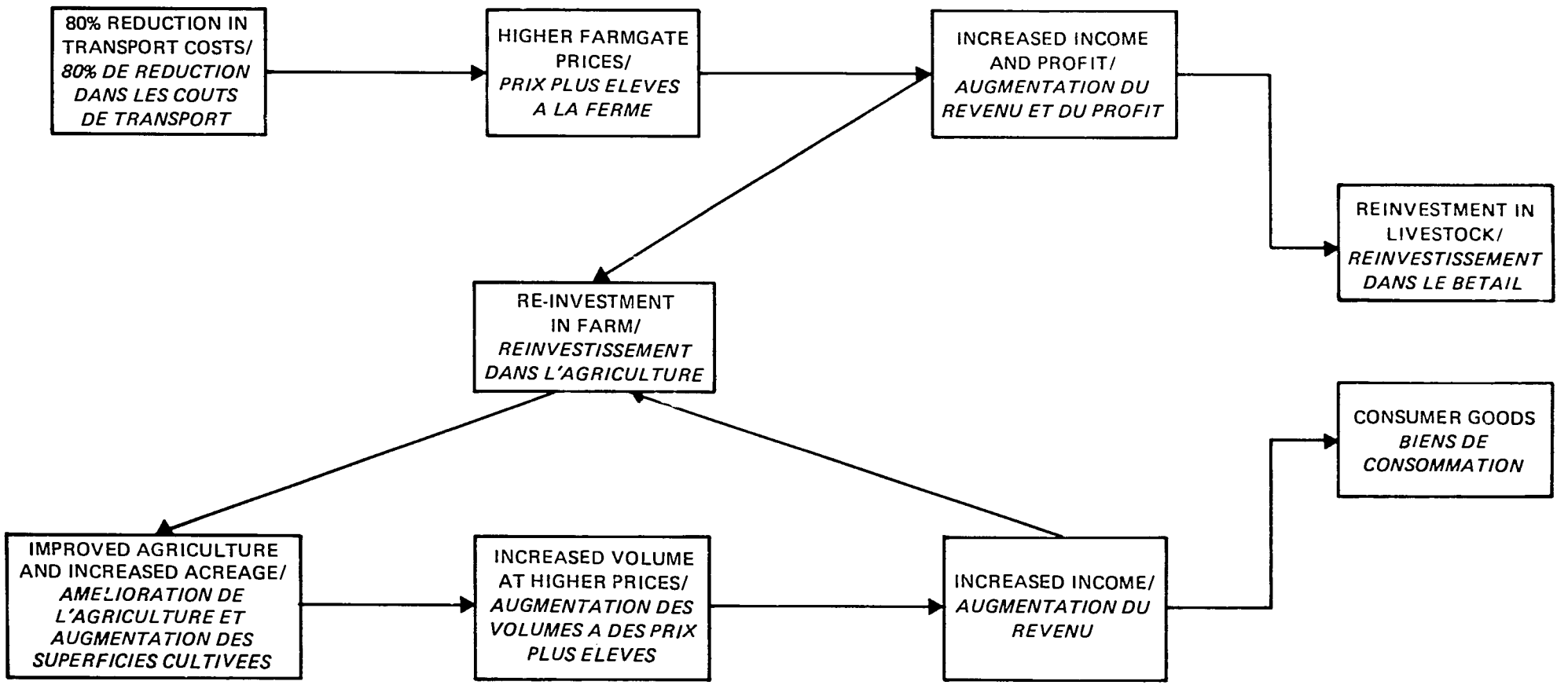
be made by the farmer for increased production. Figure 10-2 represents the process of reinvestment graphically.

Once the farmer is the recipient of increased profits from the sale of agricultural products at higher ex-farm prices, he will be in a position to invest this added income. It is believed that he will do so on: 1) consumer goods, 2) livestock, 3) increased area of production, 4) change toward cash crops, 5) improved cultivation techniques, and 6) marketing. As a result of the increased production deriving from the reinvestment of higher profits, the farmer would increase his income and therefore his reinvestment as time elapses. A cycle of development is thus established due to the provision of improved access at lower prices.

Should the reinvestment process be adopted by the whole of the rural population as soon as the road is improved, this would amount to an idealistic situation. In reality, the adoption of the process will start with a limited number of farmers and a step at a time. The degree and rate of adoption of this reinvestment cycle can vary due to social constraints and the magnitude of the incentives. Variations in degree and rate should be expected as time elapses. The study used an "S" like time series curve for projecting road improvement impacts to duplicate the expected "S" like curve of the reinvestment process. In addition, the sensitivity test of lower/higher net production value, discussed previously, is used to partly measure possible variations in the rate and degree of reinvestments in the agricultural sector.

10.1.3 MAJOR ASSUMPTIONS

Inherent in the development of the model is the basic assumption that road improvements will have a significant impact on the agricultural sector; however, positive effects on livestock development are possible but not likely. Livestock development is dealt with at the level of



TAMS

FIGURE 10 - 2
FLOW OF IMPACTS
SUCCESSION DES IMPACTS

subsequent sensitivity analyses and not directly within the computer model. In light of the discussions in Chapters 8, 9, 12 and 13, and Appendices G and H, this approach is justifiable. Later in this chapter (10.5), however, the probable impacts on the livestock sector are defined.

The model postulates the following cause and effect impacts:

- Increase in area under cultivation;
- Crop mix change with a shift towards cash crops;
- Improved levels of cultivation due to spread of rural development projects effects;
- Change in the marketing of agricultural produce towards exportation;
- Increase in ex-farm prices of agricultural produce and reduction in price of imported crops;
- Reduction in transport costs and prices; and
- Increase in per capita consumption of food stuff due to increased per capita income.

Several remarks are made relating to said impacts. First, the area under cultivation, the crop mix and the technology levels of cultivation are three factors which were considered to form a whole. All three are affected by the economic advantages that are created, and which are perceived by the agricultural producer as an incentive for increased production. The latter's response is the impact of road improvements, and must consider simultaneously all three said factors in order to adopt a coherent production strategy. He will decide on the area to cultivate, the crops to produce and the technology to use in one step. The production strategy for the region, assumed herein, is to reduce the deficit in cereal crops and increase the production of higher value cash crops, as this is perceived to be the

response of the producer in the region, in addition to the adoption by some of improved cultivation technology.

Second, the impacts due to road improvements are not constant throughout the zone of influence of the road. Maximum impacts will be reached in areas adjacent to the road; no impacts will be felt at the limits of the zone of influence. In addition to this variation in impacts along the width of the zone of influence, a variation along the length of the road should be anticipated. Areas which are furthest from the market should experience the greatest impacts, as the savings in transport costs will be the greatest due to the longer travel distance. Finally, the areas, where development projects are ongoing, should experience the greatest spread effects from the adjacent developmental activities. Recognizing all of these variations, the impacts in the northern area of the zone of influence were projected to be larger than those in the southern area. Later an average impact for the whole area was arrived at, and used as the input to the computerized model.

Third, prices of agricultural produce were assumed to be constant throughout the life of the project. Increased production in the area will not affect the supply market but in a limited manner and therefore inelasticity of price to increased supply is a reasonable assumption (See Chapter 8). However, time series effects on prices could exist. Although a limited attempt was made to study past trends of cereal prices, it was considered appropriate to be on the conservative side and to assume no time series effects on prices. Should prices rise in the future, the project would have a higher internal rate of return than reported herein.

Finally, several road improvement impacts were not quanitified; nevertheless they will occur. These are:

- Savings in transport costs for non-agricultural truck traffic;
- Additional revenues to truckers, derived when the average truck load factor (used herein at 50%) is greater than assumed in this study; and
- Savings in transport costs for government and development agencies which are present in the area.

The above impacts were considered to be either marginal or to be unreliably predictable. Had said impacts been included in the analysis, the resulting internal rates of return for the project would have been larger than reported in this study.

10.2 CROP ANALYSIS

The discussion made herein covers the system of agricultural crop production, production values and costs, and transport costs and revenues. The presentation uses one specific crop(sorghum) as an example of the workings of the model. In addition, a sample computer printout is given as Figure 10.3 for reference in following the process of calculating regional production, production value, production and transport costs. This sample output covers only the first stage of the model and applies to the following conditions: Alternative road improvement no. 5 with no additional agricultural investments. The second stage of the model is discussed in section 10.3 while the third and

EATES-NIORO ROAD
CROP ANALYSIS
CASE: NO ADDED AGRICULTURAL INVESTMENT

ROAD IMPROVEMENT ALTERNATIVE W5 - SORGHUM

	YEAR		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	CULTIVATED AREA IN CROP	HA	19800	19784	19688	19635	19565	19631	19665	19596	19564	19500	19630
3	CUM INCREMTL NEW ARA	HA	0	0	0	0	0	0	0	0	0	0	0
4	YEARLY INCRMTL NEW AREA	HA	0	0	0	0	0	0	0	0	0	0	0
5	AREA IN LVL B CULTVTION	%	.000	.030	.060	.090	.120	.160	.200	.240	.280	.320	.320
6	AREA IN LVL B CULTVTION	HA	0	594	1181	1767	2348	3141	3933	4703	5478	6240	6282
7	NET YIELD - LVL A CLTV	TON/HA	.485	.485	.485	.485	.485	.520	.520	.520	.520	.520	.520
8	NET YIELD - LVL B CLTV	TON/HA	.800	.800	.800	.800	.800	.850	.850	.850	.850	.850	.850
9	AGRI PRODCTION - LVL A	TON	9603	9307	8976	8666	8350	8575	8181	7744	7325	6895	6941
10	AGRI PRODCTION - LVL B	TON	0	475	945	1414	1878	2670	3343	3998	4656	5304	5340
11	AGRI PRODCTION - TOTAL	TON	9603	9782	9921	10080	10228	11245	11524	11742	11981	12199	12281
12	RURAL POPULATION	PERS	191804	193627	195466	197323	199197	201588	204007	206455	208932	211439	213976
13	PER CAP CONSUMPTION	KG/PRS	75	75	75	75	75	75	75	75	75	75	80
14	TOT LOCAL CONSUMPTION	TON	14385	14522	14660	14799	14940	15119	15301	15484	15670	15858	17118
15	UNIT GOVT QUOTA	KG/HA	25	25	25	25	25	25	25	25	25	25	35
16	TOT OUTBOUND QUOTA	TON	495	495	492	491	489	491	492	490	489	488	687
17	PROD CONSUMED LOCALLY	TON	9108	9287	9429	9589	9739	10754	11032	11252	11492	11711	11594
18	INBOUND LOCL CONSMPTION	TON	5277	5235	5231	5210	5201	4365	4269	4232	4178	4147	5524
19	DOMESTIC OUTBOUND	%	.95	.95	.95	.95	.95	.90	.90	.90	.90	.90	.90
20	FOREIGN OUTBOUND	%	.00	.00	.00	.00	.00	.05	.05	.05	.05	.05	.05
21	EXPT PROD NOT ON ROAD	%	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
22	TOT DOMSTC OUTBOUND	TON	0	0	0	0	0	0	0	0	0	0	0
23	TOT FOREIGN OUTBOUND	TON	0	0	0	0	0	0	0	0	0	0	0
24	EXPT PROD NOT ON ROAD	TON	0	0	0	0	0	0	0	0	0	0	0
25	DOMSTC OUT PRICE	103F/T	85.4	85.4	85.4	85.4	85.4	91.4	91.4	91.4	91.4	91.4	91.4
26	LOCL CONSMPTION PRICE	103F/T	83.4	83.4	83.4	83.4	83.4	89.4	89.4	89.4	89.4	89.4	89.4
27	DOMSTC IN PRICE	103F/T	103.0	103.0	103.0	103.0	103.0	97.0	97.0	97.0	97.0	97.0	97.0
28	FOREIGN OUT PRICE	103F/T	100.0	100.0	100.0	100.0	100.0	106.0	106.0	106.0	106.0	106.0	106.0
29	NOT ON ROAD OUT PRICE	103F/T	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
30	TOT PRODUCTION VALUE	103F	258349	277603	289602	305024	318290	582980	617136	640210	666813	689307	563467
31	UNIT PROD COST : LVL A	103F/HA	29	29	29	29	29	29	29	29	29	29	29
32	TOT PROD COST - LVL A	103F	574200	556510	536703	518172	499293	478210	456228	431897	408494	384540	387092
33	UNIT PROD COST - LVL B	103F/HA	51	51	51	51	51	51	51	51	51	51	51
34	TOT PROD COST - LVL B	103F	0	30294	60231	90117	119748	160191	200583	239853	279378	318240	320382
35	UNIT NEW LAND PROD CST	103F/HA	7	7	7	7	7	7	7	7	7	7	7
36	TOT NEW LAND PROD COST	103F	0	0	0	0	0	0	0	0	0	0	0
37	TOTAL PRODUCTION COST	103F	574200	586804	596934	608289	619041	638401	656811	671750	687872	702780	707474
38	AVRGE TRANSPORT PRICE	103F/T	17.58	17.58	17.58	17.58	17.58	11.63	11.63	11.63	11.63	11.63	11.63
39	TRANSPORT PRICE REVNUE	103F	101472	100733	100610	100224	100030	56475	55370	54917	54277	53905	72234
40	AVRGE TRANSPORT COST	103F/T	12.55	12.55	12.55	12.55	12.55	5.53	5.53	5.53	5.53	5.53	5.53
41	TOT TRANSPORT COST	103F	72439	71912	71824	71548	71410	26854	26328	26113	25809	25632	34347

Figure 10.3. Sample output of First stage computations, Alternative road improvement no. 5, sorghum, No added agricultural investment.

BATES-SHORO ROAD
CROP ANALYSIS

ROAD IMPROVEMENT ALTERNATIVE W5 - SORGHUM CASE: NO ADDED AGRICULTURAL INVESTMENT

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	19760	19890	20020	20150	20280	20410	20540	20670	20800	20930	21060	21190	21320	21450
3	0	90	220	350	480	610	740	870	1000	1130	1260	1390	1520	1650
4	0	90	130	130	130	130	130	130	130	130	130	130	130	130
5	.320	.320	.320	.320	.320	.320	.320	.320	.320	.320	.320	.320	.320	.320
6	6323	6365	6406	6448	6490	6531	6573	6614	6656	6698	6739	6781	6822	6864
7	.520	.520	.520	.520	.520	.520	.520	.520	.520	.520	.520	.520	.520	.520
8	.850	.850	.850	.850	.850	.850	.850	.850	.850	.850	.850	.850	.850	.850
9	6987	7033	7079	7125	7171	7217	7263	7309	7355	7401	7447	7493	7539	7585
10	5375	5410	5445	5481	5517	5551	5587	5622	5658	5693	5728	5764	5799	5834
11	12362	12443	12524	12606	12688	12768	12850	12931	13013	13094	13175	13257	13338	13419
12	216544	219143	221772	224433	227127	229852	232610	235401	238226	241085	243978	246905	249868	252866
13	80	80	80	80	80	80	80	80	80	80	80	80	80	80
14	17324	17531	17742	17955	18170	18388	18609	18832	19058	19287	19518	19752	19989	20229
15	35	35	35	35	35	35	35	35	35	35	35	35	35	35
16	692	696	701	705	710	714	719	723	728	733	737	742	746	751
17	11670	11747	11823	11901	11978	12054	12131	12208	12285	12361	12438	12515	12592	12668
18	5654	5784	5919	6054	6192	6334	6478	6624	6773	6926	7080	7237	7397	7561
19	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
20	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
21	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4
26	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4
27	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
28	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0
29	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
30	558108	552748	546904	541148	535103	528489	521862	514949	507837	500247	492559	484670	476400	467743
31	29	29	29	29	29	29	29	29	29	29	29	29	29	29
32	389673	392225	394806	397358	399910	402491	405043	407624	410176	412728	415309	417861	420442	422994
33	51	51	51	51	51	51	51	51	51	51	51	51	51	51
34	322473	324615	326706	328848	330990	333081	335223	337314	339456	341598	343689	345831	347922	350064
35	7	7	7	7	7	7	7	7	7	7	7	7	7	7
36	0	630	910	910	910	910	910	910	910	910	910	910	910	910
37	712146	717470	722422	727116	731810	736482	741176	745848	750542	755236	759908	764602	769274	773968
38	11.63	11.63	11.63	11.63	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03
39	73804	75362	76991	78607	83031	84787	86580	88384	90237	92138	94039	95987	97960	99993
40	5.53	5.53	5.53	5.53	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72	5.72
41	35093	35834	36609	37377	39479	40315	41167	42025	42906	43809	44713	45640	46578	47545

Figure 10.3 (continued)

final stage is presented in Chapter 11. In addition, the input for all crops and alternative road improvements are given in Appendix H for the two investment policies (i.e. in transport only and in integrated rural development) under consideration, and for whether or not the Fourth Highway program is implemented.

10.2.1 AREA UNDER CULTIVATION

The zone of influence of the road was estimated to cover an area of about 1.57 million hectares. The Kaarta study indicated that about 3.8 percent of the land within the jurisdiction of Kaarta is under cultivation at present. It has been assumed in this analysis that the same percentage of the overall zone of influence is under cultivation in 1981,or 60,000 hectares.

1981 through 1985 is the projected design and construction period for the various alternative road improvements under investigation. Based upon an evaluation of historical trends and the Kaarta projections, it is estimated that without road improvements, this total area under consideration will increase at a moderate pace to a total of about 65,000 hectares in 1985, 68,000 in 1990 and 72,000 hectares in the year 2005.

With each of the seven alternative road improvements, it is expected that this area under cultivation will increase, with the increase being larger as the road standards are higher. The rationale is that the transport cost savings that are realized through the road improvements will generate an increase in the ex-farm price for agricultural produce; a portion of this increased revenue would likely be reinvested in developing and cultivating additional agricultural land. The pattern of expenditure of these additional revenues is largely governed by the attitudes of the farmers towards financial assets and towards the concept of development. The results of the interviews carried out by the study team's sociologist and environmentalist in the service area of the existing road provided some insight into prevalent attitudes.

Empirical data relating new road construction to increases in cultivated agricultural area do not exist. The procedure used to estimate additional agricultural acreage is intended merely as a guide to evaluate the impact of the road upon agricultural production as opposed to being a rigorous analytical tool. To provide an order-of-magnitude estimate, the following general steps were followed: (1) the average additional revenue to the farmer due to increases in ex-farm prices was estimated at about 3,000 MF/ha; (2) a portion of this additional revenue (20 percent) was assumed to be reinvested in expanded agricultural acreage; and (3) the additional revenue was divided by estimated agricultural (yearly) production costs (about 30,000 MF/ha) to derive an order-of-magnitude rate of increase in area under cultivation over that which would occur without the road: 3,000 x 0.2/30,000 = 0.02/year, or 2% per annum.

Existing and projected areas under cultivation with the existing road and with the seven road improvement alternatives throughout the study period are summarized in Tables H.1, H.19, H 26, and H.31.

10.2.2 CROP AREA BREAKDOWN

There are six types or groups of crops that are presently under cultivation in the study area: (1) beans; (2) sorghum; (3) millet; (4) maize; (5) peanuts, and (6) miscellaneous crops. It is expected that these are the crops that will continue to be cultivated throughout the study period, although the crop mix is expected to change over time and will differ with and without the proposed improvements.

Table 10.1 presents the projection of crop mix with and without the proposed road improvements.* The estimates for year one (1981) are based on data from the Kaarta study. The trends for the without improvement case are similarly based on those projected by said study. Without road improvements,

* All data inputs are given in Tables H.2, H.20, H.27 and H.32

Kaarta's plans for the future are such that bean, sorghum and maize hectarage will represent a lower share of total cultivated area, with nuts and miscellaneous crops representing a somewhat higher share.

Table 10.1

Estimated Future Crop Area Breakdown (percent)

Year	Beans*	Sorghum	Millet	Maize	Peanuts	Misc.
1. Without Road Improvements						
1981	22.0	33.0	24.0	7.5	21.2	13.2
1985	18.0	30.1	24.0	7.1	22.5	13.6
1990	16.5	28.4	24.0	6.8	23.5	14.0
2005	16.5	28.4	24.0	6.8	23.5	14.0
2. With Road Improvements						
1981	22.0	33.0	24.0	7.5	21.2	13.2
1985	18.0	30.1	24.0	7.1	22.5	13.6
1990	12.0	26.0	22.8	6.0	26.0	15.0
2005	12.0	26.0	22.8	6.0	26.0	15.0

The impact of the road is assumed to accentuate the trend planned by the Kaarta project for its study area, provided basic local consumption needs are not adversely affected. The accelerated and greater change in crop mix is attributable to changes in marketing potential of cash crops, such as peanuts, when transport costs are drastically reduced due to road improvements.

Multiplying the total area under cultivation in any one year by the crop area breakdown percent for one given crop for the same year gives the hectarage under cultivation in that year for that crop. Sorghum, for example, is cultivated in 1985 on: 65,000 x 0.301 = 19,565 ha. (Refer to row 2 of Figure 10.3)

* It should be noted that the total is greater than 100 percent inasmuch as beans are produced simultaneously on the same piece of land with other crops.

10.2.3 IMPROVED CROP AREAS

The improved crop areas are those for which additional operating costs will be expended on fertilizers, insecticides, seeds, implements, etc. during the study period. The yields in these improved areas will be higher than on land under cultivation using traditional methods.

The estimated future percentages by type of cultivation of the various crops were estimated based upon the Kaarta projections and a postulation of the spread effect impacts of the alternative road improvements.* Table 10.2 summarizes the projected areas in improved sorghum cultivation expressed as a percentage of total area in sorghum cultivation. Multiplying the area in sorghum cultivation by the percent in improved cultivation, let us say for alternative road improvement no. 5, gives the hectarage in improved cultivation: 19,565 x 0.12 = 2348 ha. (Refer to row 6). The area in traditional cultivation is 19,565 x 0.88 = 17,217 ha.

The basic idea in assessing road improvement impacts is that the road improvement will spread the effect of the ongoing rural development projects in the zone of influence. The spread effect depends on the

Table 10.2

Improved Crop Area, Sorghum (percent)

Alternative	Year 1981	1985	1990	2005
1. Status Quo	0	12	18	18
2. Road Improvements				
Alt 1 & 2	↓	↓	23	23
3	↓	↓	26	26
4	↓	↓	30	30
5	↓	↓	32	32
6 & 7	↓	↓	35	35

* All data input are given in Tables H.3, H.21, H.28 and H.33

level of road improvement. The road spread effect was postulated for the highest level of road improvement (equal to the effect of the development project) and later apportioned for each level of road improvement.

Care was take to ensure that postulated road improvement impacts took account of the difference between areas within the jurisdiction of ODIK and areas not covered by ODIK's operations. Specifically, the propagation of improved technology in the areas outside ODIK's operations was assumed to be one-third as much as that projected for the areas controlled by ODIK. For example, under alternative road improvement 7 in year 2005 the spread effect would result in reaching about 25 percent of the area in ODIK's territory and about 8 percent in other areas within the zone of influence. The average for the whole zone of influence would then be 18 percent. This is equal to the average effect over the zone of influence of ODIK's operations without road improvement; the effect of ODIK in its area is set at about 30 percent.

The modeling of changes in the area under cultivation, changes in crop patterns and changes in production technology was carried out as one unit. Several trial computer runs were made for different sets of assumptions and the ensuing results were analyzed. The analysis aimed at finding that set of assumptions which resulted in reducing the deficit of staple cereals in the area of influence and in increasing the production of high value cash crops, provided the changes in the production system are commensurate with the created economic incentives and within the social and regulatory constraints at play in the region.

10.2.4 AGRICULTURAL YIELDS

The estimated agricultural yields per hectare for unimproved (traditional) and improved cultivation are shown in Table 10.3.*

* All data input are given in Table H.4 and H.5

Once again, sample values are shown for sorghum production. Net yield is defined as gross yield minus losses and seeds. The change in net yields with alternative road improvements is due to a differential reduction in transport losses.

Transport losses are reduced for higher road improvement levels. Transportation services are provided when needed and therefore losses from extended storage, during periods when the road is impassable, are reduced. Furthermore, transport costs of inputs are reduced when the road is improved; this was considered as equivalent to an added production, i.e., higher net yield.

Table 10.3

Net Agricultural Yields, Sorghum (kg/ha)

Alternative	Year	Type of Cultivation	
		Traditional	Improved
1. Status Quo &	1981 - 2005	485	800
Road Improvements	1981 - 1985		
2. Road Improvements	1986 - 2005		
Alt 1		500	825
2		505	830
3		510	840
4		515	850
5, 6 & 7		520	850

It is now possible to compute agricultural production for all crops, for all years, for all alternatives. For example, production of sorghum in 1985, under alternative road improvement 5, is equal to yields by areas under cultivation:

2348(ha) x 0.80 (ton/ha) + 17,217 (ha) x 0.485 (ton/ha) = 10,228 tons

(Refer to row 11.)

The next analytical task is to apportion this production into its component usages. If production exceeds the sum of local consumption and domestic export quota, then the surplus is exported either to domestic markets or foreign markets, using the road, or exported out of the region not using the road. If on the other hand there is a deficit, this latter is met by importation to the area.

10.2.5 DISTRIBUTION OF AGRICULTURAL PRODUCE

The first step in tracing the movement of agricultural produce is to determine whether or not the zone of influence is a surplus or deficit area. Three variables are involved in this determination: production, local consumption, and domestic export quota. Production has already been computed.

10.2.6 LOCAL CONSUMPTION

Local consumption is a function of rural population and per capita consumption. The rural population in 1980 for the zone of influence has been determined to be 190,000 and to increase at 1.2% per annum* when the road is improved to any of the alternative levels, while without road improvement the increase is estimated at 0.95% per annum. The difference is due to an expected decrease in the mortality rate (mostly children) due to improved accessibility to medical facilities.

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* Data input are given in Table H.6

As the road presently exists, it provides the necessary access for migration from the area. Improving the road will make migration cheaper but not more desirable. Chapters 12 and 13 and Appendices G and H treat this subject in more detail. Therein, the subjects of migration/resettlement are fully discussed. Migration is not expected to change due to road improvements.

Per capita consumption is given in Table 10.4.* The projected increase in per capita consumption is due to an expected increase in the standard of living traceable to the improvement of the road.

Per capita consumption of cereals is not as elastic as the consumption of perishable foods. Nevertheless, GOM projections** anticipate an increase in the consumption of cereals to a higher level than herein projected. The basic reason is that, at present, the equivalent protein intake in the First Region is below the level of normal sustenance. The projected increase is in line with dietary requirements.

Table 10.4

Per Capita Consumption, Sorghum (kg/person/year)

Crop	1981 - 1990	1991 - 2005	
	All Alternatives	Status Quo & Alt 1	Alt 2 - 7
Sorghum	75	75	80

The local consumption of sorghum (1985, Alt. 5) is equal to:
$190{,}000 \times (1.0095)^5$ (pers) x 0.075 (ton/pers/year) = 14,940 ton/year (Refer to row 14)

* Data input are given in Table H.7
** Five year National Plan

10.2.7 DOMESTIC EXPORT QUOTA

The domestic export quota may be expressed, for simplicity purposes, as a function of the area under cultivation. It is estimated that 25 kg/ha is the present quota of sorghum and that it would become 35 kg/ha starting in 1991.* This quota is what OPAM buys for later distribution to the different markets within Mali. This domestic export quota in sorghum is therefore equal to (1985, Alt 5): 0.025 (ton/ha) x 19,565 ha = 489 ton/year (Refer to row 16.)

10.2.8 DOMESTIC IMPORTATION

The production consumed locally is equal to:

10,228 - 489 = 9,739 ton/year (Refer to row 17.)

The sum of domestic export quota and local consumption:(489 + 14,940 = 15,429 ton)is larger than production (10,228 ton). Therefore, the zone of influence is a deficit area. The deficit: 15,429 - 10,228 = 5,201 ton/year (Refer to row 18.)

10.2.9 EXPORTS

Had the region shown a surplus of production over the sum of local consumption and domestic export quota, said surplus would have been exported. The exports can be destined either to domestic Malian or to foreign markets,or exported without using the road. Table 10.5 gives the assumed breakdown of exports (in percent) into the above components.** Since the area of influence does not show a surplus (1985, Alt 5), then domestic exports, foreign exports, and exports not using road are all nil. (Refer to rows 22, 23 and 24 respectively.)

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* All data input are given in Table H.8

**All data input are given in Table H.9

Table 10.5

Distribution of Sorgum Exports (percent)

Alternative	Exports on Road Domestic	Exports on Road Foreign	Exports Not Using Road
1. Status Quo	95	--	5
2. All alternative improvements	90	5	5

10.2.10 PRICES OF AGRICULTURAL PRODUCE

The ex-farm prices are used herein at the free market rate, as this rate is truly representative of the economic value of the products. The ex-farm price is the price at the farmgate, i.e., the price in the market less transportation costs to the farmgate. As described in detail in Chapter 9, the unit transport cost savings that will be realized through the road improvements will be distributed between the truckers and farmers. The portion that is passed along to the farmers will increase the ex-farm prices. These prices are shown in Table 10.6 for sorghum as an example.* The values shown are weighted averages inasmuch as the ex-farm price varies depending on what point along the road the production takes place.

Table 10.6

Ex-farm Economic Prices, Sorghum (1,000 MF/ton, 1979)

	Alternative 5	
	1981-1985	1986-2005
Domestic Export	85.4	91.4
Local Consumption	83.4	89.4
Domestic Import	103.0	97.0
Foreign Export	100.0	106.0
Export not on Road	92.0	92.0

* All data input are given in Table H.10

The use of the ex-farm price as the starting point and the allocation of transportation costs savings between farmers and truckers insures that double accounting of transport costs savings does not occur in the analysis.

Following are some notes on Table 10.6:

- The base price is that of the local consumption case. This price was derived by deducting the appropriate transport costs from the free market prices in Bamako. This price increases when a better road is provided. The increase is assumed equal to the incremental transport cost saving allocated to the farmer.
- The domestic export price is assumed to be marginally higher than the base price due to an assumed better quality of the product. This price increases when a better road is provided. The increase is the same as in the previous case.
- The domestic import price is equal to the free market price in Bamako plus transport costs to the farm gate. This price decreases when a better road is provided. The decrease is as large as the increases of the previous two cases.
- The foreign export price is based on study of prices in Sénégal. This price increases when a better road is provided. The magnitude of the increase is the same as the first two cases.
- The price of exports not using the road was assumed to be an average between the domestic and export prices. This price remains constant as the improvement of the road has no bearing on the matter.

10.2.11 PRODUCTION VALUE

The task at hand is to estimate the value of production (i.e. revenue to the farmer). Two distinct situations present themselves: (1) deficit and (2) surplus of production. In the present case, the area of influence shows a deficit in the production of sorghum in 1985. In this case the production

value equals = (value of production consumed locally) + (domestic export quota value) - (domestic import value). The value is defined as the multiplication of production by price. Therefore, sorghum production value (1985, Alt 5) = 9,739 x 83.4 + 489 x 85.4 - 5,201 x 103.0 = 318,290,000 MF/year (Refer to to row 30.)

Should the area show a surplus of production, the latter's value equals = (value of production consumed locally) + (total domestic exports value) + (foreign export value) + (value of exports not using the road).

10.2.12 PRODUCTION COSTS

Agricultural production costs were estimated for land under traditional cultivation and for land to be under improved cultivation. Also, the cost of clearing new land was estimated.* Labor costs and direct costs were determined independently and added to derive total costs to the farmer. Table 10.7 summarizes total costs per hectare. The values therein given do not consider the existing subsidies, as the latter are cost transfers with no economic value within a national economic context.

Table 10.7

Average Economic Production Costs, Sorghum (1,000 MF/ha, 1979)

Crop	Traditional Cultivation	Improved Cultivation	Clearing of New Land
Sorghum	29	51	7

* All data input are given in Table H.11

About 90% and 70% of production costs, for traditional and improved cultivation respectively, are attributable to labor costs, projected herein at 500 MF per day. The balance of the cost is made up of agricultural inputs, i.e., 3,000 and 15,000 MF/ha in traditional and improved cultivation, respectively. The transport cost savings to the farmer, due to road improvements, are only a small proportion of said values. Instead of undertaking a detailed analysis on quantities of inputs and deriving actual production cost reductions, the net yields were increased by a small percentage believed to be of a magnitude to produce the equivalent result.

The total production cost for sorghum (1985, Alt 5) is the sum of the component production costs. Since no new areas are projected to be cleared for sorghum cultivation, the total production cost = (traditional production cost + improved production cost): 17,217 (ha) x 29,000 + 2,348 (ha) x 51,000 + 0 (ha) x 7,000 = 619,041,000 MF/year (Refer to row 37.)

10.2.13 AVERAGE UNIT AGRI-TRANSPORT PRICE AND COST

The transport price is the tariff which the trucker charges the farmer. The cost refers to the trucker's expenses. The bases for estimating these parameters have been fully discussed in Chapter 9. In order to determine the average unit transport price and cost for the area of influence as a whole, the agri-production must somehow be allocated to the different sections of the road. The sketch given in Figure 10.4 is helpful in discussing the way in which the average unit transport price was modeled on the computer. The data pertinent to the present case (Alt 5, 1985) is given in Table 10.8.*

* All data input are given in Tables H.12, H.13, H,16, H.22, H.29 and H.34

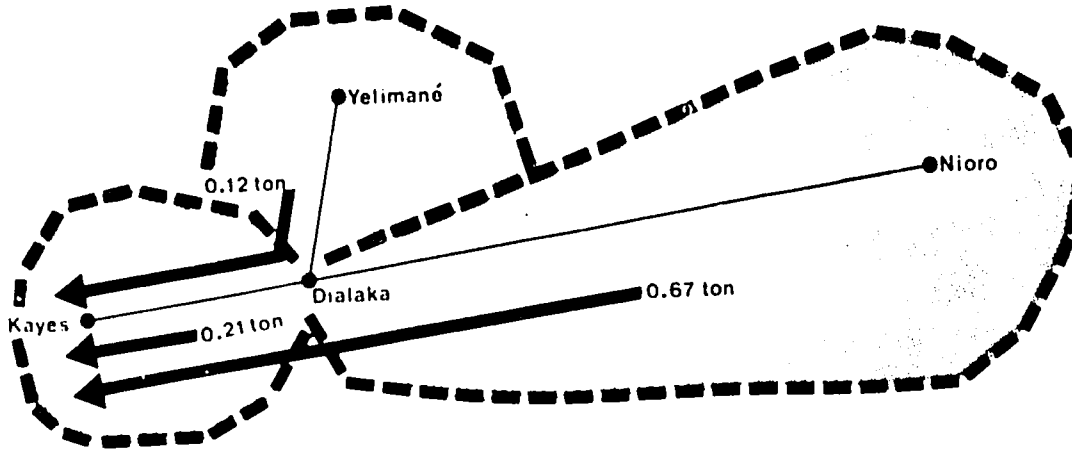

Figure 10.4 Schematic representation of Agri traffic distribution

Table 10.8

Data Input for Modeling Average Unit Transport Price and Cost (1,000 MF, 1979)

Road Section	Alternative 5, 1985		
	Length (km)	Transport Price per Veh-km	Transport Cost per Veh-km
Kayes-Dialaka	82	0.6457	0.4612
Dialaka-Nioro	168	0.6728	0.4806
Dialaka-Yelimané	68	0.6439	0.4599

The agri-production is subdivided into three elements., each attributable to the zone of influence of one road section. For example, 67% of the total production is estimated to originate between Dialaka and Nioro. The respective agri-traffic of 0.67 ton travels a distance of: 168/2 = 84 km at a cost of 480.6 MF/veh-km to Dialaka, and an additional distance of 82 km at a cost of 461.2 MF/veh-km to Kayes. Expanding this example on the assumption of 5 tons per vehicle, the average unit transport cost and price are computed as follows:

Average Unit Price = 0.67 [(0.6728 x 168/2) + (0.6457 x 82)] /5
+ 0.12 [(0.6439 x 68/2) + (0.6457 x 82)] /5
+ 0.21 [0.6457 x 82/2] /5 = 17.58 (1,000 MF/ton)
(Refer to row 38)

Average Unit Cost = 0.67 [(0.4806 x 168/2) + (0.4612 x 82)] /5
+ 0.12 [(0.4599 x 68/2) + (0.4612 x 82)] /5
+ 0.21 [0.4612 x 82/2] /5 = 12.55 (1,000 MF/ton)
(Refer to row 40)

10.2.14 AGRI-TRANSPORT PRICE AND COST

The price and cost of transporting sorghum on the road in 1985 is the multiplication of the tonnage of sorghum moving on the road times the average unit price and cost, respectively, developed above. When the area shows a deficit the tonnage of agricultural produce moving on the road is made up of the sum of the following: imports for local consumption and domestic quota exports. In the case at hand the agri-transport price and costs are:

Total price = 17.58 x [5,201 (ton) + 489 (ton)] = 100,030 (1,000 MF)
(Refer to row 39)

Total cost = 12.55 x [5,201 + 489] = 71,410 (1,000 MF)
(Refer to row 40)

Had the area shown a surplus, the tonnage of agricultural produce

moving on the road would have been computed by taking the sum of the following: total domestic exports and foreign exports.

10.2.15 SUMMARY

In the previous sections four main results have been obtained. These are, for one crop:

- Total production value
- Total production cost
- Total transport price revenue
- Total transport cost

The model, in its first part, carries out the analysis for all six crops under study. The second part of the model, titled Regional Summary Analysis, undertakes to sum up the results of the crop analyses for any given alternative road network configuration. Also, the second part of the model incorporates additional factors which directly apply to an alternative network.

10.3 REGIONAL SUMMARY ANALYSIS

The discussion made herein aims at quantifying the impacted sectors of the regional economic system for a given road network configuration. For purposes of presentation, Figure 10.5 is attached. It is a sample computer output from the second part of the model pertaining to road improvement alternative 5 with no additional agricultural investment.

10.3.1 NON-AGRI VEHICLE OPERATING COSTS

Chapter 9 has already discussed the bases for determining the operating costs of normal non-agricultural traffic. The computer model computes the total costs attendant with this traffic in a manner similar to that which was discussed in section 10.2.13. However, the projected vehicular traffic on each road section is used instead of relying on a weighting system for the different parts of the area of influence. Using the

KAYES-NIORO ROAD
REGIONAL SUMMARY
CASE: NO 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	2505780	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	8907	23867	43370	8314	11032	74857	8314	23867	43370	10277	9662
8	6637677	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 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)

Figure 10.5 Sample output of second state computations,
Alternative road improvement no. 5,
No added agricultural investment.

appropriate data input from Tables H.14, H.15 and H.16,* the normal non-agri traffic averages at 10.13 Vpd (refer to row 1, Figure 10.5) in 1985 with an average vehicle operating cost of 272.7 MF/vehicle-km (refer to row 2) for road improvement alternative 5. The total non-agri vehicle operating cost is estimated at 320,638,000 MF/year (refer to row 3).

10.3.2 AGRI PRODUCTION AND TRANSPORT COSTS

The model adds up the results of the computations made in part one, for all crops (refer to rows 4 and 5 respectively).

10.3.3 ROAD CONSTRUCTION AND MAINTENANCE COSTS

Chapters 5 and 6, respectively, provided the basis for estimating the required data input to the model. This resultant data is given in Table H.17 and H.18, respectively.**

10.3.4 AGRI PRODUCTION VALUE AND TRANSPORT PRICE REVENUE

The model adds up the results of the computations made in part one, for all crops (refer to rows 8 and 9 respectively).

10.3.5 SUMMARY FOR TOTAL NET AGRICULTURAL VALUE

The net agricultural value is defined as the sum of revenues minus the sum of costs associated with agricultural production and transport. Furthermore, the main results of this part of the model are:

- Total non-agri vehicle operating costs;
- Capital investment costs;
- Road maintenance costs; and
- Total net agricultural value of region.

The model carries out this analysis for all eight road network configurations (i.e. status quo plus seven alternative road improvements prior

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* All other data input are given in Tables H.23 and H.35.

**All other data input are given in Tables H.24, H.25, H.30, H. 36 and H.37.

to carrying out inter-alternative comparisons with the aim of estimating regional added value. These comparisons are discussed in Chapter 11, wherein the results of the value added analysis are presented.

The discussions in this chapter have so far centered on the transport and agricultural sectors of the region's economy. In addition, the sample used for the above presentation applied to the case where capital is invested only on improving the Kayes-Nioro road. The discussions to follow cover the subjects of added rural development investment and the livestock sector.

10.4 ADDITIONAL RURAL DEVELOPMENT INVESTMENT

So far, the agricultural sector of the region's economic system has been modeled on the basis of existing conditions and ongoing development projects. Herein, an agricultural development program is conceptually defined for inclusion as a component in the project.

10.4.1 BACKGROUND

The main reasons for considering the issue of an agricultural program in conjunction with a road improvement project are as follows:

- The goals of improving the road extend beyond the provision of access; the road is but a part of the rural development of the area it serves. Additional investment in the agricultural sector would further the general goals of the project; i.e. to assist the rural poor and reduce dependence on deficit and subsistence agriculture; and
- The feasibility of road investments is a function of the impact of road improvements. This impact is a direct function of the base economic conditions. If these are depressed, the impact is slight; on the other hand, if the base conditions are "primed" (i.e. funds are invested in the economy) the road impact is magnified.

The process which was adopted to define the proposed agricultural program is closely interwoven with the feasibility analysis of road improvement investments. The objective of the agricultural program is to "prime" the economy of that area, within the zone of influence of the road, which is not yet developed to the level necessary to justify the feasibility of improving a road section to minimum standards. This objective will result in defining the target area and magnitude of the agricultural program.

It is proposed that this program be targeted to the Yelimané and Ségala areas. This recommendation stems from the fact that the Yelimané branch of the Kayes-Nioro road is not feasible without added agricultural investment in those areas which it serves (Refer to Chapter 11). In addition, it will be noted that USAID has some interest already in both of these areas. Furthermore, the proposed locations provide the required potential and are closer to the main regional market (Kayes) than areas covered by the Kaarta project. The closeness to market is a factor which affects the total cost of production including transport cost.

In order to define the magnitude of the agricultural program, it is necessary to choose a development strategy and attendant program goals; (i.e. scope). Once this is carried out it becomes possible to quantify the effects of the agricultural program on the economy of the target area. Subsequently, the impact of road improvements can be modeled.

10.4.2 SCOPE OF AGRICULTURAL PROGRAM

The agricultural development program is defined using the Kaarta project as a model. This strategy was chosen, as pertinent data necessary to quantify the effects of other possible development strategies are not available. Should other and possibly more effective strategies be adopted, the development of the target areas would be larger and road improvement impacts would be greater. Therefore, it can be concluded that the choice of Kaarta as a model is a safe choice that can possibly be improved upon. It

will be noted at this stage that the agricultural program was developed only to a conceptual level. Further work is required prior to reaching a project preparation stage. However, the level to which the agricultural project is herein defined is adequate for establishing its preliminary feasibility and for analyzing the feasibility of the Yelimané branch of the Kayes-Nioro road.

It is envisioned that the added agricultural program will include the following components: Extension Services, Farm Credit, Agri Physical facilities and Feeder Roads.

To transfer the improved and appropriate technology to the individual farmers, local extension personnel will be recruited, selected and given training in education/extension methodology. Beginning with the first to be selected pilot area, a cadre of extension agents will begin the process by establishing demonstration farms, where the improved technology will be introduced. The extension agents will receive practical "hands on" training so that they will be able to effectively train other extension personnel. Extension agents will assist selected farmers in every procedure of crop production, from land preparation, seeding, fertilizing, cultivating, weeding, etc. The object of extension services is to introduce improved agricultural technology and insure that this technology is adopted by the local farmer.

One of the most important items contributing to the successful adoption by the farmer of an improved technology is farm credit Far too often this vital element is either assumed to be provided, or encumbered by restrictive or ill-defined parameters which discourage or prohibit the small farmer from participation. In this program, we advocate a strong and all-inclusive farm credit component comprising three elements:

- A Revolving Loan Fund which is provided to farmers on a short-term basis to enable them to (1) develop their land (2) purchase annual inputs such as improved and recommended varieties of seeds, fertilizers, plant protection materials, implements, etc.

- Incentive Funds which during the initial promotional period will be used to defray a percentage of the costs of inputs until the farmer has proven to himself that it is economically beneficial for him to use the recommended improved technology. This is a once only introduction cost for each selected area.

- A promotional and shared cost fund to introduce and promote the use of appropriate implements and on-farm storage facilities. This is a once only introduction cost for each selected area.

The physical facilities required for this program will include primarily warehouse and storage space sufficiently adequate to maintain an inventory of inputs such as seeds, fertilizers, plant protection materials and equipment, demonstration and pilot implements and equipment, and collection and temporary storage of agricultural products. Provision will be made for such facilities construction in each target area.

In order to distribute farm inputs and to evacuate agricultural produce, it is proposed that a limited number of seasonal tracks be improved to provide adequate access to the Yelimané branch.

10.4.3 COSTS OF AGRICULTURAL PROGRAM

The magnitude of an agricultural intervention in the chosen target areas is related to the impacts (i.e. goals) which are required to justify a minimum investment for improving the Yelimané branch. In addition, the absorption capacity of the target areas must be considered. A review of interim (part 2) results provided by the model for the agricultural production system and the Kaarta project leads to the following conclusions:

- The absorption capacity of the target areas, on the basis of Kaarta type investment geared to the agricultural sector, is in the range of one to 1.5 billion Malian Francs;

- Such an agricultural program will introduce improved agricultural technology (Kaarta type) on about 10,000 hectares and will affect about 2,000 production units.
- A smaller program will result in a reduced return on investment as the proportion of program overhead costs to total program costs would be larger; i.e. the impact of the program per unit of investment is lower.

On the basis of the above, the proposed program budget is given in Table 10.9.

Table 10.9

Proposed Budget for Agricultural Program (Million MF, 1979)

Item	Cost	
Extension Services		240
Salaries	160	
Support items	80	
Farm Credit		280
Revolving Loan Fund	140	
Input Incentives	100	
Physical Incentives	40	
Feeder Roads		200
Storage Facilities		60
Management & Operations		470
Technical Assistance	240	
Counterpart Salaries	70	
Operations	160	
TOTAL		1,250

The task now at hand is to incorporate this added agricultural investment in the economic feasibility analysis, using the developed model

previously presented. The results of this endeavor are discussed in Chapter 11.

10.5 THE LIVESTOCK SECTOR

For reasons previously enumerated, the livestock sector was not incorporated into the main body of the analysis. Herein, however, this economic sector is quantitatively described and the possible impacts of road improvements are determined for later use in a sensitivity test of the project's economic feasibility.

10.5.1 BACKGROUND TO ANALYSIS

The object of studying the livestock sector is to assess the possible impact of road improvements. Therefore, the analysis that follows concentrates on those elements of the livestock sector which would be impacted as a result of improving the road.

The livestock sector in the zone of influence is fully described in Chapters 2 and 8 and Appendix F. The social constraints which are placed on this sector are described in Chapter 12. In order to simplify the analysis, cattle, sheep and goats are expressed,in its later stages,in terms of tropical livestock units (UBT).

The analysis is carried out using market prices instead of farm gate prices, as the farm gate concept is not so clear in this situation as it is with the agricultural sector. This implies that the benefits which could accrue to the herder and to the transporter are not split up. In other words, the two beneficiary groups are considered as one. Since no social weighting of benefits was adopted in this study, as discussed in Chapter 7, the herein adopted method of analysis is valid.

10.5.2 PROGRAMMED TRENDS

Chapter 8 discussed the programs being implemented by the

Kayes-Nord and Kaarta projects in the zone of influence. These programs, in quantitative terms, aim at changing the herd composition in order to increase the offtake and the value of such offtake.

An analysis of herds by sex and age group was carried out to project these herds to the planning horizon. In addition, the liveweight of these herds was estimated, and unit market prices were adopted depending on the average age of the offtake. Later, the above input was expressed in terms of tropical livestock units. Table 10.10 presents the projection of the programmed trends, wherein the calculation process is indicated. The work is based in part on the studies carried out by Kayes-Nord and Kaarta and the discussion to follow relates to the basis upon which the inputs were derived.

The size of herds in the zone of influence was projected to increase at a linearly changing rate until 1995 when it is programmed to stabilize at 1.7% per year. The offtake, presently at a low level of about 13%, is expected to increase to the 20% range by 1985. The offtake will experience a drop in the late eighties and early nineties as the herds would be in a rebuilding phase. By the year 2000 the offtake is programmed to reach over 20%.

Local meat consumption is placed by GRM at 20 kg/person per year for Mali. However, it is reported that this consumption is lower in the rural areas. A constant rate of 15 kg/person has been assumed in the analysis.

The average liveweight of livestock in the zone of influence is in direct relation to the herd composition by sex, age group and type. As livestock is presently marketed by treking, the weight of meat sold in Kayes is lower than if the sales took place within the zone of influence. Due to death and walking during the trek to market, livestock losses are placed at about 15% of marketable liveweight prior to arrival at Kayes.

Production costs include all component elements which are mostly

Table 10.10

The Livestock Sector, Programmed Trends
(constant 1979 prices)

	Calculation	Year					
		1981	1985	1990	1995	2000	2005
1. Size of herd in zone of influence (1,000 UBT)	Input	193	195.1	202.8	216.9	235.0	256.8
2. Offtake (Percent	Input	12.7	19.2	18.3	17.7	20.5	21.9
3. Offtake (1,000 UBT)	(1) x (2)	24.5	37.5	37.1	38.4	48.1	56.2
4. Local Consumption (1,000 kg)	Input	2,850	2,970	3,120	3,279	3,433	3,500
5. Average liveweight in zone (kg/UBT)	Input	343.5	31 .3	308.4	299.2	281.6	267.5
6. Average liveweight at Market gate (kg/UBT)	(5) x 0.85	292.0	269.7	262.1	254.3	239.4	227.4
7. Weight of Marketed livestock (1,000 kg)	[(3) x (6)] - (4)	4,304	7, 44	6,604	6,486	8,148	9,180
8. Production Cost (MF/UBT)	Input	2,887	2,805	2,859	2,735	2,721	2,681
9. Total Production Cost (Million MF)	(1) x (8)	557.2	547.2	579.8	593.2	642.2	688.4
10. Market Price (MF/kg)	Input	361.1	355.8	372.6	396.2	401.9	414.2
11. Regional Revenue (Million MF)	(7) x (10)	1,554	2,542	2,461	2,570	3,275	3,802
12. Regional Benefit (Million MF)	(11) - (9)	997	1,995	1,881	1,977	2,633	3,114

composed of labor costs. The market price of meat depends on the age of the livestock being sold. This is therefore estimated in conjunction with the projection of herd composition.

10.5.3 IMPACTED TRENDS

Several possible impacts can occur as a result of road improvements. These are postulated as follows:

- Reinvestment in livestock by purchase from transhuman's herds; this will result in a slight increase in herds' size and unit production costs;
- Due to possible trucking of livestock, losses in marketable liveweight are reduced; this impact is assumed to be gradual;
- Due to better quality meat, resulting from trucking, a slight increase in prices can be expected; this increase is tied to the rate at which trucking is adopted as a means of transport; and
- Trucking costs are introduced into the chain of livestock production and marketing for that portion of livestock which is trucked to market.

Table 10.11 gives the results of the impact estimates made for purposes of the economic sensitivity analysis. The assumptions inherent in the computations are given as footnotes to the table. The results therein given were derived using road improvement alternative no. 5 as a reference case. Later these estimated impacts were marginally distributed to each road improvement level in proportion to a heuristically derived allocation ratio. These rations account for road standards, road section length and presence of ongoing livestock programs.

The difference between the benefit streams for the programmed case (without improvement) and the impacted case (with improvement, alt. 5) is the projected net benefit from road improvement alternative no. 5. The net

Table 10.11

The Livestock Sector, Trends With Road Improvement
(constant 1979 prices)

	Calculation	Year					
		1981	1985	1990	1995	2000	2005
1. Size of herd in zone of influence (1,000 UBT)	Input 1/	193.0	195.1	203.8	220.5	243.4	268.7
2. Offtake (Percent)	Input	12.7	19.2	18.3	17.7	20.5	21.9
3. Offtake (1,000 UBT)	(1) x (2)	24.5	37.5	37.3	39.0	49.9	58.8
4. Local consumption (1,000 kg)	Input	2,850	2,970	3,120	3,279	3,439	3,600
5. Average liveweight in zone (kg/UBT)	Input	343.5	317.3	308.4	299.2	281.6	267.5
6. Average liveweight at market gate (kg/UBT)	(5) x (f) 2/	292.0	269.7	265.2	260.3	249.2	240.8
7. Weight of Marketed livestock (1,000 kg)	[(3) x (6)] - (4)	4,304	7,144	6,772	6,873	8,996	10,559
8. Production Cost (MF/UBT)	Input 3/	2,887	2,805	2,862	2,738	2,728	2,688
9. Production Cost (Million MF)	(1) x (8)	557.2	547.2	583.3	603.6	663.9	722.1
10. Market Price (MF/kg)	Input 4/	361.1	355.8	374.5	400.2	407.9	422.5
11. Regional Revenue (Million MF)	(7) x (10)	1,554	2,542	2,536	2,751	3,669	4,461
12. Trucked livestock (Percent of Marketed)	Input 5/	0	0	8	15	23	30
13. Trucked livestock (1,000 kg)	(7) x (13)	0	0	542	1,031	2,069	3,168
14. Transport Cost (1,000 MF/Ton)	Input 6/	38	41	42	42	44	46
15. Transport Cost (Million MF)	(13) x (14)	0	0	23	43	91	146
16. Total Cost (Million MF)	(9) x (15)	557	547	606	647	755	868
17. Regional Benefit (Million MF)	(11) - (16)	997	1,995	1,930	2,104	2,914	3,593

1/ Size of herds is assumed to increase at a rate of 0.25%/year, by 1995, greater than when the road is not improved.
2/ The factor (f) is directly related to the proportion of livestock marketed by truck. (f) = 0.87 in 1995 and = 0.90 in 2005.
3/ Production costs include reinvestment in livestock at a rate of 1% and 2.5% of without road production costs, for years 1995 and 2005 respectively.
4/ Market price is increased by 5% by year 2005.
5/ Assumes that 1/7 of cattle and 1/3 of ovines are trucked by 1995, and 1/4 and 1/2 are trucked respectively by 2005.
6/ Based on analysis from Chapter 9.

benefits which could result from alternative levels of road improvements are then derived as previously stated. The resultant analyses are presented in Chapter 11.

CHAPTER 11

CHAPTER 11

THE COMPREHENSIVE ECONOMIC ANALYSIS

11.1 GENERAL

This chapter presents the results of the comprehensive economic analysis which was carried out to compare the costs and savings/revenues resulting from all alternative road improvements with those resulting from maintaining the road in its present condition, i.e., without improvement.

The economic analysis was undertaken for two distinct investment options, those being:

- Investment in road improvement, assuming that only those agricultural programs (i.e., Kaarta and Kayes-Nord) that are firmly programmed for implementation would impact development in the area; and
- Investment in road improvement and in additional agricultural development.

Furthermore, the sensitivity of the results to changes in key elements of the analysis was evaluated.

Two types of comparisons were made. First, each of the seven proposed road network improvement alternatives was compared to the without improvement alternative. Second, marginal analyses were performed, which involved the comparison of each alternative with the one preceding it, in order to assess the feasibility of each incremental investment associated with the next higher road improvement level. Table 11.1 defines the nomenclature used for the comparisons between the different alternative road improvements.

Table 11.1

Definition of Nomenclature
Used for Comparisons Between
Alternative Road Improvements

Description of Improvement			Improvement Nomenclature	
Kayes-Dialaka	Dialaka-Nioro	Dialaka-Yelimané	From	To
Min. Standard	Min. Standard	-	Without Improvement (w/o)	Alt. 1 (W1)
Min. Standard	Min. Standard	Min. Standard	" " "	Alt. 2 (W2)
Laterite/Gravel	Min. Standard	Min. Standard	" " "	Alt. 3 (W3)
Laterite/Gravel	Laterite/Gravel	Min. Standard	" " "	Alt. 4 (W4)
DBST	Laterite/Gravel	Min. Standard	" " "	Alt. 5 (W5)
DBST	DBST	Min. Standard	" " "	Alt. 6 (W6)
DBST	DBST	Laterite/Gravel	" " "	Alt. 7 (W7)

Description of Incremental Improvement				
Kayes-Dialaka	Dialaka-Nioro	Dialaka-Yelimané	From	To
-	-	Min. Standard	Alt. 1 (W1)	Alt. 2 (W2)
Laterite/Gravel	-	-	Alt. 2 (W2)	Alt. 3 (W3)
-	Laterite/Gravel	-	Alt. 3 (W3)	Alt. 4 (W4)
DBST	-	-	Alt. 4 (W4)	Alt. 5 (W5)
-	DBST	-	Alt. 5 (W5)	Alt. 6 (W6)
-	-	Laterite/Gravel	Alt. 6 (W6)	Alt. 7 (W7)

The economic analyses were performed on the computer; in effect, a deterministic simulation was prepared to evaluate the economic impacts of all alternative levels of investment upon the study area. Figure 11-1 is a sample output summarizing the incremental costs and savings/revenues streams resulting from a comparison of road improvement alternative No. 5 and the without improvement alternative. This sample applies to the case when capital investment is limited to road improvements.

Internal rates of return and net present values were calculated for each of the comparisons. The internal rate of return is the interest rate at which the discounted present values of the cost and benefit streams are equal. The net present value is the difference between the present worth of the cost and benefit streams, discounted at the opportunity cost of capital, assumed herein to be ten percent.

Since the overall objective is to maximize regional (within the context of national economy) income, the development alternative that generates the highest net present value is, in economic terms, the optimum solution.

11.2 INVESTMENT IN ROAD IMPROVEMENT

Table 11-2 summarizes net present values and internal rates of return for all road improvement alternatives as compared with the without-improvement case, and as compared with one another. The comparisons with the without-improvement case indicate the feasibility of the overall alternative, while the marginal or sequential comparisons indicate the feasibility of the incremental improvement or difference between alternatives.

The marginal comparisons reveal that:

- It is not feasible to improve the Dialaka-Yeliman é section even to a minimum standard;

KAYES-NIORO ROAD
VALUE ADDED ANALYSIS
CASE: NO ADDITIONAL 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	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	20842	21189	21435	23122	23122	23291	23847	23847	25533	25533	25852	25852	27296	27794
8	6755-	6721-	6689-	6651-	6832-	6783-	6751-	6717-	6686-	6642-	6614-	6560-	6467-	6375-
9	240657	243689	246579	250996	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

Figure 11.1 Sample output of third part of model.

Table 11.2

Economic Feasibility Indices:
Without Additional Agricultural Investment***

Improvement From	Improvement To	Net Present Value (Million 1979 MF)	Internal Rate of Return (%)
Without Improvement (w/o)	Alt. 1 (W1)	1,933.7	16.4
" " "	Alt. 2 (W2)	605.5	11.7
" " "	Alt. 3 (W3)	676.0	11.4
" " "	Alt. 4 (W4)	549.3	10.8
" " "	Alt. 5 (W5)	960.3	11.1
" " "	Alt. 6 (W6)	408.1	10.5
" " "	Alt. 7 (W7)	(301.0)**	9.8%
From	**To**		
Alt. 1 (W1)	Alt. 2 (W2)	--*	--*
Alt. 2 (W2)	Alt. 3 (W3)	70.4	10.5
Alt. 3 (W3)	Alt. 4 (W4)	(126.8)	9.5
Alt. 4 (W4)	Alt. 5 (W5)	411.0	14.5
Alt. 5 (W5)	Alt. 6 (W6)	(552.3)	5.8
Alt. 6 (W6)	Alt. 7 (W7)	--*	--*

* At zero percent, the present value of costs exceeds the present value of benefits; there is no interest rate at which discounted costs equal discounted benefits.

** Values between parenthesis are negative.

***Appendix I (pages I.24 to I.44) presents the computer output on which this table is based.

- It is feasible to improve the Kayes-Dialaka section to a laterite/gravel surfaced road (W3-W2) and even to a double surface treated road (W5-W4); and
- It is feasible to improve the Dialaka-Nioro section to a laterite/gravel surfaced road (W4-W3).

Alternative road improvement No. 1 (W1) provides the highest internal rate of return, at 16.4 percent, and the highest net present value at 1.934 billion MF, inasmuch as road improvement alternatives No. 2 through No. 7 [(W2) through (W7)] include a non-feasible component, the Yelimané branch. Therefore, the Dialaka-Yelimané branch was omitted from the network and the road improvement alternatives were redefined; henceforth, these will be termed "modified" alternatives. The adjusted results for said modified alternatives are summarized in Table 11.3.

As may be observed, modified Alt. 5 (W5M) has the highest net present value at 2.288 billion MF, and has an overall internal rate of return of 13.0%. Since this is the alternative that will generate the largest increase in national income level, it is the preferred alternative in economic terms. Assuming that there is no additional investment in agricultural development other than those programs firmly programmed for implementation, the optimum network would consist of the following:

- A double surface treated road between Kayes and Dialaka, and
- A laterite/gravel surfaced road between Dialaka and Nioro.

Should this network be adopted, the following points are made in regards to the system as a whole:

- Road construction represents the highest cost factor in the analysis, amounting to more than three times the present value of agricultural production costs;
- Incremental agricultural production value, which increases at an annual average rate of about 5.4%, from 997 million MF in

Table 11.3

Economic Feasibility Indices For "Modified" Alternatives*: Without Additional Agricultural Investment

Improvement		Net Present Value (Million 1979 MF)	Internal Rate of Return (%)
From	To		
Without Improvement (w/o)	Modified Alt. 2 (W2M)**	1,933.7	16.4
" " "	Modified Alt. 3 (W3M)	2,004.1	14.4
" " "	Modified Alt. 4 (W4M)	1,877.3	12.8
" " "	Modified Alt. 5 (W5M)	2,288.4	13.0
" " "	Modified Alt. 6 (W6M)**	1,736.2	11.9

* The "modified" alternatives are the original alternatives less the Dialaka-Yelimane branch road.

**Modified alternatives 1 and 2 [(W1M) and (W2M)] are the same, and modified alternatives 6 and 7 [(W6M) and (W7M)] are the same.

1986 to about 2.714 billion MF in the year 2005, is, by far, the major element in the revenue/benefit stream; and

- Non-agricultural vehicle operating cost savings amount to only about 10 percent of the agricultural production value, and incremental truckers' profits represent an even smaller share.

The last two points demonstrate conclusively that the value added approach is the appropriate one for the economic analysis.

The overall impact of capital investment in improving the Kayes-Nioro road proper to the level of modified Alternative 5 (W5M) is vividly represented by the following:

- The average regional net present value added (total revenues/ savings less total costs) for each ton of agricultural produce is projected to increase from 183,000 MF in the without improvement case to 303,000 MF; and
- The corresponding increase in regional net present value added for each hectare under cultivation is from 102,000 MF to 191,000 MF.

The first criteria, used to measure the effect of road improvement represents mainly the combination of projected ex-farm price increases with changes in crop patterns towards higher value crops. The second criteria combines, in addition to the above, the projected adoption of improved agricultural technology.

11.3 ADDITIONAL INVESTMENT IN AGRICULTURE

Herein, the impact of additional agricultural investment in the area of influence upon the feasibility of each road section and the entire road network is evaluated.

Based on the analysis in Chapter 10, it is judged that an additional agricultural investment, on the order of 1.0 to 1.5 Billion MF, may be assimilated into the service area of the Dialaka-Yelimané branch road. For purposes of this analysis, the impact of an investment of 1.250 Billion MF was evaluated and a new set of feasibility indices were calculated. These are summarized in Table 11-4.

As can be seen, the marginal improvements from W1 to W2, from W2 to W3, from W3 to W4 and from W4 to W5 are all economically feasible with rates of return greater than 10 percent. Road improvement alternative No. 5 (W5), including the Dialaka-Yélimané branch, has the highest net present value at 7.261 Billion MF and is therefore the optimum solution in economic terms. The resultant network, if an additional agricultural investment of 1.25 Billion MF is made in the Yelimané-Segala areas, would consist of the following:

- A double surface treated road between Kayes and Dialaka,
- A laterite/gravel surfaced road between Dialaka and Nioro, and
- A minimum standard road between Dialaka and Yelimané.

Since the net present value is higher than that associated with modified alternative 5, (7.261 billion MF versus 2.288 billion MF), it would be economically advantageous to invest the additional 1.250 billion MF in agriculture and to construct the Yelimané branch. Additional agricultural investment over and above said amount would not be warranted -- the area will not likely be able to assimilate a markedly larger investment modeled on the Kaarta strategy.

The behavior of the regional system, as a whole, is similar to that reported in the previous section. Capital investment costs are the major elements in the overall incremental cost stream, and the incremental agricultural production value is the most significant factor (about 90%) in the overall incremental revenue/savings stream.

Table 11.4

Economic Feasibility Indices
With Additional Agricultural Investment*

Improvement		Net Present Value (Million 1979 MF)	Internal Rate of Return (%)
From	To		
Without Improvement (w/o)	Alt. 1 (W1)	1,925.0	16.4%
" " "	Alt. 2 (W2)	4,174.6	17.3%
" " "	Alt. 3 (W3)	5,557.5	17.3%
" " "	Alt. 4 (W4)	5,587.2	15.8%
" " "	Alt. 5 (W5)	7,261.0	16.4%
" " "	Alt. 6 (W6)	6,705.7	15.5%
" " "	Alt. 7 (W7)	6,407.7	14.8%
From	To		
Alt. 1 (W1)	Alt. 2 (W2)	2,250.6	18.6%
Alt. 2 (W2)	Alt. 3 (W3)	1,382.8	17.3%
Alt. 3 (W3)	Alt. 4 (W4)	29.7	10.2%
Alt. 4 (W4)	Alt. 5 (W5)	1,673.8	23.3%
Alt. 5 (W5)	Alt. 6 (W6)	(555.4)**	5.5%
Alt. 6 (W6)	Alt. 7 (W7)	(298.0)	6.4%

* Appendix I (pages I.2 to I.22) presents the computer output on which this table is based.

** Values in parenthesis are negative.

The overall impact of capital investment in road improvement alternative No. 5 as well as in an additional agricultural program can be vividly represented by the following:

- The average regional net present value added (total revenues/savings less total costs) for each ton of agricultural produce is estimated to increase from 183,000 MF in the without improvement case to 367,000 MF; and
- The corresponding increase in regional net present value added for each hectare under cultivation is from 102,000 MF to 260,000 MF.

11.4 SENSITIVITY ANALYSIS

As noted in Chapter 7, seven types of sensitivity tests were conducted: with twenty percent higher and twenty percent lower construction and maintenance costs; with twenty percent higher and twenty percent lower net revenues; with limited maintenance; with a positive impact on livestock development; and an increase in the minimum opportunity cost of capital to twelve percent. The main analysis represents the best judgment as to the most likely or most probable future course of events. The sensitivity analyses provide an indication of how the results would change if various key elements in the study differ from the projected values; i.e., whether future conditions are more optimistic or more pessimistic than anticipated. These tests were carried out for the two investment options discussed in the previous two sections.

The two sensitivity tests pertaining to the cost side of the economic analysis are necessary to account for possible variations in the cost streams which are made up of capital investment in construction and recurrent expenditures in maintenance. The higher cost test assesses the conditions

where construction quantities* or unit prices or both are larger than estimated in this study; in addition it assesses the conditions where higher unit costs and/or more expensive maintenance activities are required. The lower cost test assesses the opposite conditions. The limits of these tests, as set at the ±20% level, measure reasonably the possible variation in the cost side of the analysis.

All economic analyses, reported on, used implementation program option A (see Chapter 4) as the basis for estimating the disbursement schedule of construction costs. An analysis of the net present value of the construction cost stream under implementation program option B revealed an extremely slight variation from that one under option A, for the adopted opportunity cost of capital. This implies that the numerical results of the economic analysis are not affected by which implementation program option is selected.

The two sensitivity tests pertaining to the revenue side of the economic analysis are necessary to account for probable variations in the revenue streams which are made up of recurrent benefits to the farmers and truckers. The higher net revenue test assesses the conditions whereby production and market prices are larger than estimated in this study. Such a turn of events could be the result of underestimating the incentives created by road development and the response of the agricultural sector to these incentives. The lower net revenue test assesses the opposite conditions resulting from having overestimated the incentives created by road development. Furthermore, both tests account for possible variations in the socio-economic base data and the rate at which road development impacts take effect.

The maintenance cost estimates derived in this study (See Appendix H) are those required to carry out the adequate maintenance of the road improvements. Provided the Fourth Highway Program is successfully implemented,

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* Larger construction quantities could derive from the later adoption of higher design standards; i.e., wider platform and/or wider double surface treatment - 6 meters instead of 5 meters (See Chapter 3).

these estimates represent a realistic projection. As the implementation and success of said World Bank program are not yet finalized, and in light of past experience in Mali whereby road maintenance is relegated to a low priority, a sensitivity test was devised to assess the feasibility of road improvements should road maintenance remain at its presently inadequate level. This test is referred to as "limited maintenance" and is defined as follows: Maintenance of the road is carried out to an adequate level for the first five post construction years, after which only very limited routine road maintenance is undertaken at a level comparable with present efforts in the First Region. The maintenance of the road during the first five post construction years relies on the equipment acquired for force account construction, a recommendation for either investment option.

It is possible, but not likely, that road improvements will have a significant impact upon the livestock sector. For this reason, said sector was analyzed with a view at including possible impacts as a sensitivity test rather than being incorporated in the main analysis.

Finally, as discussed in Chapter 7, it is difficult to estimate the opportunity cost of capital with precision. A middle range rate of 10 percent was used for the main analysis. It is necessary, however, to test the reliability of the conclusions should this rate be judged to be on the low side.

As can be seen from Tables 11.5 and 11.6, the recommended road development levels, for each investment option, have an internal rate of return larger than 12 percent. This implies that the recommended project options are still economically feasible. Although the recommended project options are feasible they are not optimal. A study of Tables 11.2 and 11.4 show that the optimum road improvement levels are as follows: 1) When capital investment is limited to road improvements, the optimum level of development consists in a double surface treated road between Kayes and

Dialaka, and a "least cost" road between Dialaka and Yélimané, and 2) when capital investment is multi-sectoral, the optimum level of development is the same, excepting the Yélimané branch road is included at a "least cost" standard.

The project feasibility indices for all alternative road improvements are summarized in Tables 11-5 and 11-6, each table relating to one investment option. The resultant conclusions are as follows:

- Should capital investment be limited to road improvements, modified alternative road improvement No. 5 (W5M) still defines the optimum network under all sensitivity tests relating to optimistic future conditions. However, this conclusion would not be valid for all pessimistic sensitivity tests. Should these situations come to pass, no road improvement would be feasible if net revenues were twenty percent lower than expected, (none of the alternative improvements would generate a positive net present value), and modified alternative road improvement No. 2 (W2M) would otherwise define the optimum network (i.e., minimum standard road between Kayes and Nioro.

- Should capital investment include an additional agricultural component, alternative road improvement No. 5 (W5) defines the optimum network under all sensitivity tests, whether representative of optimistic or pessimistic conditions. These results indicate that the additional agricultural investment tends to stabilize development in the study area.

Should the option of only investing in road improvement be the one which is selected, then road maintenance is the critical issue which needs to

Table 11.5

The Sensitivity Tests:
Without Additional Agricultural Investment
(1979 prices)

	Sensitivity Tests	IMPROVEMENT OF EXISTING ROAD TO: Modified Alt. 2 (W2M)	Modified Alt. 3 (W3M)	Modified Alt. 4 (W4M)	Modified Alt. 5 (W5M)	Modified Alt. 6 (W6M)
Pessimistic Conditions	Limited Maintenance					
	NPV (Million MF)**	1143	893	262	701	156
	IRR (Precent)	14.4	12.3	10.5	11.1	10.2
	Lower Net Revenues					
	NPV (Million MF)**	(206)*	(389)	(875)	(702)	(1468)
	IRR (Percent)	9.2	9.0	8.6	9.0	8.2
	Higher Costs					
	NPV (Million MF)**	1110	932	408	631	(278)
	IRR (Percent)	13.2	11.8	10.5	10.7	9.7
	BASE ANALYSIS					
	NPV (Million MF)**	1934	2004	1877	2288	1736
	IRR (Percent)	16.4	14.4	12.8	13.0	11.9
Optimistic Conditions	Lower Costs					
	NPV (Million MF)**	2757	3076	3347	3946	3750
	IRR (Percent)	20.6	17.9	15.8	16.0	14.9
	Higher Net Revenues					
	NPV (Million MF)**	4073	4397	4629	5279	4940
	IRR (Percent)	22.1	18.8	16.3	16.4	15.1
	Livestock Impact					
	NPV (Million MF)**	2153	2406	2427	2896	2395
	IRR (Percent)	16.9	15.1	13.4	13.6	12.6

* Numbers in parentheses are negative.

** The present, for the Net Present Value (NPV) is 1980.

Table 11.6

The Sensitivity Tests:
With Additional Agricultural Investment
(1979 prices)

		IMPROVEMENT OF EXISTING ROAD TO:						
		Alt. 1 (W1)	Alt. 2 (W2)	Alt. 3 (W3)	Alt. 4 (W4)	Alt. 5 (W5)	Alt. 6 (W6)	Alt. 7 (W7)
Pessimistic Conditions	Limited Maintenance							
	NPV (Million MF)**	1318	3367	4202	3694	5067	4569	4090
	IRR (Percent)	14.8	16.4	16.1	14.2	15.2	14.2	13.6
	Lower Net Revenues							
	NPV (Million MF)**	(216)*	1167	2037	1678	2868	2102	1693
	IRR (Percent)	9.2	12.3	13.0	11.7	13.0	11.7	11.4
	Higher Costs							
	NPV (Million MF)**	1101	2881	4016	3648	5134	4222	3748
	IRR (Percent)	13.3	14.5	14.8	13.3	14.2	13.0	12.3
	BASE ANALYSIS							
	NPV (Million MF)**	1924	4175	5556	5587	7261	6706	6408
	IRR (Percent)	16.4	17.3	17.3	15.8	16.4	15.5	14.8
Optimistic Conditions	Lower Costs							
	NPV (Million MF)**	2747	5468	7099	7526	9388	9189	9067
	IRR (Percent)	20.5	21.1	20.8	18.9	19.8	18.6	18.0
	Higher Net Revenues							
	NPV (Million MF)**	4064	7182	9078	9497	11654	11309	11122
	IRR (Percent)	22.0	21.7	21.1	18.9	19.8	18.3	17.7
	Livestock Impact							
	NPV (Million MF)**	2329	4394	6177	6137	7869	7365	7140
	IRR (Percent)	17.3	17.6	17.9	16.0	16.9	15.8	15.2

* Numbers in parentheses are negative.

** The present, for the Net Present Value (NPV) is 1980.

be resolved; otherwise the optimal level, to which it is recommended that the Kayes-Nioro road be improved, is no longer optimal, and a "least cost" level of improvement is preferable from an economic point of view. Engineering wise, this would not be sound (See Chapter 3); furthermore, the Kayes-Nioro Road would deteriorate to its present condition some time at the turn of the century, and the cycle of development will need to be retraced anew, unless planned obsolescence of infrastructure improvements is an acceptable policy.

11.5 CONCLUSIONS

1. With only those agricultural programs firmly programmed for implementation, the optimum investment [modified alternative No. 5, (W5M)], in economic terms, is to improve the Kayes-Nioro Road as follows: a double surface treated road between Kayes and Dialaka, and a laterite/gravel surfaced road between Dialaka and Nioro. It would not be feasible to upgrade the existing Dialaka-Yelimané branch road.

2. If an additional 1.250 billion MF is invested in the agricultural sector in the Yelimané-Segala areas, the Dialaka-Yelimané branch road would become feasible and the optimum improvements of the road network (Alternative No. 5, W5) would be as follows: a double surface treated road between Kayes and Dialaka, a laterite/gravel surfaced road between Dialaka and Nioro, and a minimum standard road for the Dialaka-Yelimané branch.

3. Although alternative improvement No. 5, with the additional agricultural investment, provides the highest regional net present value under all conditions, it need not be considered the most favorable investment option; issues, additional to

economic considerations, could be introduced into the decision making process. For this reason, it is deemed more appropriate to offer a choice between two projects, one for each investment option.

CHAPTER 12

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SOCIAL SOUNDNESS ANALYSIS

12.1 INTRODUCTION

The Social Soudness Analysis has been prepared specifically to answer these questions:

> Will people who are expected to participate in this project want to participate?
>
> Will this project have spread effects? That is, can the innovation introduced by this project be adopted by others in contiguous regions, classes, groups, etc.?
>
> Who will benefit from this project? Will the project introduce benefits for some at the expense of others?

For the Kayes-Nioro road, these questions were addressed by surveys conducted in nine villages along or near the road, by interviewing of government officials and merchants and collateral review of documents and literature. In the villages, investigations focused on how villagers perceived the benefits of the improved road, how they would view participation in road construction and how the improved road would fit within the social context and organization of farming and livestock raising. A copy of the questionnaire

and data summarizing responses to selected questions are presented in Appendix G.

12.2 PROFILE OF SOCIAL CONDITIONS

This social profile summarizes information pertinent to evaluating the road. It was obtained from the nine village survey, other interviews and relevant literature. More detailed information can be found in Appendix G and in Appendix F, The Existing Environment, which provides data pertinent to both the Social Soundness Analysis and the Environmental Assessment in order to avoid duplication.

12.2.1 GENERAL BACKGROUND

The Kayes-Nioro road passes through an area inhabited primarily by members of Sarakolé (or Soninké), Khassonké, Peul, Mauré, Bambara and Malinké ethnic groups. The primary ethnic groups are Sarakolé, Khassonké and Peul. Villages included in the survey represented the Khassonké, Peul, Sarakolé and Bambara. In each of the ethnic groups represented in the survey, descent is patrilineal and authority is vested in male heads of families.

Historically, there have been major differences among these ethnic groups: the Sarakolé and Bambara were known as traders and agriculturalists, the Peul as cattle nomads, the Khassonké as agriculturalists and pastoralists. The survey revealed more similarities than differences. Each village was located near a water source, surrounded by cultivated lands and separated from neighboring villages by uncultivated savannah used for pasturage.

Vestiges of traditional orientations remain; the Peul village in the survey and investigations undertaken for the Kaarta project verified that Peul were not traditionally farmers and that they did not cultivate as much land as other ethnic groups. While Peul groups may specialize relative to other groups in raising livestock and other groups are oriented to farming,

these distinctions have been somewhat lost in this area.

Villagers practice rainfed agriculture during the rainy season of June through August. Some villages practice flood recession (décrue) agriculture near rivers and streams as water recedes after the rains. The major crop is grain--one of many varieties of millet, sorghum, maize or rice, or a combination of these. These are supplemented by peanuts, cotton, ladle gourds and a large variety of vegetable crops including beans, onions, tomatoes, okra, melons, squash, calabashes and rootcrops. Agricultural technology remains basic; although plows and oxen exist in a few places, the short-handled hoe is the principal tool of cultivation.

Villagers own cattle which are put to pasture on areas unused and generally unsuitable for agriculture. Usually the cattle are herded by Peul shepherds who take them on transhumance into Mauritania during the rainy season. None of the surveyed villages depended solely on livestock for their livelihood, although such groups may exist in the northern areas.

12.2.2 THE ROLE OF GRAIN AND LIVESTOCK

Grain buying in times of shortage and grain sale are important issues for villagers. Each year at harvest time, OPAM government representatives deposit a predetermined number of sacks in each villages. The village is obliged to fill these sacks with grain and they are then sold to the OPAM at fixed government prices which are below free market prices. After the sacks have been filled and economic police are no longer on the roads, normal (parallel) market prices return. Farmers with no capital reserves sell at harvest time when prices are lowest. Some store surplus grain until prices are higher. Villagers were concerned that they were forced to sell to the government at fixed prices when grain prices were low, but when their grain supplies ran out they were forced to buy back when prices were high. (See Appendix G for quoted prices of grain.)

The issue of government marketing of grain is beyond the scope of

this analysis. Villagers, however, were not enthusiastic about raising more grain to be sold at government prices; many of the development projects in the region are aimed at increased grain production; and truckers feel that they lose money on the transport of OPAM marketed grain from this area. Despite these sentiments, the parallel market in grain is economically larger than the controlled market and both farmers and truckers make up their losses by tariffs charged to the parallel grain market.

Livestock play a special role in the economy of these villages. Livestock represent a form of investment, savings and a display of wealth. Money invested in cattle does not depreciate since cattle reproduce themselves, nor does it require further investment or maintenance since cattle graze on lands outside the cultivated areas. Cattle are sold much as one would take money out of a savings bank: for a marriage, to pay taxes, or when for some reason one needs money. If the harvest is bad and farmers are forced to buy grain, then cattle are sold. Thus, the availability of cattle is linked on the market to the shortage of grain.

The marketing of cattle is done by merchants who buy and assemble herds of cattle large enough to walk on foot to Kayes or Bamako. In Nioro, members of the Livestock Merchants Cooperative estimated that 75% of the livestock from the Nioro region were marketed in Kati (near Bamako); only 25% went to Kayes. It takes 22 days to walk the cattle to Kati and 16 days to Kayes; during the trek about 10% (5 out of 50) of the cattle die. For a herd of 50 (100) animals going to Kayes, 2 (3) herders are employed at 20,000 F each plus 5,000 F for food.

12.2.3 ORGANIZATION OF WORK AND ROLE OF WOMEN

Work within the village is organized by age and sex division of labor, with specific tasks assigned to men and women varying from one ethnic group to another. Men are most likely to be responsible for providing grain for the family. Women are more frequently responsible for production of vegetables

and spices which go into food sauces (see Appendix G for crops of women). This production is important nutritionally since it provides most of the proteins and vitamins which complement the basic starch staple. Women may also raise grain but this is not considered her primary responsibility. Women work on common fields with men and, in addition, they cultivate their own fields. In some villages, men and women have separate fields. The produce from a woman's fields is considered her own. If there is a surplus, she may sell it and dispose of the income.

In some of the villages visited, women were extremely active in trade and in the production of items for sale. A number of village women were engaged in nothing but trade. Women travel large distances over the road to sell such items as tomatoes, onions, okra, mangoes and ladle gourds. They bring back fruit, spices, cloth, peanut oil, shea butter, black pepper, tea and sugar. In Sandaré, for example, young women take onions to sell in Kayes and buy cloth and cooking utensils which serve as their dowry. In Ségala, women take cloth they have dyed to sell in Kayes and return with indigo and fruit. Reciprocally, women from Kayes will market products in local villages and return with dried okra, ladle gourds, bitter tomatoes, and onions. Men appear typically responsible for commerce in calabash and other products. Grain is usually bought from special merchants in local markets or sought in Kayes.

There is some difference among ethnic group traditions concerning women and trade. Male , Peul villagers in Dioka were insistent that their wives' principal role was that of housewife and that they did not engage in commerce. Different castes also play different roles in the production and marketing of goods (see Appendix F).

Wage labor does exist in the villages, primarily for agricultural work. Laborers are paid a sum for the morning's work and a supplement for work done in the afternoon. In addition, they are provided with food and

housing. Wages in the area are currently 1,000 MF for the morning, 500 F for the afternoon. Reported wages did go as low as 750 MF in the morning plus 500 in the afternoon. Dry season wages are less than rainy season wages, sometimes as low as 500 for the morning and 250 for the afternoon. There is a tradition in some villages, but not all, that members of the same ethnic group do not work for each other.

12.2.4 LABOR MIGRATIONS

Finding themselves on the margins of cultivable land, with few resources and with little work in the dry season, villages have responded to the existence of labor markets elsewhere by large scale temporary migration. The Soninké in particular have established a pattern of migration for young men who work as manual laborers in France. Typically, they work in France for periods of four to eight years, send money home in the form of mandats and subsequently return to their home village. While the Soninké villages are more dependent than others on labor migration to France, villages visited shared the reliance on migratory labor of their young men for economic survival. Laborers also travel seasonally and for longer periods to the Ivory Coast or Sénégal; some villages reported having young members as far as Gabon, Zaire and Rhodesia. In the villages visited, young women might go with their husbands, but traditionally did not, nor did they seek employment themselves.

This form of labor migration has been observed in many developing countries. In other places it tends to follow a trend. At first, young men emigrate alone, sending money to villages. Later they may establish themselves abroad and return for wives and family. Long periods of absence also lead to loosening of family bonds and authorities and the abandonment of traditional obligations by some of the men. In some places, men emigrate with their wives, thus beginning patterns toward nuclear families. Despite this social change, the strength of traditional loyalties remains.

In addition to migrant labor, the people of the area have traditions in trade and commerce. They spoke of relatives who were in commerce in Kayes or in Bamako. These economic links with areas of greater wealth and economic opportunity are important to the villages. Sometimes they create wealth which is repatriated to the villages.

12.2.5 USE OF KAYES-NIORO ROAD

Villagers use the road primarily for commerce, but also to obtain medical care, to visit relatives and to obtain mandats from the post office (often via trusted emissaries). (More detailed data regarding services can be found in Appendix F.) The road is sometimes not used for transport of fragile products because of its condition. From Sandaré, for example, mangoes are sent to Yelimané on donkeys. In towns south of Sandaré, a dominant orientation to Kayes was noted. North of Sandaré, Nioro became a major point of orientation but villagers still traveled to Kayes. In the Yelimané vicinity, in the one village where interviews were conducted, the road going directly to Kayes rather than via Dialaka was preferred. In one village south of Nioro, villagers had a dominant orientation to Bamako.

The price of transport is officially regulated by the Malian government based upon the classified state of the road. The fixed passenger price from Kayes to Nioro is 3,000 FM. The official transport price for freight on the Kayes-Nioro road is fixed at 64.24 FM per ton kilometer. The 250 kilometer journey from Kayes to Nioro should therefore cost approximately 15 F per kilogram. According to the President of the Transporters Cooperative in Kayes, the official price for the Kayes-Nioro road is too low to make transport profitable.

The costs paid by villagers were obtained in the nine village survey. From Kayes to Nioro passengers paid approximately 5000 FM and over the same distance freight cost approximately 30 FM per kilo. (Details regarding intermediate points are provided in Appendix G.) While current fixed transport

prices would appear to be a subsidy to the passengers, in fact real costs are passed to the consumer.

12.2.6 VILLAGE ROAD CONSTRUCTION AND MAINTENANCE

There is currently operating a system of maintenance for village trails. Each village is responsible for maintaining half the distance of the trail between itself and the next village. The work consists of tree cutting, grass clearing, rock removal and hole filling, but such maintenance does not always occur each year. This existing system indicates the willingness of villagers to participate in road maintenance when it is in their interest.

According to the survey results, labor would be available in the area to work on roads, at the going wages. Respondents volunteered the information that their young men would prefer to work at home rather than to migrate for work elsewhere. Young men, however, were not directly sampled and there exists the possibility that psychological and social reasons as well as economic ones motivate external migration. Villagers were concerned that labor be paid at going wage rates since they had memories of forced labor under French colonization.

12.3 SOCIAL IMPACT OF KAYES-NIORO ROAD

This section examines the impact or benefit perception of those affected by the road and the road's impact on existing social patterns. The road's socio-cultural feasibility and an evaluation of the appropriateness of the intervention are summarized in a concluding discussion.

12.3.1 IMPACT PERCEPTION

The nine villages surveyed are considered representative of impact perception by villagers, the rural poor, who are intended to be the principal beneficiaries of the project.

The answer to whether or not villages perceived the improvement of

the road to be in their benefit was, with one exception, unequivocally yes. The exception was the village of Fassoudebé, closer to the road from Nioro to Bamako, where villagers perceived the road from Nioro to Bamako to be of greater importance. (See Appendix G.)

The villagers frequently used the French word of the administrative officials for the region, "enclavé." Their area was cut off, isolated from anything but itself, during the rainy season of the year and a long, arduous journey at other times. Benefit perceptions of an improved road focused around these principal themes:

- Better access to medical care.
- Ease in marketing products, buying goods and having goods available, particularly viewed as beneficial to women who participate in commerce.
- Possibility of selling different types of agricultural produce, especially fresh produce and milk and butter, which now spoils, and of obtaining better materials and farm implements.
- Lowered costs for transport, vehicle repair and fuel with the likelihood of lowered costs for goods purchased and more profit (or higher prices) for goods sold.
- Savings of time.
- Improved comfort of travel for sick and old persons.
- Visiting relatives with greater ease and frequency.
- Investment in vehicles, a more worthwhile expenditure since they wouldn't be damaged so quickly.
- Transport of sheep and goats by truck.

This summary does not cover the variety of comments made by villagers. These are listed by village in Appendix F and illustrate specifically the readiness of villagers to think of ways they could use the road to improve their livelihood.

12.3.2 TYPES AND DIRECTION OF IMPACTS

The road has a variety of social impacts in addition to the perceived

social impacts voiced by villages. This section reviews these effects by category. Section 12.6 profiles the incidence of impacts and their spread effects by beneficiaries.

The economic impacts of the road improvement, under a variety of design options, are thoroughly discussed in Chapters 10 and 11. The magnitude of economic benefits stemming from accelerated farm production and the expansion of farm units varies, but generally involves enhanced production and marketing of cash crops, including vegetables, and some increases in livestock marketing in accordance with the development goals of the Kaarta and Kayes-Nioro development projects. This review emphasizes the primarily social impacts of the project and points out those areas where mitigative measures are appropriate to consider.

PSYCHOLOGICAL ACCESS: The psychological value of opening up an area that sees itself as cut off or isolated from the modern sector and from the rest of Mali should not be underestimated. Although active adults do indeed travel and market, they know the constraints of the road's travel time and conditions and sense themselves to be lacking in opportunities. Psychological access creates more receptive conditions for the exploitation of new markets and different products to be marketed. The existing road is a severe constraint to younger people who cannot visit home if they are away at school, to the sick who cannot get to the hospital and to the elderly who find it difficult to visit relatives.

SERVICES: The road assists most in improving access to medical care in the regional centers of Kayes and Nioro and allows extension services to reach villages more effectively. Some benefits to education, principally for administrators, teachers and students who travel long distances will be achieved. Since bearing and raising children is a significant aspect of women's lives in villages and carries the risk of maternal and child death, easier access to maternal and child care will be of special benefit to women.

ORGANIZATION OF WORK AND ROLE OF WOMEN: The improved road will have a definite beneficial impact on marketing by lowering the costs of transport paid by villagers and thus raising the ex-farm prices for products. (See Chapter 11.) The lowered transport costs and the improved condition of the road will provide incentives to villagers to market more products and in turn, as they reap more profit, to reinvest in the farm unit. Villagers may also choose to market their own products and to invest in vehicles. Improvement of the road will enable women to increase their already active trade in vegetables. Getting fresh vegetables to market has economic advantages to villagers since fresh produce, as opposed to dried produce, brings higher prices. This vegetable production and marketing is seen by the villagers as the province of women. Although special questions related to livestock and grain production were included in the questionnaire because development projects in the region emphasize these two aspects of production, villagers did not share the bias of the questionnaire toward this largely male production system. They consistently emphasized the importance of vegetable production and marketing to their economy and the benefits the road would bring to this sector.

In the future, the project is likely to lead to greater specialization of roles, particularly in marketing, but also in villagers' provision of their own transport. The organization of work, now divided according to sex, may also change with increased commercialization. Encouragement of the vegetable sector in the O.P.I. (Irrigated Perimeters Operation along the Sénégal) has taken the form of irrigation and commercialization and this sector has come to be dominated increasingly by men. This effect, should it occur, will not be mitigated simply. There appears to be no group or development project which would take action to prevent such a change. It is suggested that the proposed USAID First Region Pilot Development Project pay particular attention to the role of women in their agricultural expansion and extension efforts.

MIGRATION: Rural outmigration, both seasonal and long-term, already exists and population data indicates a significant rural-urban flow. The building of the road will not stem the rural exodus from this area. In the short run, the road may have the opposite effect since it permits an easier route for short term migrants who have already demonstrated their willingness to travel long distances in search of better employment opportunities while retaining their family homes.

The demographic trends for this area will be most affected in future years by two major factors: the death rate and the differential imbalance in economic opportunities between this region and urban centers in Mali and abroad. One can anticipate a decline in mortality rates resulting from extension of rural health services. Unless this is accompanied by a decline in fertility rates, which appears unlikely in the short run, this will result in an increasing rural population. Since the agricultural potential of the area is not high, there is little reason to believe that economic opportunities in the region will come over the next years to correspond with those elsewhere. Therefore one can predict that with increased population growth the actual number of out-migrants will increase.

From the point of view of population policy, the importance of the road is in the stabilization of the existing equilibrium. If such low income rural areas are ignored by government services and development programs, they are subject to increasing stagnation. In the extreme, it leads to a situation where productive land is not only underutilized but abandoned. From a national point of view, this results in loss of agricultural produce and an oversupply of urban labor.

The construction of a single high quality road through the region will cause imbalance in access between those on the road and those not on the road. This will predictably cause some migration of villages and markets to the road. The most obvious benefit imbalance of a road project is that

those far from the road are relatively disadvantaged. Its obviousness does not, however, imply lack of importance. It therefore seems important that future development projects in the area investigate and plan secondary and feeder roads with respect to the location of existing population.

ROAD CONSTRUCTION AND MAINTENANCE: The project will not directly call for participation of villagers in road construction. (See Chapter 4.) This is not a negative social impact, but its absence eliminates the opportunity for the learning of construction skills and the transfer of such skills to the maintenance of bush or connector roads. One of the major problems in the Mali in transport system is the lack of road maintenance. From the point of view of the villager, not only may the Kayes-Nioro road deteriorate within five years, but if he does not live directly on the road, he still faces major transport hurdles. Additional attention could be given to the existing voluntary system of road maintenance which operates within each village to maintain village tracks. If simple investments could be made which facilitate or improve the existing community effort, then villages off the road will reap greater benefits from the Kayes-Nioro road and the Yelimané branch.

12.3.3 SOCIO-CULTURAL FEASIBILITY

One of the objectives of a social soundness analysis is to identify, before project implementation, areas in which the motivation of people whom the project serves differs from that assumed by project designers and that will make a project successful. The sociocultural feasibility or appropriateness of the intervention, an improved road, is based upon the answers to two related questions. First, is the road project consistent with the values and social organization of those whose use of the road is assumed? Second, are the rural participants willing to expand production and trade and respond to the road's economic incentives, i.e. how is the road project dependent upon or linked to larger development goals?

The rural participants welcome an improved road; their motivation to participate can be defined as their stated desires to have better access to markets, to improve their economic state and to improve the quality of their lives by access to services. Since people already make long journeys on the existing road, the road and its use is not a new innovation which requires villagers to alter basic values. Rather, the road feeds into the values, social structure and organization of communities, particularly those of the Sarakolé who are renowned as traders and merchants.

From the vantage point of those who use the road to deliver services to the rural population, an improved road is also welcome; improvement removes an impediment to the accomplishment of their goals. It permits agencies of the Malian Government to carry out their educational, health and cultural programs more effectively and with less costs. The time lost in travel and the extra expense of fuel, vehicle maintenance and vehicle repairs engendered by a road in extremely poor condition create difficult and often impossible jobs of responsibility for public services and risk the premature destruction of scarce government vehicles.

Rural participants sampled were genuinely interested in increased marketing of products and in the availability of more equipment and ways of reducing the destruction to crops. Respondents were especially enthusiastic about marketing perishable vegetables and fruits. Generally speaking, villagers are likely to respond to the road's economic incentives since these are largely consistent with their social values. A few caveats which do not undermine the road's sociocultural feasibility are, however, in order. One of the major intentions of government and donor agency development programs for the Kaarta region surrounding Nioro du Sahel, is to increase production and marketing of cereal grains and livestock. For the Kayes Nord project serving the region west of Kaarta, livestock development is the major goal. Village investigations revealed that farmers were somewhat unenthusiastic about increased grain production at controlled government prices. They did

not yet see cattle production as a form of income generation. The function of cattle for investment and savings is still very important in these relatively isolated village economies.

The existing role of livestock production is open to change and evolution as villagers discover that more cattle can be sold and more goods purchased. Evidence of increased responsiveness to marketing of livestock was encountered in the village of Diandioumé, north of Nioro. When asked if cattle sales had increased, they said they had because merchants now come to their market to buy and that the largest sellers were 3-5year old steers. Reasons for sale included buying grain, children's clothing and goods such as salt, sugar and tea. Under these circumstances, consumer goods and houses may become new symbols of wealth and status, but it is difficult to see what the villager will rely upon as a form of secure savings, unless more attention is paid to credit and savings. From this point of view, development planners would do well to consider how this evolution might take place, and how development interventions can assist increased commercialization consistent with the self-interest of the inhabitants of the region.

12.4 SPREAD EFFECTS

12.4.1 SPREAD EFFECTS OF THE ROAD PROJECT

The original concept of spread effects of a project is not easily applicable to a road project. It is typically applied to a pilot project: will an innovation once introduced be copied elsewhere and will the beneficial effect of the investment be greater than the success of a particular project. The most immediate application to the Kayes-Nioro road regards construction and maintenance. If foreign contractors are responsible for construction, the ability to construct similar roads is not imparted to the Malian construction industry. The use of force account rather than contractors on the Yelimané-Dialaka road or the Dialaka-Sandaré section has been proposed and is analyzed in Chapters 2 and 4.

Since a road project does not reproduce itself but deteriorates and disappears without maintenance, the way to increase the spread effects of the project itself is to amplify the capacity of the Ministry of Public Works to maintain roads.

12.4.2 SPREAD EFFECTS OF DEVELOPMENT PROJECTS FACILITATED BY THE ROAD

An improved road can bring to an isolated area opportunities for the diffusion of ideas, of technology and services. By connecting the administrative centers of Kayes and Nioro du Sahel, the road will increase contact among health and education staff and others engaged in service delivery and with the areas under their jurisdiction. The easier access will also permit enhanced communication among the agents of the existing development projects in the road's zone of influence (Kayes-Nord, Kaarta, O.V.S.T.M. and the USAID Yelimané health project) and the proposed USAID First Region Pilot Development Project. Since both those responsible for social services and for development projects have leadership roles and wide patterns of mobility (two criteria for spread effects of the Social Soundness guidelines), the diffusion of information among this circle and beyond it to other administrators is likely. In turn, those engaged in development projects and service delivery have rural clienteles whom they serve and to whom they can communicate the information, ideas or technology to which they have been exposed. By making contact less difficult and less time-consuming and by removing the barriers to frequent travel, the road permits the spread of knowledge.

The rural poor who participate in development projects and benefit from service delivery also use the road and are likely to communicate with others regarding the results or benefits of their participation. This type of spread effect, dependent upon communication of information among small groups, will be difficult to quantify. The effects will be difficult to monitor because of the varying exposure to development projects and the relatively short time horizons for the development projects. Conceptually, however, the road as a facilitator of communication and travel among people who do

travel and desire to travel more should facilitate the spread of techniques and knowledge as well as products.

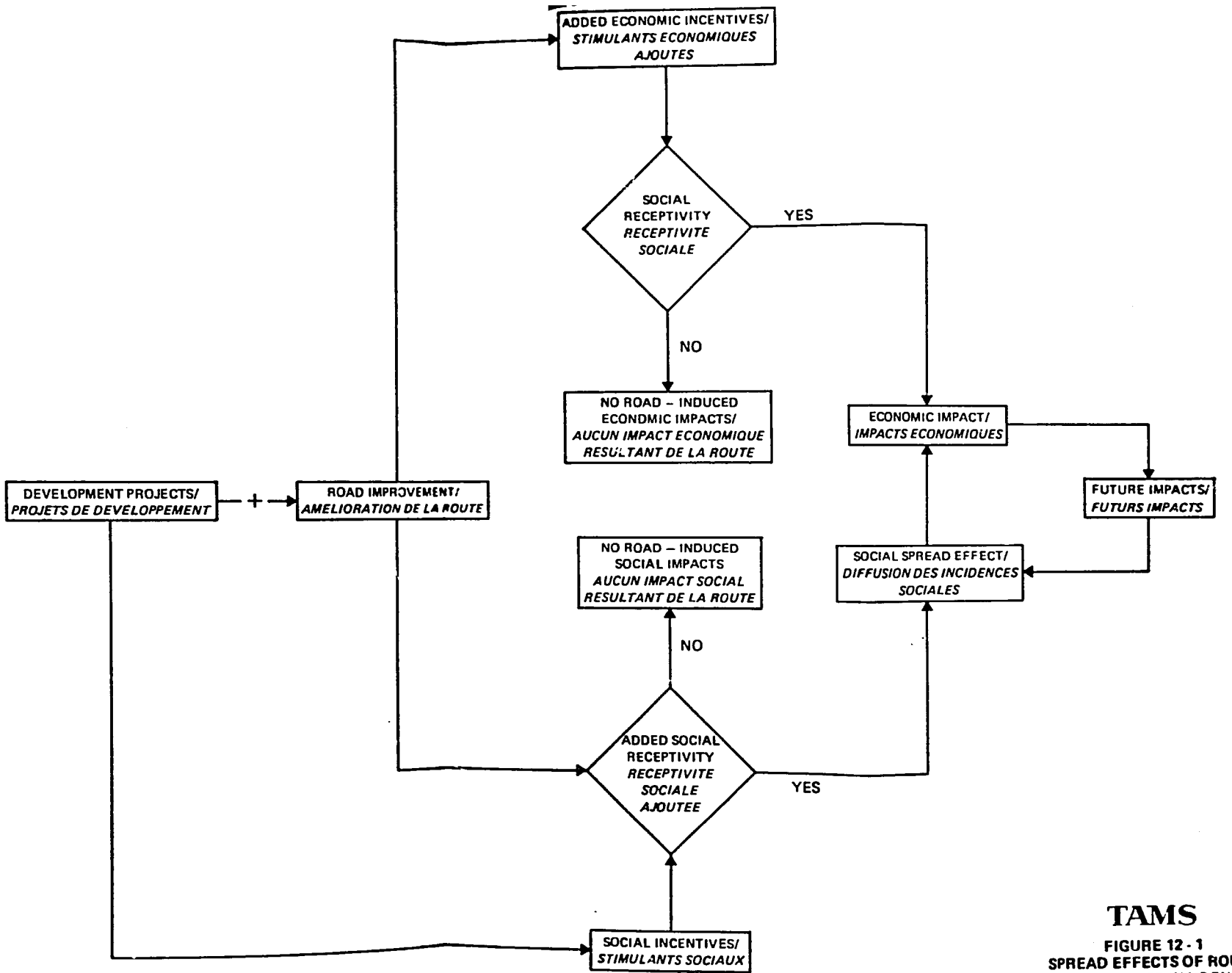
The economic feasibility analysis has compared development with the road and without the road. This analysis indicates that increased production and marketing of goods will result and goals of development projects will be accelerated and diffused among the rural population. This feasibility analysis which quantifies economic spread effects took into account the general social receptivity of the population to economic incentives in the zone of influence, including constraints to increased grain production and motivation to change livestock practices. Based upon the social receptivity of villagers and leaders to the road, the process of economic spread effects related to the road has been conceptualized in the diagram on the next page.

12.5 BENEFIT INCIDENCE

Two principal types of benefits will accrue from an improved road: value added benefits and user cost savings. The principal beneficiaries of these benefits are farmers and transporters or merchants, i.e. those who use the road to transfer products. Others who use the road, such as visitors, ill people, laborers and the like and agencies who use the road to distribute supplies or deliver services, are the beneficiaries primarily of user cost savings.

12.5.1 VALUE-ADDED BENEFITS TO FARMERS AND TRANSPORTERS/MERCHANTS

The benefits of reduced transport costs, i.e. the savings achieved by transport of goods on a better road, will be distributed between the rural farmer and the transporter such that 80% of the savings will go to the farmer and 20% to the transporter. Figure 10-1 outlines diagramatically how the process is conceptualized for a typical product with prices and costs averaged over the distance of the road. The farmer will benefit from the savings in the form of higher prices received at the farm gate, i.e. a higher profit and greater



TAMS

FIGURE 12 - 1
SPREAD EFFECTS OF ROUTE
DIFFUSION DES INCIDENCES DE LA ROUTE

income than he had before the road was improved. The transporter will realize an increase in profit (approximately 24% for the case shown) with the result that a transporter's profit becomes approximately equal to his cost or a profit rate of about 100%. The bulk of the benefits can go to the farmer and still permit an absolute increase in profit and an increased profit rate to the transporter, principally because of the relatively large reduction in transport costs. The case shown in Figure 10-1 assumes the minimum cost road, i.e. the least savings in transport costs. For other design options the transport savings are higher. If the transporter's profit is kept constant, then the proportion of savings going to the farmer increases. While the proportion of savings going to the transporter decreases in those cases, his rate of profit, given the lower transport costs, still increases.

The merchant or middleman will benefit in different ways according to the type of merchant. A merchant who is among the rural poor, i.e. living in a rural village and part of a farm production unit, will at the level of the household benefit like the farmer and share in the same way in transport savings. The rural village merchant benefits as an individual only from the increased volume of products which will be sold: the unit profit remains the same, but total profit increases. The urban merchant or the atypical case of the rural merchant who is not part of a farm production unit, will benefit primarily from the increased volume of transported products, i.e. a net higher profit but no change in profit rate. To the extent that merchants may bargain with transporters for a reduction in transport costs, they will share in the savings realized by transporters.

The process outlined above also has ramifications and responses beyond these initial benefits. Figure 10-2 traces these for the rural farmer. With increased income and profit the farmer will reinvest in the farm, both through expansion of the farm unit and inputs applied to its cultivation. This increased volume of production, i.e. the achievement of development goals which depend upon the assistance of Kaarta and O.V.S.T.M., will

then lead to the sale of more products at the new higher price and the use of extra income for reinvestment in the farm, in livestock and in consumer goods. For the transporter, a similar chain of effects can be anticipated: reinvestment goes partly to increased capital stock, e.g. more trucks; increased volume of goods to be transported and better ways of doing so leads to increased income.

Benefits to the farmer and to the rural merchant could be increased to the extent that these groups use some income to invest in vehicles to transport goods or form a rural cooperative to serve the entire village. Some villagers indicated they could already afford to do so. This particular avenue of development warrants further exploration by USAID in its conception of the proposed First Region Pilot Development Project.

Livestock merchants will benefit in a way similar to other merchants but to a lesser extent than other types of merchants since the bulk of livestock movement will continue to be on foot rather than by truck.

12.5.2 USER COST BENEFITS

The benefits of user cost savings (a reduction in transport price of approximately one-third to one-half) will flow to all road users and to recipients of services whose delivery depends upon the road. Generally these benefits are available to the 240,000 people in the zone of influence, but certain groups are singled out here for discussion.

Women: Women, who benefit as merchants from the increased volume of transport, also benefit by lower costs for medical care when they seek medical care outside the village. Reciprocally, they benefit when health care becomes more available within the region as the costs of vehicle travel and improved accessibility permit better service delivery. To a lesser extent, but likely to gain in importance in the long-run, are accessibility to and availability of educational and literacy programs.

Elderly: The elderly will have enhanced and cheaper opportunities to visit relatives and to receive medical care.

Development Programs: Extension agents will better serve the region; the transport of goods necessary to the mobilization and implementation of development programs will cost less and the benefits of these programs will be multiplied.

Service Agencies: Costs of service delivery will be reduced which can lead to more money available for the service itself. The services (social, educational, health and extension work) can reach people more effectively. This benefit will have a relatively large impact on relatively small administrative budgets for such services.

12.5.3 SUMMARY

Guidelines for Social Soundness Analysis suggest four criteria for assessing social costs and social benefits.

1. The majority of benefits to be derived generally fall within the domain of access to resources and opportunities. This access results in a higher distribution and amount of income to the rural farmer and the farm family. The project will not limit or deny access to any group.

2. Employment benefits are not directly attributable to the road project, except for construction work (see 4.7 of Environmental Assessment); in the long run increased employment in marketing and merchandising as the volume of production expands can be anticipated. No employment will be eliminated because of the project. To the extent that the road provides for greater use of labor-replacing devices in agriculture, the existing constraint of available labor on the expansion of farm production will be lessened.

3. Rural displacement, migration and urbanization were discussed at 12.3.3. No other social costs nor social benefits are anticipated in this regard since the road project will not alter the more basic changes occurring

in Malian society. The road may stem somewhat the exodus to urban areas, but such a change cannot be assumed.

4. Changes in power and participation between the target group of rural farmers and other groups may occur as farmers gain more income and participate more widely in the regional economy. It is possible that the emphasis of benefits on production and marketing will be differentially taken advantage of by the Soninké ethnic group who already have a dominant position in the zone of influence with respect to size of farm units and participation in commerce.

CHAPTER 13

CHAPTER 13
ENVIRONMENTAL ASSESSMENT

The feasibility study of the Kayes-Nioro road includes the preparation of an environmental assessment. The scope and emphasis of the assessment is based, in part, upon the Initial Environmental Examination (IEE) of August 9, 1978, completed by USAID. The IEE concluded that reconstruction of the Kayes-Nioro road would produce little or no negative impacts on the natural environment. The examination recommended, however, that effects upon the human environment be investigated in greater detail and undertaken in conjunction with the Social Soundness Analysis. Preliminary economic and engineering reconnaissance of the road suggested that the road's impact on desertification be addressed; subsequent discussion with agency officials of the Government of the Republic of Mali corroborated that desertification, particularly related to fire, deforestation and reforestation, should be included.

This assessment is based upon field reconnaissance, investigations in selected villages and interviews with officials of the Government of the

Republic of Mali. The bibliography includes a list of interviewees. The names and locations of villages where investigations were performed and a copy of the questionnaire used are contained in Appendix G. Field investigations were conducted jointly for the Environmental Assessment and the Social Soundness Analysis. Aspects of the analysis pertinent to changes in production and in employment were derived from the economic analysis presented in the feasibility study. Greater detail or documentation on these topics may be found in the feasibility study, referenced as appropriate.

13.1 PROJECT DESCRIPTION

13.1.1. REASON FOR THE PROJECT

13.1.1.1. BACKGROUND

Please refer to Chapter 1, INTRODUCTION

13.1.1.2. PROJECT GOALS

Please refer to Chapter 1, INTRODUCTION

13.1.2. PROJECT ACTIVITIES AND FEATURES

13.1.2.1. KAYES-NIORO ROAD

Please refer to Chapter 3, ENGINEERING ASPECTS

13.1.2.2. PROPOSED DEVELOPMENT OPTIONS

Please refer to Chapter 11, ECONOMIC ANALYSIS

13.2 DEFINITION AND EVALUATION OF ALTERNATIVES

13.2.1. NO-ACTION AND ROUTE ALTERNATIVES

Please refer to Chapter 2, STUDY OF ALTERNATIVES

13.2.2. DESIGN AND MAINTENANCE ALTERNATIVES

Please refer to Chapter 2, STUDY OF ALTERNATIVES

13.2.3. CONSTRUCTION METHODS

13.2.3.1. LABOR BASED VERSUS MECHANIZED

Please refer to Chapter 2, STUDY OF ALTERNATIVES

13.2.3.2. FORCE ACCOUNT VERSUS CONTRACT

Please refer to Chapter 4, CONSTRUCTION IMPLEMENTATION PROGRAM

13.3 AFFECTED ENVIRONMENT

13.3.1 INTRODUCTION

The Kayes-Nioro road links the northern undeveloped part of the First Region to the principal center of Kayes, situated on the Sénégal River and the Dakar-Bamako railroad. The route connects this administrative and marketing hub with Nioro du Sahel, center of Nioro Cercle, and via the Yelimané branch with the center of Yelimané Cercle. The zone of influence encompasses 15,600 square kilometers, approximately a 25 kilometer band (both sides of road) defined as a day's donkey journey and adjusted for the location of feeder roads. Figure 1-1 illustrates the regional context; Figure 2-2 shows the zone of influence and administrative units. Figure 8-1 outlines the area of three principal development projects within the zone: Operation Mil-Kaarta; Kayes-Nord Livestock Development and Operation Vallée Sénégal Terekolé-Lac Magui (OVSTM). This zone lies within the Sahel, a landscape subject to variable rainfall and drought risk, constrained in its past development by limited resources, lacking in infrastructure and technology and typified by low population density, subsistence agriculture and extensive use of range for livestock.

The following description of the affected environment is drawn from the extended discussion in Appendix F, Existing Environmental, Economic and Social Conditions and from a nine village survey, described in Appendix G, conducted in the road corridor.

13.3.2 CLIMATE AND AIR QUALITY

The zone nearest Kayes receives an average of 760 mm of yearly rainfall, while the Nioro area averages 616 mm. The rainy season lasts from May through October but rain falls principally in July and August. November to February is dry and cooler with northeast winds; March to May is hot with desicating (Harmattan) winds from the east. Extreme variation in annual rainfall and thus in soil moisture content, under conditions of high potential evapotranspiration, leads to unpredictable crop production. Smaller rainfalls, of which the drought is a dramatic instance, have been attributed to long-term climatic changes, but scientific debate surrounds this issue.

No significant sources of industrial or urban pollution exist; the principal sources of pollutants are dust haze and brush fires.

13.3.3 PHYSIOGRAPHY, GEOLOGY AND SOILS

The route crosses geomorphologically different areas. From west to northeast, these are: the Sénégal River Basin and the southern extent of the Lake Magui Basin (Terekolé-Kolombiné and Krigou Rivers); the dolerite plateau (sedimentary schists with dolerite intrusions) approximately midway; and the schist plateau (slate) to the east. The Yelimané branch follows the elevated terrace of the river basin to the west of the escarpments marking the dolerite plateau (elevations of 250 to 400 meters). Soils are typically shallow and lateritic throughout, but floodplain soils are richer. Areas of sandy soil are present, especially in the north and between north of Samantara to north of Dioka along the route. Overall, soils have limited agricultural capability, but pockets of fair and good capability do exist, principally in river valleys. Within the Kaarta region, approximately 16% of the land is classified as having fair (average) or marginal capabilities but none is prime agricultural land.

13.3.4 HYDROLOGY AND WATER RESOURCES

The Sénégal is the only permanent water source in the zone which

contains a number of intermittent streams and rivers. In the Terekolé-Kolombiné-Lake Magui system, swamps and ponds dry slowly and provide watering points for livestock. In the Kaarta region, studies indicate that groundwater reserves are probably not large, but localized aquifers could be exploited. Further studies for the Kaarta operation and a three-year study by the Federal Republic of Germany for the Terekolé-Kolombiné-Lake Magui region will provide baseline information on streamflow and water resources which is now lacking. Village wells, typically placed in alluvium and colluvium, are not deep and water supply and quality (livestock may use the same source) are major concerns to villagers.

13.3.5 TERRESTRIAL RESOURCES

13.3.5.1 VEGETATION

Savannah vegetation, characterized by singly occurring trees (especially baobab and acacia), bushy scrub and seasonal grasses, varies in type with depth to water table, seen as bands of lusher vegetation near watercourses, and with rainfall, shown by increased tree density in the southern zone.

Among the species present and protected by Mali's Code Forestier are Acacia albida and Acacia senegal. Ronier palm, also protected, may be found in selected areas.

13.3.5.2 FORESTRY

The route passes through the Classified Forest of Nioro and other areas considered part of the classified or protected forest domain under the Malian Code Forestier (explained at F.5.2). Commercial exploitation of trees is regulated by permits, but cannot be enforced; typically trees are cut by entrepreneurs to sell for firewood in urban areas.

Within the Sahelian zone, the practice of ébranchage, the uprooting of trees or stripping and tearing of tree limbs, is illegal. Done in order to

feed livestock, the practice causes death and injury to trees, but its control is impossible to enforce. In the same zone, special fire restrictions apply. Although fires have traditionally been set to favor growth of palatable grasses and improve range, careless and accidental fires are thought to be more common and can destroy range land, if set at the wrong time of year.

Reforestation is planned by the Kayes-Nord and Operation Kaarta projects; the Federal Republic of Germany is sponsoring a greenbelt program around Kayes and establishing nurseries. The clearing of firebreaks to discourage large-scale spread of fires forms a major component of the Kayes-Nord livestock project.

13.3.5.3 WILDLIFE

Limited wildlife information indicates that protected birds likely to be present are vultures, calalos and spatule herons; protected mammals include gazelles and oryx. Wild boar, small mammals and lizards were observed during field reconnaissance. Hunting has been forbidden in the zone because of diminishing wildlife populations.

13.3.6 POPULATION

13.3.6.1 COMPOSITION AND DISTRIBUTION

The population within the road's zone of influence, including the branch to Yelimané, numbers around 246,000. Its distribution by administrative district is shown in Table 13-1. The absent population (included in "population de droit") is from 2.5% to 5% of the population present and predominantly male. Visitors (included in "population de fait") constitute 1.5% to 2%. Some nomadic population appears to be included in the census statistics; based upon estimates made for Kaarta, nomads could increase the population by 15%. Average population density in the zone (Kayes excluded) is 12 persons per square kilometer, but is unevenly distributed and is largely influenced by availability of water supply. Based upon nationwide statistics, the birth

Table 13-1

Distribution of Population in Zone of Influence By Administrative District

Administrative	Total Population in District: Population De Droit [1]	Population De Fait [2]	Estimated Population in Zone of Influence: 1976 [3]	1980 [4]
Kayes Cercle				
Kayes Commune	44,700	44,500	45,000	56,500
Kayes Central	19,900	19,100	4,000	4,400
Lontou	10,200	10,100	2,000	2,200
Ségala	30,500	28,800	26,000	28,900
Remainder Kayes Cercle	102,800	100,000	-	-
Total	208,100	202,500	77,000	92,000
% of Cercle Pop. served	38%			
% of Zone Pop. in Cercle			35%	
Yelimané Cercle				
Yelimané Central	33,400	33,200	28,000	29,400
Kirané	17,600	17,100	4,000	4,200
Marena	6,100	6,100	6,000	6,300
Tambakara	17,100	16,900	5,000	5,400
Remainder Yelimané Cercle	-	-	-	-
Total	74,200	73,300	43,000	45,300
% of Cercle Pop. served	59%			
% of Zone Pop. in Cercle			18%	
Nioro Cercle				
Nioro Commune [5]	11,600	11,400	12,000	12,000
Nioro Central [5]	33,000	31,900	32,000	32,000
Bema	23,100	22,800	6,000	6,000
Gavinané	22,600	21,800	18,000	18,000
Gogui	6,500	6,500	1,000	1,000
Lakamané	12,800	12,700	3,000	3,000
Sandaré	10,200	10,400	10,000	10,000
Simbi	9,000	8,700	4,000	4,000
Tourougoumbé	18,300	17,800	8,000	8,000
Remainder Nioro	53,800	52,100	-	-
Total	200,900	196,100	94,000	94,000
% of Cercle Pop. served	48%			
% of Zone Pop. in Cercle			38%	

Table 13-1 (cont'd)

Administrative District	Total Population in District		Estimated Population in Zone of Influence	
	Population De Droit 1/	Population De Fait 2/	1976 3/	1980 4/
Bafoulabé Cercle				
Diakon	13,600	13,000	10,000	10,600
Oussoubidiana	25,800	24,900	4,000	4,200
Remainder Bafoulabé	64,600	63,700	-	-
Total	104,000	101,600	14,000	14,800
% of Cercle Pop. served	14%			
% of Zone Pop. in Cercle			6%	
Total Population	587,200	573,500	246,100	
% of Cercles Pop. served	43%			
% of Zone Pop. in Cercles			100%	

1/ Population de droit also called resident population is composed of residents who are present and residents who are absent.

2/ Population de fait is composed of persons physically present at the time of enumeration, i.e. residents who were present and visitors.

3/ Estimated to nearest thousand based upon proportion of arrondissement within zone and location of major villages.

4/ Extrapolated from 1976 population using past annual growth rates: Kayes urban at 6.05%; Kayes rural at 2.67%; Yelimané at 1.25%; Nioro at -0.05% and Bafoulabé at 1.4%.

5/ Nioro Commune including town of Nioro du Sahel estimated by Kaarta (ITC 1977) as 18,300 and Nioro central as 36,500 to make total of 54,800.

Source: Ministere du Plan, Bureau Central de Recensement. Recensement General de la Population du Mali (1976); Resultats Provisoires. Fevrier 1977.

rate is approximately 50 per thousand and the death rate is approximately 29 per thousand. Infant mortality has been estimated at between 120 and 210 per 1,000 live births and life expectancy is 37 years for males and 40 years for females.

13.3.6.2 ETHNIC GROUPS

Sarakolé, Peul, Bambara, Khassonké and some Maure and a few Malinké inhabit the zone. The Sarakolé (also called Soninké) are thought to be in the majority. Known as travellers and entrepreneurs, they both practice agriculture and keep livestock; women play a relatively active role in trade and vegetable production. The Peul in the zone are sedentary and semi-sedentary groups who raise crops and who have a point of attachment in a home village. Peul herders move cattle in a cycle of transhumance and often move livestock of other groups. The Khassonké of Mali are centered primarily in the area near Kayes; they are agriculturalists and keep livestock. The Bambara, the largest ethnic group in Mali, are a minority in the area. They are agriculturalists who raise limited numbers of livestock. Each ethnic group encountered in the nine village survey practiced Islam. A three-part class division of society is common to these groups: nobles who control land distribution; a casted class of artisans; and less esteemed members of "serfs and/or caste".

13.3.6.3 POPULATION MOVEMENT

Three types of migration occur: rural-urban; seasonal; and long-term temporary migration. The past growth rate of urban Kayes at 6.05% per year contrasts to an average of 1.4% for the whole First Region. This urban flow is likely to continue as part of the process of modernization. Seasonal migrations occur during the dry season when villagers (predominantly male) seek agricultural work in Sénégal or the Ivory Coast and work as laborers or artisans in cities of Mali and larger towns of neighboring areas. Long-term temporary migrations of male Sarakolé to France for four to eight years to

work as laborers are followed by return home, marriage and another shorter migration abroad before permanent return. This and other ethnic groups also move for a few years at a time in other directions (Sénégal, Ivory Coast and other African countries) in response to labor market opportunities. Women are not generally among the migrants. Earnings, sent home via postal mandat, provide significant capital inflow and journeys to or from the post office are an important use of the road.

Some population movement associated with transhumance occurs, but generally herders, rather than populations, move north to Mauritania in the rainy season and into Mali in the dry season. Little reliable information exists regarding Peul and Mauré nomads who are known to move within the zone.

13.3.7 LAND USE

Land nearest a village, distributed by the elders, is typically cultivated each year and fertilized with manure. Outlying areas of less desirable land are farmed less frequently and left to fallow for two to fifteen years. Distant lands are cultivated by establishment of hameaux de culture during the cultivating season; they may eventually become permanent settlements and they provide a way to practice itinerant agriculture. Staple crops are millet, sorghum, rice and maize. Peanuts, beans, calabash and numerous vegetables and some fruits are also grown.

The percent of cultivated land area is estimated to be higher in the southwestern part of the zone of influence than in the Kaarta region for which statistics are available. Here 3% is cultivated intensively and 10% is moderately or non-intensively cultivated (including fallow). Approximately 9% is not utilized; the remainder or dominant use (78%) is rangeland.

Three types of rangeland use exist: sedentary stocking and grazing on the outskirts of villages; semi-nomadic or seasonal grazing with herds moved north and south by shepherds; nomadic grazing along defined paths by nomadic groups. Watering points, especially in the Lake Magui sector

of the Kayes-Nord project area and along routes of transhumance, are overgrazed; estimates of range carrying capacity for Kaarta show the northeastern zone (Gavinané, Nioro, Gogui, Tourougoumbé) especially subject to overgrazing.

The number of cattle within the zone is estimated for 1980 at 195,000 and the number of sheep and goats at 319,000. Translated into tropical animal units (UBT) this number of animals is equivalent to an average range use of 8.3 hectares per animal unit (12 animal units per square kilometer). The carrying capacity of parts of the range is judged by Kayes-Nord and Operation Kaarta to be somewhat larger than present use, if redistribution of cattle from points of concentration can be implemented. Without redistribution or reduction in stocks, carrying capacity is in many areas exceeded or precariously close to excess, especially in a dry year.

13.3.8 ECONOMIC CONDITIONS

The rural economy of the zone of influence is based upon agriculture and livestock production. The estimated annual per capita income is $45 to $50. Women and men each cultivate specific crops (see Appendix G) but women specialize in okra, tomatoes, onions and ladle gourds. Wage labor is employed during the cultivating season, an occurrence believed to stem from the long-term absence of young men. Availability of labor constrains agricultural production, largely dependent upon the short-handled hoe.

Less than 1% of the active or working population is engaged in non-agricultural employment, but the rural population engages in home industries such as pottery making, weaving and cloth dyeing and other artisanal production. Casted classes are typically the artisans; division of labor between men and women varies with ethnic groups.

The products of home industry (dyed cloth, calabash bowls, mats and fans) and excess agricultural production are sold in the markets of Kayes or Nioro or in the weekly markets of villages. Women play an especially

active role in commerce.

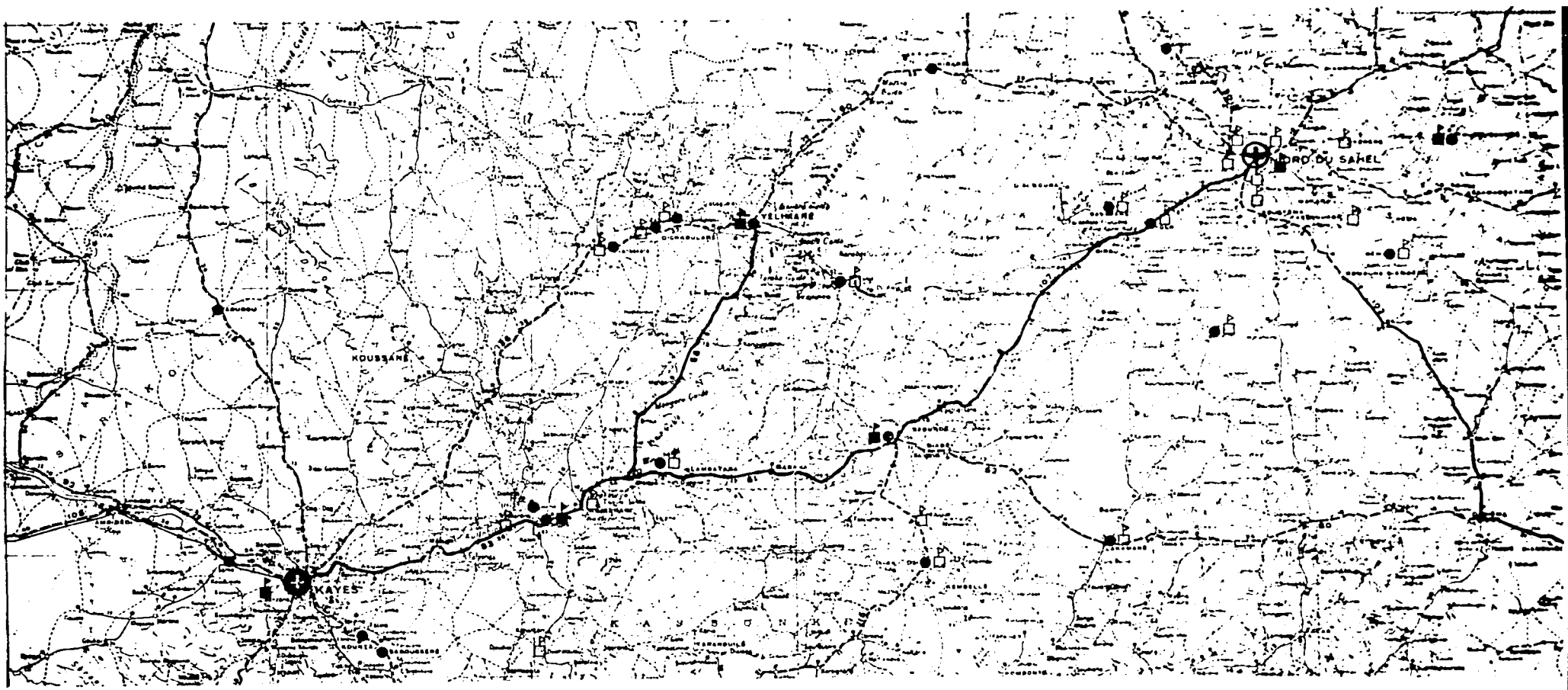
Grain sales are officially controlled, but a strong parallel market exists, including clandestine sales to Mauritania. The farmer in an isolated zone such as this one, according to the Club du Sahel report on grain marketing (CILSS/1977), is especially disadvantaged. The costs and risks of shipping mean that, in a good year with falling prices, the supply may not be absorbed by the parallel market or is sold at a low price by the farmer. In a bad year, the farmer in an isolated zone may pay higher parallel market prices in order to buy grain.

Livestock are sold when villagers need money and herds are not managed for production and sale. The numbers of cattle needed for year-round lactation, the vulnerability of cattle to disease or death, the use of older animals to manage herds and the role of cattle as an inflation-proof investment, make livestock sales a complex affair governed by social custom and environmental conditions. For instance, movement of cattle over common range both keeps them away from fields during the growing season and allows owners to respond to variations in rainfall and available pasturage. Specialized merchants gather livestock from herders or at collecting markets. After regrouping, cattle are walked to Kati or Kayes (with a loss of about 10%); sheep and goats are sometimes trucked but are mostly walked.

13.3.9 SOCIAL SERVICES

Health conditions are poor; health facilities are inadequate, understaffed and undersupplied.

Poor road conditions affect transport of the ill and absorb administrative budgets for health in vehicle repair and maintenance. Figure 13-1 shows the location of medical facilities. The regional hospital at Kayes is the principal point of orientation for serious medical needs. In addition to the administrative structure of health care (based upon arrondissement dispensaries and regional centers), a USAID rural health project is centered



LEGEND/*LEGENDE*

- REGIONAL HOSPITAL/*HOPITAL REGIONAL*
- SECONDARY HOSPITAL/*HOPITAL SECONDAIRE*
- DISPENSARIES AND HEALTH CENTERS/*CENTRES DE SANTE ET DISPENSAIRES*
- SCHOOL OF 1st AND 2nd CYCLE/*ECOLE DE 1er ET 2ème CYCLES*
- SCHOOL OF 1st CYCLE/*ECOLE DE 1er CYCLE*

NOTE: URBAN KAYES HAS SEVERAL SCHOOLS INCLUDING A LYCEE
LA VILLE DE KAYES EST DOTEE DE PLUSIEURS ECOLES ET D'UN LYCEE

TAMS

FIGURE 13 – 1
LOCATION MAP OF SCHOOLS AND HOSPITALS
CARTE DE SITUATION DES ECOLES ET DES HOPITAUX

at Yelimané to provide low cost health care at the village level. A new national strategy for primary health care (Soins de Santé Primaires) organized around village health teams is now beginning and will emphasize public health and preventive care.

The rate of school attendance is not high in the rural areas; and nationally the rate was around 24% in 1972-1973. Statistics available for the Ségala arrondissement show that for the first six grades the school service radius is limited (see Table 13-2). Officials estimated it generally at 10 kilometers. Attendance beyond the first cycle and at lycée typically requires absence from home in the rural area because of the distances involved. Figure 13-1 also illustrates school locations in the zone of influence.

Extension services for agriculture, livestock and literacy currently originate through the three principal development projects in the zone.

13.3.10 DESERTIFICATION

No statistical data is available to indicate how much desertification exists within the zone. Overgrazing, fires and deforestation do occur and these are precursors to desertification. Causes of desertification have been linked to herding and livestock management practices and to the "tragedy of the commons" or the unchecked exploitation of a free resource. This explanation has led to a policy focus on changing the social organization of the livestock sector and the common use of rangeland. Some climatologists, however, argue that desertification is part of a long-term climate change; others link desertification to increases in the earth's reflectivity, affected by the increasing proportion of cultivated land, which alters rainfall patterns. Some social scientists stress as causes the impetus of development which has removed traditional constraints, such as water and disease, altered livestock practices and compressed available rangeland. Despite differences in theory and policy, the trio of deforestation, fires and overgrazing, can be seen as three changes to be avoided in order to combat desertification.

Table 13.2

Attendance Statistics for Schools of First Cycle in Ségala Arrondissement

Location of Schools in Ségala Arrondissement	Villages Sending Students (5 highest)	No. of Students/ No. of Eligible Children	Ethnic Group	Distance to School in Kms.
Ségala (168 students)	Ségala	75/92	Peul	
	Ségalaba	52/60	Bambara	1
	Kalaou	4/23	Sarakolé	3
Marena-Diomboko (159 students)	Marena Diomboko	79/107	Sarakolé	3
	Madina-Kouta	26/31	Khassonké	3
	Doro	18/18		5
	Kabaté	16/16	Peul	12
	Niamiga	20/63		8
Koniakary (199 students)	Koniakary	109/175	Peul	
	Marintoamaniya	20/25		5
	Gouvel-Smaba	30/22		3
	Tintiba	15/32		8
	Oussoubidiana	25/57	Khassonké	7

Source: G.O.M. Inspection de l'enseignement fondamental de Kayes. Rapport de rentrée: Année scolaire 1978-1979.

13.3.11 CULTURE AND HISTORY

Traditional modes of production and social organization remain in the rural area, despite the emigration of young men,who return to assume traditional roles. Modern medical care and access to education, however, are concerns of villagers. Villages are also receptive to other innovation and noted that they were interested in better implements than the daba or short-handled hoe, in purchasing vehicles and in marketing more produce (see Social Soundness Analysis).

History, the tracing of lineage and pride in ethnic group and clan are important features of Malian culture. The griots or storytellers perpetuate oral history and the clan's conventional wisdom. Superstition, although inquired about in the survey of villages, was not much revealed. Administrative officials and published materials indicate that traditional practices , superstition surrounding the appropriate places for childbirth and female excision do exist.

13.4 CONSTRUCTION IMPACTS OF PROPOSED ACTION

13.4.1 INTRODUCTION AND SUMMARY

The proposed action includes alternative options for design standards. These options, defined in Chapter 2, were subsequently analyzed for physical and economic feasibility. The magnitude of the impact can be considered greatest for a paved road, somewhat less significant for a laterite gravel road and least for a low cost upgrading, but are not greatly different for construction related impacts. Mitigative measures, where appropriate, are incorporated into the topical discussion of impacts.

The construction phase will last four years in all with each of the three segments of the route requiring a two to three year construction period. Capital-intensive equipment methods will be utilized and temporary work camps will be located along the road. Negative construction impacts are quite limited and can be mitigated through guidance to the contractor in the location of work camps and uses of the environment. Positive construction related impacts will flow from additional employment and spending in the construction sector.

13.4.2 CLIMATE AND AIR QUALITY

Construction impacts on air quality will be localized. The use of heavy equipment and the process of construction itself will generate dust and fumes, but should not fundamentally degrade air quality. No construction-related impacts on climate should occur.

13.4.3 PHYSIOGRAPHY, GEOLOGY AND SOILS

The construction process will alter microtopography, but no major cut and fill operations are anticipated. The extraction of laterite borrow material from areas near the road (see Chapter 3 for locations) will produce shallow pits and disturb some vegetation. Where depressions result, the

potential for stagnant water can be mitigated by requiring contractors to install proper drainage. Replacement of vegetation should be considered according to the specific conditions of the borrow site and relative cost and ease of doing so, but is not likely to be generally warranted. Some localized alteration of soil profiles adjacent to the route will also occur.

13.4.4. HYDROLOGY AND WATER RESOURCES

Minor, temporary water quality alterations will occur during bridge and ford construction/rehabilitation as the result of increased sediment produced by disturbance to soils and vegetative cover. Impacts will be modest, if construction is scheduled primarily during the dry season. Embankment protection will also help deter slope erosion. These limited, negative effects should not endure beyond the construction phase.

Water use will increase when work camps are established along the road. It is recommended that contractors dig their own wells in order to avoid tapping the limited number and capacity of wells serving the resident population. Water requirements for road construction must also be carefully met. Water resource studies are underway for the Lake Magui-Terekolé-Kolombiné valleys and for Kaarta; results of these should guide identification of suitable water sources for road construction.

13.4.5 TERRESTRIAL RESOURCES

13.4.5.1 VEGETATION

Impact on vegetation during construction will be minor since the road will largely follow existing alignments. Where reconstruction may require more than occasional removal of vegetation, particularly trees, replanting is recommended. Protected species (Acacia albida, Acacia senegal, Ronier Palm) should be avoided. The location for work camps should be chosen to minimize new clearing of land or destruction of vegetative cover.

Once work camps are dismantled, replanting or reseeding should be considered where cover has been extensively altered.

13.4.5.2 FORESTRY

While work camps are in operation, the felling or pruning of trees for firewood should be discouraged in order not to exacerbate the deforestation already occurring. Where trees are cut, replanting should be done. Where reconstruction of the route will require traversing the Forêt Classée de Nioro, replacement of trees taken is advised; the number of trees affected will be small in this forest. Advice of the Service of Eaux et Forêts should be sought to minimize effects and to establish guidelines for replanting.

13.4.5.3 WILDLIFE

During construction, impacts on wildlife will be minor since the disruption will occur along an existing road corridor and will not to any significant degree reduce or remove unique or scarce habitats. Laborers should be advised of the prohibition against hunting and the restrictions should be enforced by the contractors in order to avoid creating additional hunting pressure on wildlife.

13.4.6 POPULATION

A temporary influx of 300 persons, lodged in several work camps along the route, will occur in any one year during the construction period over the entire route. Construction for a specific segment will involve about 100-150 workers in a particular camp at any one time. In order to avoid competition for resources or conflict with villagers' activities (see also 13.4.3 and 13.4.5), camps should be self-contained.

No major construction-related dislocation of population is anticipated. Widening or realignment of the road will require the taking of few houses (possibly none). Provisions should be made to pay owners costs of house reconstruction.

13.4.7 LAND USE

Construction impacts on land use will be modest if precautions in work camp locations are taken and assuming road realignment is limited. Where cultivated lands of a village are disrupted due to realignment, costs of the crop or a token payment for the land disrupted should be made. When questioned regarding dislocation of houses versus fields, villagers showed an ambivalence in the matter. Since cultivated lands nearest villages are often the best lands, care should be taken to minimize the use of such land. Interference of construction with grazing activities is not anticipated.

13.4.8 ECONOMIC CONDITIONS

Benefits of employment generated through construction work will be in the order of $1 to 2 millions for local labor over the four year period. The purchase of supplies in Mali to support the construction project will reach a similar magnitude. These benefits will accrue to Mali workers and to Mali businesses, but will not necessarily be concentrated in or spent in the road's zone of influence. Some villagers will be hired locally and some purchases will be made locally, both for the project itself and by construction laborers.

The bulk of labor is likely to come from Kayes and the First Region. Given an annual estimated regional income of $44 million (at $50 per capita), the expenditure of $250 to 500 thousand per year for local labor represents one percent or less of the regional income. If laborers are drawn principally from the Kayes urban area and other portions of the road's zone of influence, expenditures on labor would represent approximately 2% to 4% of the zone's income.

13.4.9 SOCIAL SERVICES

No construction related impacts on access to or availability of services are anticipated.

13.4.10 DESERTIFICATION

No construction-related impacts on desertification are likely to occur.

13.4.11 CULTURE AND HISTORY

In the nine villages along the route where inquiries were made, villagers reported that no places of special religious, cultural or symbolic importance were located adjacent or close to the route. Additional inquiries should be made where realignment or significant widening is necessary to ensure no disturbance of special places. Field reconnaissance indicated that in some villages cemeteries were located close to the route; in particular, these should not be infringed upon.

No archaelogical investigations were performed; however, histories of Mali indicate the long settlement in and around Nioro. Contractors should be alerted to the possible presence of archaelogical finds. Prior to construction the contractors should establish contact with the national museum and other interested parties in order to provide adequate procedures for meeting this eventuality. Because of the great pride which Malians take in the history of their country and in their lineage, this precaution is considered culturally desirable and important.

13.5 LONG-TERM IMPACTS OF PROPOSED ACTION

13.5.1 INTRODUCTION AND SUMMARY

Long-term impacts attributable to improvement of the road are directly traceable impacts, both primary and secondary. Secondary consequences, in particular, depend upon and assume the existence of other development projects in the road's zone of influence. Section 13.6 deals with generic and indirect linkages of the road to development projects and spin-off consequences, not directly traced to the road but nevertheless related to it.

The principal impact of the road will be the amelioration of access accompanied by a decrease in transport costs. Improved access will improve service delivery to the rural population will permit villagers to seek services more easily and less expensively in larger villages along the road and will provide opportunities for villagers to obtain specialized services in the regional centers at Kayes and Nioro. The road will facilitate and reduce the cost of transport for agricultural products to and from markets and enhance the ability of villagers to travel to urban areas and other countries for seasonal employment.

While an improved road by definition provides improved access, it is not always clear that a rural and traditional population will be receptive to or avail itself of altered opportunities. Based upon structured interviewing conducted in the nine villages in or near the route (see Appendix G, Socio-Environmental Survey), villagers of all ethnic groups, representing both agriculturalists and sedentary pastoralists, now use and depend upon the route. Villagers will welcome the lessening of travel time, decreased travel cost, diminished travel fatigue and reduced damage to goods provided by an improved road. Furthermore, villagers are likely to respond to these improvements by reinvestment in the agricultural and livestock sectors and by increased production of goods.

Mitigative measures to alleviate negative effects are discussed in the text where appropriate.

13.5.2 CLIMATE AND AIR QUALITY

The vehicular traffic is projected to increase significantly over present levels (5 - 30 per day according to segment). This additional traffic of about 100 vehicles per day (averaged over the road and over the economic life of the project) is insufficient to make air pollution a serious issue.

The road itself will bring about no long-term impacts on climate.

Although the variability in rainfall and the amount of evapo-transpiration constrain development of agriculture without irrigation, projected increases in yields are feasible for the climatic condition of the region.

13.5.3 PHYSIOGRAPHY, GEOLOGY AND SOILS

In the long term, the road will have a localized positive impact by better controlling the runoff and, in turn, the erosion which currently exists on and along the road. For example, the control of ditch scour through relief culverts, properly designed catch basins and properly sloped and maintained ditches will improve drainage. Design attuned to topographic features will also favor the maintenance of slope stability and diminish uncontrolled runoff. Vegetative cover should be established, where lacking, to help stabilize soils. Revegetation would also contribute positively to the ease of long-term roadside maintenance.

13.5.4 HYDROLOGY AND WATER RESOURCES

Long-term negative effects on water quality are not anticipated because of the road itself. By comparison to the current condition of the road and its bridges and fords which encourage erosion, improvements to existing road drainage and embankment protection should lead to reduced sediment load in the intermittent streams and rivers of the drainage basins through which the road passes.

13.5.5 TERRESTRIAL RESOURCES

13.5.5.1 VEGETATION

Modest long-term impacts on vegetation will result from increases in the amount of land under cultivation (see 13.5.7).

13.5.5.2 FORESTRY

Because of easier access, the road is expected to increase the

amount of deforestation by making exploitation of wood in the road's vicinity easier and more profitable. This effect has been observed when access has been improved in other areas (Service of Eaux et Forêts, Personal Communication 1979). Similarly, the increased traffic on the road will increase the risk of accidental fires through carelessness. It should also be stressed that deforestation is among the most important natural environmental concerns voiced by the Government of Mali and is also of concern from the general perspective of desertification in the Sahel. The Service of Eaux et Forêts suggests that all actions in the Sahel favor the regeneration of natural vegetation.

Control of woodcutting will be extremely difficult through enforcement of laws, given available personnel. In order to mitigate probable deforestation, therefore, a program of reforestation along the road is recommended. The Service of Eaux et Forêts recommends that a band of trees 15-20 meters wide be planted on both sides of the route. Nurseries under the direction of the Service of Eaux et Forêts can supply seedlings, if labor to plant trees can be provided. Specific areas, especially those where deforestation has occurred, should be selected as initial targets in a pilot program. The program will need to be accompanied by an educational program among villagers whose participation in tree planting can also be enlisted. Such a program would emphasize the soil and water conservation values of trees in order to discourage destructive woodcutting and to involve villagers in helping to prevent illegal forms of commercialized exploitation. An expanded program could include establishment of areas planned for the purpose of commercialized wood production. This concept of a pilot program for route reforestation should be further refined during the course of design work for the road. Its implementation during construction for the road is recommended in order to reduce mobilization and equipment expenditures for such a program.

In order to deter the spread of accidental fires, trees should be planted well back from the route and the shoulders and ditches of the road

should be kept clear and free. A wide and clear right of way will also act as a forest fire barrier. While prevention of accidental fires will be difficult, distribution of information to the truckers association and village elders should also be attempted.

13.5.5.3 WILDLIFE

The easier access provided by the route is expected to increase the amount of hunting and poaching. Like forest fires and exploitation of wood, these effects will be difficult to control. In this case, the distribution of information to transporters and village elders is recommended.

13.5.6 POPULATION

Current total population of 240,000 within the zone of influence is expected to grow at a rate of 2.3% per year, an increase of 0.2% over the calculated past growth rate of 2.1%. The increase in population will come primarily from a lowering of the death rate, especially the infant mortality rate, because of significantly better and year-round access to health care. The rural population within the zone of influence of approximately 189,600 is expected to experience a growth rate of 1.2% per year, an increase of 0.30% over the past growth rate of .90%. The decrease in death rate is proportionally higher for the rural population considered by itself than for the entire zone of influence, since no decrease in death rate was assumed for the Kayes urban area.

Changes in birth rate due to the road are not projected. While in the long run a decrease might occur as the population has better access to birth control and undergoes development, such a change in social patterns should not be attributed to the road per se but to more general structural changes in society brought about by increased economic well being, monetarization of the economy, and education.

Similarly, no changes in migration rates are expected. Migration

already occurs for underlying economic and social reasons and the existing road is sufficient to permit its accomplishment. It is also difficult to predict whether migration might increase or decrease due to an improved road. The road, on the one hand, makes outmigration from the zone of influence cheaper and psychologically more attractive, but it will also, on the other hand, make staying in the zone more attractive because of the increased income available due to improved and cheaper marketing and enhanced agricultural production.

Temporary migration for work during the dry season is expected to continue as it has in the past. The financial benefits flowing to those who migrate for seasonal work will increase; individuals' travel costs will diminish by approximately one-third to one-half (depending on design option chosen) per person per trip.

The improved road itself should not alter nomadic population movement. Statistics regarding nomads are elusive, as pointed out in Appendix F, Section 6.

Modest or minor redistribution of population within the zone of influence can be anticipated. Typically when access is created, but also when it is improved, settlements move closer to a road. Since the road already exists and is passable nine months of the year and since feeder roads as part of the Kaarta project will also improve access to the main road, this effect will be moderated. If paving is chosen for the Kayes-Dialaka segment, the incentive to relocate there is likely to be greater. Village relocation can have negative effects if conflicts with other ethnic groups over land tenure and grazing rights or competition for resources result. This impact will depend on where resettlement occurs, but the low density of population and distant spacing of villages should allow for movement without such consequences. To the extent that villages find it in their interest to relocate and are successful in doing so, they will reap economic benefits. The distance and price paid for transport of products to be sold and of inputs and goods

to be purchased will diminish and their relative income should increase. Monitoring the extent of these effects is recommended in order to provide a basis of comparison for future road improvements in Mali.

13.5.7 LAND USE

13.5.7.1 AGRICULTURAL LAND USE

The road will accelerate an increase in area cultivated. The Kaarta project has projected increases of from one to two hectares per farm unit by ethnic group. These increases will be achieved sooner and will be larger because of the road. Some increases in area cultivated are anticipated in the other portions of the zone of influence. For the entire 15,700 square kilometers in the zone, this change from 3.8% to about 5 - 6% by year 2005 can be accommodated by shortening the fallow period on now less intensively cultivated lands.

The lowered costs of transport for agricultural products and inputs to produce them will raise the ex-farm prices and hence the net income derived from agricultural products by the farmer. Within the limits set by the constraints of available labor, some of this added income will be invested in new land clearing. Some of the added income will also be invested in materials such as seeds, pesticides and fertilizers and will permit significant increases over present yields. Furthermore, a relatively greater proportion of cultivated land will be devoted to vegetables and other cash crops, as marketability of such products will become more beneficial.

More detailed explanation of these changes can be found in the Feasibility Analysis. That villagers are receptive to these economic changes is summarized in Section 13.5.8 and is explicitly treated in the Social Soundness Analysis

Because of the availability of land suitable for cultivation over and above the amount currently cultivated, increased agricultural land use should not significantly create conflict over rights to land. Because of the relatively

small proportion that agricultural lands are of total land and in comparison to grazing lands, increased agricultural use should not alter rangeland uses. These changes in agricultural land use, while estimated as an average for the road's zone of influences, will not be evenly distributed. One can expect greater relative changes to occur in the northern and Kaarta portions of the route where additional net income will be larger as transport savings are greater. Agriculturally better suited lands near Bema and in Tourougoumbé of the Kaarta project and lands of the river valleys in the southwestern portion are likely to be the locus of change.

13.5.7.2 PASTORAL LAND USE

The road itself will not radically alter the amount of land devoted to grazing, except by the small increase in land used for agriculture. To the extent that farmers use their extra income to reinvest in livestock, herd sizes will increase. This increase is not expected to be large nor necessarily to exacerbate overgrazing. At the same time, development projects will be encouraging changes in the age structure of herds and increases in the off-take rate and modifying grazing patterns to reduce concentrated use near watering points.

13.5.8 ECONOMIC CONDITIONS

13.5.8.1 GENERAL ECONOMIC CONDITIONS AND EMPLOYMENT

The rural economy of the road's service area is expected to improve. Per capita income will about triple within the project life, based upon changes in the production and marketing of agricultural and livestock products.

The improved access is likely to lead to greater specialization in marketing by some members of the labor force. Most employment, however, will continue to be concentrated in the agricultural and livestock sectors.

Expansion in agricultural production may lead also to the use of more hired labor for cultivation and harvesting than is currently the case.

Obtaining hired labor during the rainy season within the zone of influence will be facilitated with better access. For these laborers, as well as for residents who leave the zone of influence in the dry season to seek seasonal employment, the lowered transport costs will represent a financial savings.

The improved road is not likely to cause a major change in the development of artisanal and home industry nor in and of itself promote the development of cottage industries. In the long run, the road has the potential for making cottage industries (weaving, cloth dyeing, straw mats, calabash bowls) more feasible and some greater specialization in these activities can be expected gradually, should programs be devised towards this end. The road will not stimulate tourism. The lack of significant tourist attractions and of any plans to develop them in the zone of influence make tourism a remote and unlikely possibility.

Males already seek out employment in urban areas via the existing road. The improved road will have only a marginal and incremental impact on access to urban employment opportunities. Linkages of the road to other projects, which will increase employment opportunities, will have a more significant effect on employment patterns.

13.5.8.2 MARKETING PATTERNS

Villagers interviewed felt that improvements to the road would have a direct and positive impact on marketing. Villagers specifically noted that women would be able to market goods more easily and would have greater incentives to do so once the improved road shortened the journey and made it less costly. (See Social Soundness Analysis for impacts on women). Expansion of commerce is likely to have induced effects leading to increased monetarization of the economy.

Additionally, an improved road, villagers noted, allows the marketing of fresh produce, such as okra, instead of the dried commodity by reducing spoilage. Villagers indicated that they would be stimulated to grow more cash

crops, since a good road permits the marketing of these crops. Villagers also felt that they could more easily and cheaply purchase consumer goods in Kayes or in their local market. Some felt that investments in trucks would be justified, given the longer vehicle life and lower vehicle maintenance costs. In the extreme northern portion of the zone of influence, west of Yelimané, dry season travel to Kayes will favor the direct route. In areas of the zone close to the Bamako road, an orientation to Bamako will continue to prevail. Nevertheless, the road will make economic orientation to Kayes more likely.

The benefits will flow more to those of the Sarakolé ethnic group than to others, not only because they are dominant but because of their greater involvement in production and trade of agricultural products. An inquiry of merchants made by ODIK (1979) in Nioro revealed that about half were Sarakolé and a quarter Peul. Peul specialized in the sale of meat and milk whereas only Sarakolé in the Nioro market study sold peanuts and millet.

13.5.8.3 AGRICULTURAL PRODUCTION

Increased agricultural production is one of the most significant impacts of the improved road. These benefits are mostly due to reinvestment from higher ex-farm prices reaped as a result of reduced transportation tariffs The larger the transport cost savings the higher the ex-farm prices and the greater the impacts. These impacts have been previously discussed at length in Chapter 11. Villagers were receptive to acquiring new tools, plows, and even tractors in one instance and indicated willingness to increase production.

13.5.8.4 LIVESTOCK PRODUCTION

The improved road will result in some increase in livestock production for the same economic reasons that apply to agricultural production; however, only a fraction of livestock off-take will be marketed over the road. Social factors in livestock practices will continue to limit the marketing of livestock. The impacts on livestock production have already been

discussed at length in Chapter 11.

13.5.9 SOCIAL SERVICES

13.5.9.1 HEALTH

Improved access to health care facilities principally in Kayes, but also in Nioro, is considered by villagers to be a major benefit. In this particular instance the road is virtually creating new access to specialized medical services. The road's condition is now so poor that the condition of the ill person is aggravated or the voyage so prolonged that the patient dies. From the viewpoint of villagers, transport to hospitals is particularly important since clinics in the arrondissement centers are viewed as understocked and understaffed.

Improved access will permit medical personnel to reach rural health facilities in order to take care of emergency situations and to carry out training and will make transport of medicines easier (Keita, Regional Director at Kayes Hospital, Personal Communication, 1979). Overcoming the difficulty of transport is perceived as essential to delivering better health care.

Administrative costs for health care will also be reduced. Transportation cost savings, while small in comparison to the economic benefits of the project, will be significant to the budget of the existing health services. Vehicle equipment and maintenance have absorbed from one-quarter to one-half of the administrative budget for health care.

The new Malian strategy for primary health care will also benefit from the improved road access by allowing villages to be reached less expensively and by permitting communication among primary health care teams.

13.5.9.2 EDUCATION

The 1978-79 report on primary education in the circle of Kayes summarized the administrative problem of transport and education: "Transport infrastructure in the First Region does not permit a vehicle to last very long.

Routes and tracks are everywhere full of holes or so extremely rough that vehicles are 'killed' in record time." Providing technical assistance and supplies to rural schools has become a difficult problem and has impeded effective overseeing of the schools, a problem which the improved route will help to overcome.

The improved route is unlikely to change access of students to education at the primary level or first cycle of six grades, since the service radius of 10 kilometers will not change and students will continue to walk. Both the lack of sufficient schools and sufficient teachers for the rural population are a more limiting factor than the current road conditions. The new route will facilitate access of first-cycle students and teachers to exam centers in the region.

The Kayes-Nioro route and the extension to Yelimané will be beneficial to students who are eligible and able to go beyond the first six grades. Schools offering instruction at the second cycle level are located at Kayes, Segala, Sandaré, Yelimané and Nioro. Students typically live away from home, with relatives. Because of the road's condition, the length and the cost of the trip, students do not now visit home frequently, may be unable to return to school according to schedule and/or may be less likely to continue their education. The improved road will reduce these disincentives and permit more regular visits home, a benefit noted by villagers interviewed. In the long run, the availability of reliable access may encourage attendance by a greater number of children.

Students attend lyceé wherever there are available places and not necessarily in Kayes, a condition which requires long absences and infrequent visits home. The improved route will shorten the journey and allow more frequent contact with the home village.

12.5.9.3 EXTENSION SERVICES

The availability of extension services for livestock and agriculture

will improve by diminishing administrative transport costs and absorbing less time of extension workers in travel. While these impacts cannot be readily quantified, they will have linkages to development projects and in turn will support the changes in agricultural production and livestock raising promoted by the projects. The road will also support other types of extension services directed at changing rural and traditional attitudes.

13.5.10 DESERTIFICATION

The road itself will neither significantly accelerate nor decelerate desertification. No reliable quantitative information can be located to suggest that the small increase in cultivated area will promote desertification per se. Programs of reforestation and measures to reduce accidental fires along the road will also help to reduce desertification deriving from these causes.

The most important relationship of the road to desertification lies with its linkages to other development projects. It can be argued that the programs of Kayes-Nord and Kaarta regarding reforestation, firebreaks and attempts to reduce overgrazing (by reducing livestock concentration at existing watering points) are likely to achieve some degree of greater and more rapid success in combatting desertification because of the greater facility of transport. To the extent that these programs are also successful in changing attitudes toward livestock raising, increasing herd off-take, promoting ownership of lands and reducing transhumance, desertification will be reduced, in the measure that these are indeed the major causes of desertification.

13.5.11 CULTURE AND HISTORY

The impact of the road on cultural dilution was specifically requested as part of the scope of work.

The improved road will, by definition, allow improved access to areas where cultures differ. This effect is not categorically different from

the effect which is already occurring. Young men travel to France or other African countries for employment of a few years duration. This impact has not radically changed culture in the region and young men return to a traditional style of life. The migration phenomenon has indeed been integrated into the traditional way of life.

Villagers interviewed as part of this study were receptive to improvements in their subsistence existence. Many villagers were able to point out how improved road access would save lives, raise their incomes or in other ways enable them to lead a more than marginal existence. Visiting relatives, for example, who had previously moved for lack of economic opportunities, was frequently cited as an advantage and can be construed as a way of maintaining cultural ties, now hard or costly to maintain.

The Office of Social Affairs of the Mali Government specifically pointed to benefits of the road which would help to eradicate superstition (Dembelé, Affaires Sociales, Personal Communication 1979). The improved route, it was suggested, carries a social message--that one can come and go more easily and the eradication of superstition was viewed as a benefit to the growth and development of Malian society.

The highly regarded tradition of Malians, including those who are urbanized, for their ancestors and their roots is known by individuals and perpetuated by griots (storytellers)and will not be easily eroded by the improvement of the road. This tradition has strong cultural roots that are in part an identifying feature of Malian society and culture.

Cultural dilution as a term implies that improved access will attenuate traditional cultures detrimentally. Success of the road project will alter traditional ways of life, specifically by raising income and providing for a different type of life. That these alterations might be negative implies a value judgment regarding the normative order of society. Cultural change is likely to occur, but the normative values attached to it are not necessarily negative.

Thus, these conclusions can be drawn. The relationship between resources and the traditional ways of using them and marketing the products gained from them will change. These economic and social changes do not, however, imply that particular ethnic groups will lose sight of the value of their heritage. The economic advantages conferred by the road can be viewed as consistent with the tradition, particularly of the Sarakolé, which emphasizes the entrepreneurial role.

13.6 RELATIONSHIP OF THE PROJECT TO LAND USE POLICIES AND PLANS

This section first outlines the land use policies and plans and other development plans to which the project is related, as specified by USAID Environmental Assessment regulations, and next discusses the linkages derived from the relationship of the project to these plans.

13.6.1 LAND USE POLICIES AND DEVELOPMENT PLANS

The Five Year Plan of 1974-78: The plan divided Mali into rural zones oriented to the production of a specific crop or containing similar natural or agricultural characteristics. The northern part of the Kayes cercle, the Yelimané cercle and the Nioro cercle are within the Sahel rural zone. The structural mechanism for implementation of development plans is the "operation". The operations are autonomous units coordinating and executing rural development and able to obtain direct funding from foreign donors. The operation is an integrated approach to rural development, not tied to particular sectors or ministries. Subsequent to the 1974-1978 plan a number of operations foreseen for the area served by the Kayes-Nioro road have been supported by foreign donors and other development projects have been conceptualized. Since the new five year plan is now in preparation and not yet available, this section summarizes available information (obtained from project documents) regarding operations and projects in the Kayes, Nioro and Yelimané units of the First Region.

L'Amenagement des Espaces Pastoraux: Kayes-Nord. This project for livestock development in the northern pastoral zone of Kayes is an arm of a larger development project for Livestock Development in the Sahel. Funded by Saudi Arabian monies, the five year project aims to: 1) utilize pasture and water resources more effectively and develop as appropriate to social and physical conditions of the area, zones for cattle breeding and fattening; 2) increase revenue to livestock raisers; and 3) increase export of cattle to both Bamako and Sénégal. The project will seek to reduce overgrazing in the area and degradation of the range through better management and at the same time increase livestock production.

The Kayes-Nioro road will generally support this project's efforts, particularly those directed to the southeast sector (axis of transhumance). An improved road trunk to Yelimané from Dialaka will support project activities in the northern sector. Portions of the Kolombiné sector (west of Yelimané and including Yaguine, Dionkoulane and Gori) will also be supported by the Yelimané extension. Although the route will be used for the transport of only a portion of cattle (continued herding of cattle to market is expected), the route will assist in getting veterinary services and dietary supplements to the northern zones of cattle raising. It will also facilitate communication and access between training or technical assistance personnel and livestock associations. The road is likely to have a more direct influence on the transport of sheep and goats to Kayes where a new slaughterhouse has been constructed.

O.P.I. - O.V.S.T.M. (Operation Perimetres-Irrigés-Operation Vallée Sénégal-Terekolé-Magui)

This project has as its goals increased agricultural production and the provision of agricultural extension services. Although most activities have so far been concentrated in the Irrigated Perimeters near the Sénégal, the project foresees expansion of dryland farming in the sectors of Ségala and Yelimané. The village of Ségala would become the center of the activities

and from which agents would be sent into surrounding villages. The soils of the river valleys from Kayes to Ségala to Yelimané are considered rich with a high potential for corn production and use of decrue agriculture. This project has not been well funded in the past, but there are plans for further development. The road will particularly support activities in the Ségala sector both by providing the means to transport agricultural production and to move extension agents in the sector.

Operation Mil-Kaarta. This operation is geographically centered on Nioro and the surrounding region. It encompasses 35,000 square kilometers including all of Nioro cercle and some areas outside it. As an integrated operation, it has a number of directions: agriculture, livestock, forestry, feeder road development, health, literacy, agricultural and livestock research, training and water resource development. The road project will accelerate the increases in agricultural production and enlargement of farm units foreseen by the project. Additionally, it will support the other elements of the operation, particularly feeder road development. Since the agricultural interventions of Kaarta occur during the rainy season, the existence of an all-weather road which ties into feeder roads will be a significant benefit. The Kaarta project document states for its own feeder roads that "without unlocking (opening up) the region, it is impossible to organize the commercialization of production and to launch an economy of exchange at the level of agriculturalists and livestock raisers". This statement applies equally well to the Kayes-Nioro road.

Water Resources Study--Federal Republic of Germany. This project which is investigating water resources development in the Terekolé-Kolombiné-Lake Magui river basin will provide baseline data and lead to water resource development. The road will support this project and the water resource strategies of other development projects which will increase the number of wells and, in the case of the German study, lead to the construction of small dams in the southwestern portion of the zone of influence. Irrigation

would help to boost agricultural production which will depend upon the road for effective commercialization of products.

Yelimané Rural Health Development Services Project (USAID). This project offers a demonstration, low cost, village-based health services system and includes training programs for health practioners and supervision of health workers in order to utilize community resources to diagnose and treat health problems and institute health education. Like any other service, the road will support mobilization and implementation and better permit the spread effects of communication.

First Region Pilot Development Project (USAID). The elements of this project had not been finalized at the time of field reconnaissance. Given, however, its general emphasis on agriculture and related development, this project will be assisted in much the same way as Operation Kaarta. This project, because of its pilot nature, provides opportunities for addressing some of the social and environmental issues raised in this assessment and in the Social Soundness Analysis.

13.6.2 LINKAGES AND INDUCED CONSEQUENCES OF THE PROJECT

The improved road, by supporting existing and proposed development projects, is part of a chain of linked consequences. This section illustrates some benefits and some problems which could occur.

Introduction of management practices on lands within the zone of influence should be positively affected by the contribution of the road to the more successful implementation of ongoing development projects. Reforestation and fire control, for example, will contribute to reduced erosion and soil loss. Development of water resources will overcome a principal limiting factor to agricultural productivity. In turn, enhancement of productivity will promote even greater use of the road for marketing of agricultural products. Plans for agricultural development include the application of chemical fertilizers and pesticides which through runoff will alter the chemical quality

of surface waters. The extent to which these linkages to development projects negatively affect aquatic life and use of water for consumption is both beyond the scope of this analysis and not directly the responsibility of USAID. In the long term, larger-scale changes in vegetation, forestry and wildlife can be anticipated if protective measures,such as reforestation, and if administrative support for the conservation of waters and forests do not keep pace with the expansion of agricultural land use and the introduction of new techniques.

Current plans for the livestock sector that call for substitution of more formal group control of land for social or clan mechanisms (Kayes-Nord) and the sedentarization of livestock herds (Operation Kaarta) may not be socially successful in the near future. Combined with improvements such as the digging of wells and veterinary services, increasing livestock herds and overgrazing could jeopardize the natural environment. On the other hand, livestock strategies of development projects are not totally dependent upon changes in social organization and increases in herd-offtake may occur as expected. The achievement of a zonal stratification policy advocated by CILSS, which aims to use the northern Sahel as a breeding zone and higher rainfall areas further south as a growing and fattening zone, would lead to the development of fattening ranches and feedlot operations in the vicinity of Kayes. Such efforts would lead to increased employment in the agri-business sector and in commercialized slaughtering operations for which Kayes is particularly well situated to serve the export market to Sénégal.

13.7 PROBABLE ADVERSE IMPACTS

This section summarizes unavoidable and avoidable adverse impacts.

Unavoidable adverse alterations principally involve localized changes of soil profiles and microtopography, small increased sediment load in rivers and disturbance to vegetation in borrow areas during construction. Sound construction practices will substantially mitigate these effects. Construction impacts on wildlife and vegetation can be avoided through requirements

placed upon the contractor regarding obedience to local hunting and forestry laws or mitigated by replacement of any damage to vegetation. Similarly, careful placement of work camps so as not to interfere with village activities and resource use can eliminate adverse impacts.

The risk of accidental fires and increased woodcutting are more serious and specific mitigative measures have been suggested (see 13.5.5). Mitigative measures will not eliminate these impacts, although they can redress them. Reforestation could be conceived as part of the road project in order to make the project contribute positively to one of the more serious envir .-mental issues facing Mali.

No adverse impacts on people and their means of livelihood are anticipated. Selective changes in roles, i.e., of women, are possible. These impacts, however, may not be viewed as adverse by the culture concerned. In related projects funded by USAID, specifically those oriented to agricultural production such as the First Region Pilot Development Project, sensitivity to the issue of commercialization and the role of women is advised.

Environmental impacts of related or linked projects upon which the road's feasibility depends and vice-versa are not addressed here since existing projects with such possible impacts are not under the direction of USAID. The proposed First Region Pilot Development Project, however, should pay particular attention to the introduction of pesticides or insecticides, changes in the use of water and livestock watering points, and the long-term viability of introduced seed materials that cannot be reproduced naturally or at least locally. Changes in agricultural technology (such as deep plows or tractors) that may not be suitable to local soil conditions or may jeopardize either the double-cropping of fields or the practice of planting next year's crop in the decaying organic matter of this year's weeding should be examined.

13.8 RELATIONSHIP BETWEEN SHORT-TERM USES AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The project is conceived as one with long-term benefits, the full extent of which are not realized until 2005. The proposed action involves relatively few short-term losses (see 13.7) in order to achieve long-term gains in social and economic development. No long-term losses involving the productivity of the environment are anticipated. The ability of the project to realize and maintain long-term benefits will depend upon continued maintenance of the road.

Since the road exists, its improvement to the design options under consideration does not foreclose future options regarding the use of the environment or its protection. Rather, improvement makes the region more accessible to possible uses and to the implementation of goals to diminish overgrazing and deforestation. By extending access to health care, the project brings distinct improvements to the productivity of human lives and to the range of human options available.

13.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The project requires no major irreversible or irretrievable commitments of natural or cultural resources. The minor and obvious commitments of resources include those used to implement the project such as construction supplies, fossil fuel and laterite borrow material. The alignment once improved and resurfaced, becomes a relatively irreversible commitment to linear access through the region. It is not likely to disappear as a travelled right of way, whatever the level of maintenance, but such use of land is not an irretrievable commitment.

CHAPTER 14

CHAPTER 14
FINANCIAL ANALYSIS

14.1 GENERAL

This chapter presents a series of comprehensive disbursement schedules for two project options, in both U.S. Dollars and Malian Francs. Costs are presented for the road construction as well as the agricultural components of the project from 1981 through 1985. The major items shown under the road component of the project options are: (1) contractor construction; (2) force account operations including construction and equipment procurement; and (3) road design and supervision. The major items shown under the agricultural component of project option A are: (1) the agricultural operations and (2) the agricultural program management.

The analyses underlying the cost estimates were presented in earlier chapters, and only the results are summarized herein. The estimates have been derived on the basis of two alternative implementation programs (Chapter 4). Should these programs be modified or assumed productivities not be met, adjustments would be required in the disbursement schedules.

The recurrent expenditures of the GOM for project road and bridge maintenance over the study period and an evaluation of the Government's ability to carry out the required maintenance are presented in Appendix H and Chapter 6, and are not repeated herein.

The subject of whether or not donor funding would be provided for part of the local component costs has not been addressed as many intangibles are involved and their analysis herein could be conjectural at best. Furthermore, no comments are made as to the nature of funding - breakdown,

between grant and loan. In addition, no attempts were made to partition project costs into component parts, readily adaptable for joint financing as no data was available and no discussions to that effect could be held with GOM officials, although a number of attempts were made by USAID/Mali.

14.2 DISBURSEMENT SCHEDULES - PROJECT OPTION A

Table 14.1 summarizes the financial costs in constant 1979 prices* for project Option A consisting of the Kayes-Nioro road, the Yélimané branch and an agricultural component. Using this as a basis, Tables 14.2 and 14.3 present project costs in current Malian Francs and U.S. Dollars, respectively. Costs were inflated from 1979 prices at 10 percent per year. Following is a summary of project costs:

Project Option A

Costs in Current prices (1,000 U.S.$)**

Calendar Year	Road Component	Agricultural Component	Total Project 1,000$	Total Project Percent
1981	557.5	--	557.5	1.2
1982	4,910.0	1,038.0	5,948.0	12.5
1983	24,097.5	2,294.0	26,391.5	55.6
1984	10,779.0	1,257.0	12,036.0	25.4
1985	2,534.5	--	2,534.5	5.3
Total	42,878.5	4,589.0	47,467.5	100.0
Local Currency(%)	26.7	45.7	28.6	--
Foreign Component (%)	73.3	54.3	71.4	--

* These costs are equivalent to the economic costs as no shadow pricing is necessary and taxes are excluded.

** Exchange rate is U.S.$1 = 400 Malian Francs.

Table 14.1

Summary of Project Financial Costs
(Constant 1979 Prices, Million MF)

Project Option A
Kayes-Nioro Road, Wellmann Branch and Agricultural Development

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
I. THE KAYES-NIORO ROAD																		
1. Contractor Construction	0.0	0.0	0.0	838.0	279.0	1,117.0	4,106.0	1,368.0	5,474.0	1,339.0	447.0	1,786.0	409.0	136.0	545.0	6,692.0	2,230.0	8,922.0
2. Force Account Operations																		
Equipment Procurement	0.0	0.0	0.0	0.0	0.0	0.0	287.0	43.0	330.0	283.0	42.0	325.0	0.0	0.0	0.0	570.0	85.0	655.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	326.0	109.0	435.0	330.0	110.0	440.0	0.0	0.0	0.0	656.0	219.0	875.0
	0.0	0.0	0.0	0.0	0.0	0.0	613.0	152.0	765.0	613.0	152.0	765.0	0.0	0.0	0.0	1,226.0	304.0	1,530.0
3. Road Design & Supervision																		
Technical Assistance	85.0	0.0	85.0	166.0	0.0	166.0	160.0	0.0	160.0	59.0	0.0	59.0	12.0	0.0	12.0	482.0	0.0	482.0
Counterpart Operations	0.0	99.0	99.0	0.0	193.0	193.0	0.0	184.0	184.0	0.0	67.0	67.0	0.0	15.0	15.0	0.0	558.0	558.0
	85.0	99.0	184.0	166.0	193.0	359.0	160.0	184.0	344.0	59.0	67.0	126.0	12.0	15.0	27.0	482.0	558.0	1,040.0
TOTAL COSTS FOR KAYES-NIORO ROAD	85.0	99.0	184.0	1,004.0	472.0	1,476.0	4,879.0	1,704.0	6,583.0	2,011.0	666.0	2,677.0	421.0	151.0	572.0	8,400.0	3,092.0	11,492.0
II. THE AGRICULTURAL COMPONENT																		
1. Agricultural Program	0.0	0.0	0.0	109.0	101.0	210.0	218.0	203.0	421.0	109.0	101.0	210.0	0.0	0.0	0.0	436.0	405.0	841.0
2. Ag. Program Management																		
Technical Assistance	0.0	0.0	0.0	55.5	19.5	75.0	112.0	39.0	151.0	55.5	19.5	75.0	0.0	0.0	0.0	223.0	78.0	301.0
Counterpart Operations	0.0	0.0	0.0	5.0	22.0	27.0	10.0	45.0	55.0	5.0	22.0	27.0	0.0	0.0	0.0	20.0	89.0	109.0
	0.0	0.0	0.0	60.5	41.5	102.0	122.0	84.0	206.0	60.5	41.5	102.0	0.0	0.0	0.0	243.0	167.0	410.0
TOTAL COSTS FOR AGRICULTURAL COMPONENT	0.0	0.0	0.0	169.5	142.5	312.0	340.0	287.0	627.0	169.5	142.5	312.0	0.0	0.0	0.0	679.0	572.0	1,251.0
GRAND TOTAL COSTS FOR PROGRAM	85.0	99.0	184.0	1,173.5	614.5	1,788.0	5,219.0	1,991.0	7,210.0	2,180.5	808.5	2,989.0	421.0	151.0	572.0	9,079.0	3,664.0	12,743.0

Table 14.2

Summary of Project Financial Costs
(Current Prices, Million MF)

Project Option A
Kayes-Nioro Road, Yélimané Branch and Agricultural Development

Calendar Year

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
I. THE KAYES-NIORO ROAD																		
1. Contractor Construction	0.0	0.0	0.0	1,115.0	371.0	1,486.0	6,011.5	2,003.0	8,014.5	2,156.5	720.0	2,876.5	724.5	241.0	965.5	10,037.5	3,335.0	13,342.5
2. Force Account Operations																		
Equipment Procurement	0.0	0.0	0.0	0.0	0.0	0.0	420.0	63.0	483.0	456.0	67.5	523.5	0.0	0.0	0.0	876.0	130.5	1,006.5
Construction	0.0	0.0	0.0	0.0	0.0	0.0	477.5	159.5	637.0	531.0	177.5	708.5	0.0	0.0	0.0	1,008.5	337.0	1,345.5
	0.0	0.0	0.0	0.0	0.0	0.0	897.5	222.5	1,120.0	987.0	245.0	1,232.0	0.0	0.0	0.0	1,884.5	467.5	2,352.0
3. Road Design & Supervision																		
Technical Assistance	103.0	0.0	103.0	221.0	0.0	221.0	234.5	0.0	234.5	95.0	0.0	95.0	21.5	0.0	21.5	675.0	0.0	675.0
Counterpart Operations	0.0	120.0	120.0	0.0	257.0	257.0	0.0	269.5	269.5	0.0	108.0	108.0	0.0	26.5	26.5	0.0	781.0	781.0
	103.0	120.0	223.0	221.0	257.0	478.0	234.5	269.5	504.0	95.0	108.0	203.0	21.5	26.5	48.0	675.0	781.0	1,456.0
TOTAL COSTS FOR KAYES-NIORO ROAD	103.0	120.0	223.0	1,336.0	628.0	1,964.0	7,143.5	2,495.0	9,638.5	3,238.5	1,073.0	4,311.5	746.0	267.5	1,013.5	12,567.0	4,583.5	17,150.5
II. THE AGRICULTURAL COMPONENT																		
1. Agricultural Program	0.0	0.0	0.0	145.0	134.5	279.5	319.0	297.0	616.0	175.5	162.5	338.0	0.0	0.0	0.0	639.5	594.0	1,233.5
2. Ag. Program Management																		
Technical Assistance	0.0	0.0	0.0	74.0	26.0	100.0	164.0	57.0	221.0	89.5	31.5	121.0	0.0	0.0	0.0	327.5	114.5	442.0
Counterpart Operations	0.0	0.0	0.0	6.5	29.0	35.5	14.5	66.0	80.5	8.0	35.5	43.5	0.0	0.0	0.0	28.0	130.5	158.5
	0.0	0.0	0.0	80.5	55.0	135.5	178.5	123.0	301.5	97.5	67.0	164.5	0.0	0.0	0.0	356.5	245.0	601.5
TOTAL COSTS FOR AGRICULTURAL COMPONENT	0.0	0.0	0.0	225.5	189.5	415.0	497.5	420.0	917.5	273.0	229.5	502.5	0.0	0.0	0.0	996.0	839.5	1,835.0
GRAND TOTAL COSTS FOR PROGRAM	103.0	120.0	223.0	1,561.5	817.5	2,379.0	7,641.0	2,915.0	10,556.0	3,511.5	1,302.5	4,814.0	746.0	267.5	1,013.5	13,563.0	5,422.5	18,985.5

Table 14.3

Summary of Project Financial Costs
(Current Prices, Thousand US $)

Project Option A
Kayes-Nioro Road, Yéllimané Branch and Agricultural Development

Calendar Year

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
I. THE KAYES-NIORO ROAD																		
1. Contractor Construction	0.0	0.0	0.0	2,787.5	927.5	3,715.0	15,029.0	5,007.5	20,036.5	5,391.5	1,800.0	7,191.5	1,811.5	602.5	2,414.0	25,019.5	8,337.5	33,357.0
2. Force Account Operations																		
Equipment Procurement	0.0	0.0	0.0	0.0	0.0	0.0	1,050.0	157.5	1,207.5	1,140.0	169.0	1,309.0	0.0	0.0	0.0	2,190.0	326.5	2,516.5
Construction	0.0	0.0	0.0	0.0	0.0	0.0	1,194.0	399.0	1,593.0	1,327.5	443.5	1,771.0	0.0	0.0	0.0	2,521.5	842.5	3,364.0
	0.0	0.0	0.0	0.0	0.0	0.0	2,244.0	556.5	2,800.5	2,467.5	612.5	3,080.0	0.0	0.0	0.0	4,711.5	1,169.0	5,880.5
3. Road Design & Supervision																		
Technical Assistance	257.5	0.0	257.5	552.5	0.0	552.5	586.5	0.0	586.5	237.5	0.0	237.5	54.0	0.0	54.0	1,688.0	0.0	1,688.0
Counterpart Operations	0.0	300.0	300.0	0.0	642.5	642.5	0.0	674.0	674.0	0.0	270.0	270.0	0.0	66.5	66.5	0.0	1,953.0	1,953.0
	257.5	300.0	557.5	552.5	642.5	1,195.0	586.5	674.0	1,260.5	237.5	270.0	507.5	54.0	66.5	120.5	1,688.0	1,953.0	3,641.0
TOTAL COSTS FOR KAYES-NIORO ROAD	257.5	300.0	557.5	3,340.0	1,570.0	4,910.0	17,859.5	6,238.0	24,097.5	8,096.5	2,682.5	10,779.0	1,865.5	669.0	2,534.5	31,419.0	11,459.5	42,878.5
II. THE AGRICULTURAL COMPONENT																		
1. Agricultural Program	0.0	0.0	0.0	362.5	336.5	699.0	797.5	742.5	1,540.0	439.0	406.5	845.5	0.0	0.0	0.0	1,599.0	1,485.5	3,084.5
2. Ag. Program Management																		
Technical Assistance	0.0	0.0	0.0	185.0	65.0	250.0	410.0	142.5	552.5	224.0	79.0	303.0	0.0	0.0	0.0	819.0	286.5	1,105.5
Counterpart Operations	0.0	0.0	0.0	16.5	72.5	89.0	36.5	165.0	201.5	20.0	88.5	108.5	0.0	0.0	0.0	73.0	326.0	399.0
	0.0	0.0	0.0	201.5	137.5	339.0	446.5	307.5	754.0	244.0	167.5	411.5	0.0	0.0	0.0	892.0	612.5	1,504.5
TOTAL COSTS FOR AGRICULTURAL COMPONENT	0.0	0.0	0.0	564.0	474.0	1,038.0	1,244.0	1,050.0	2,294.0	683.0	574.0	1,257.0	0.0	0.0	0.0	2,491.0	2,098.0	4,589.0
GRAND TOTAL COSTS FOR PROGRAM	257.5	300.0	557.5	3,904.0	2,044.0	5,948.0	19,103.5	7,288.0	26,391.5	8,779.5	3,256.5	12,036.0	1,865.5	669.0	2,534.5	33,910.0	13,557.5	47,467.5

14.3 DISBURSEMENT SCHEDULES - PROJECT OPTION B

Table 14.4 summarizes the financial costs, in constant 1979 prices, for project Option B consisting solely of the Kayes-Nioro Road. Using said table as a basis, tables 14.5 and 14.6 present project costs in current Malian Francs and U.S. Dollars, respectively. Costs were inflated from 1979 prices at 10 percent per year. Following is a summary of project costs:

Project Option B

Costs in Current Prices (1,000 U.S. $)

Calendar Year	Project Costs 1,000 $	Percent
1981	1,211	3.3
1982	4,365	11.9
1983	15,687	42.8
1984	14,525	39.6
1985	896	2.4
TOTAL	36,684	100.0%
Local Currency	8,374	22.8
Foreign Component	28,310	77.2

Financial and economic costs are equivalent as no shadow pricing is necessary and taxes (transfers) are excluded. The adopted exchange rate is U.S. $ 1 = 400 Malian Francs.

The present value of capital investment costs, at 10% amortization rate, for the different levels of road improvements is nearly equal under both alternative implementation schemes, although the disbursement schedules are different. This indicates that the economic analyses, as carried out, were not affected by the choice between the two proposed implementation programs.

Table 14.4

Summary of Project Financial Costs
(Constant 1979 Prices, Million MF)

Project Option B
Kayes-Nioro Road

Calendar Year

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
1. Contractor Construction and Supervision																		
Kayes-Dialaka	--	--	--	377	126	503	1,128	376	1,504	1,128	376	1,504	--	--	--	2,633	878	3,511
Sandaré-Nioro	--	--	--	291	97	388	874	292	1,166	874	292	1,166	--	--	--	2,039	681	2,720
	--	--	--	668	223	891	2,002	668	2,670	2,002	668	2,670	--	--	--	4,672	1,559	6,231
2. Force Account Operations for Dialaka-Sandaré																		
Equipment Procurement	--	--	--	--	--	--	570	85	655	--	--	--	--	--	--	570	85	655
Construction & GOM operations	--	--	--	--	--	--	685	229	914	685	229	914	152	51	203	1,522	509	2,031
Construction Management	--	--	--	20	--	20	48	--	48	24	--	24	--	--	--	92	--	92
	--	--	--	20	--	20	1,303	314	1,617	709	229	938	152	51	203	2,184	594	2,778
3. Consultant Work																		
Design & Photography	288	32	320	288	32	320	--	--	--	--	--	--	--	--	--	576	64	640
Additional Studies	80	--	80	80	--	80	--	--	--	--	--	--	--	--	--	160	--	160
	368	32	400	368	32	400	--	--	--	--	--	--	--	--	--	736	64	800
TOTAL COSTS FOR KAYES-NIORO ROAD	368	32	400	1,056	255	1,311	3,305	982	4,287	2,711	897	3,608	152	51	203	7,592	2,217	9,809

Table 14.5

Summary of Project Financial Costs
(Current Prices, Million MF)

Project Option B
Kayes-Nioro Road

Calendar Year

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
1. Contractor Construction and Supervision																		
Kayes-Dialaka	--	--	--	502	168	670	1,651	550	2,201	1,816	605	2,421	--	--	--	3,969	1,323	5,292
Sandaré-Nioro	--	--	--	387	129	516	1,280	427	1,707	1,407	470	1,877	--	--	--	3,074	1,026	4,100
	--	--	--	889	297	1,186	2,931	977	3,908	3,223	1,075	4,298	--	--	--	7,043	2,349	9,392
2. Force Account Operations for Dialaka-Sandaré																		
Equipment Procurement	--	--	--	--	--	--	834	124	958	--	--	--	--	--	--	834	124	958
Construction & GOM operations	--	--	--	--	--	--	1,003	335	1,338	1,103	369	1,472	269	89	358	2,375	793	3,168
Construction Management	--	--	--	27	--	27	70	--	70	39	--	39	--	--	--	136	--	136
	--	--	--	27	--	27	1,907	459	2,366	1,142	369	1,511	269	89	358	3,345	917	4,262
3. Consultant Work																		
Design & Photography	348	39	387	383	43	426	--	--	--	--	--	--	--	--	--	731	82	813
Additional Studies	97	--	97	106	--	106	--	--	--	--	--	--	--	--	--	203	--	203
	445	39	484	489	43	532	--	--	--	--	--	--	--	--	--	934	82	1,016
TOTAL COSTS FOR KAYES-NIORO ROAD	445	39	484	1,405	340	1,745	4,838	1,436	6,274	4,365	1,444	5,809	269	89	358	11,322	3,348	14,670

Table 14.6

Summary of Project Financial Costs
(Current Prices, Thousand U.S. Dollars)

Project Option B
Kayes-Nioro Road

Calendar Year

	1981			1982			1983			1984			1985			Total		
	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total	Foreign Comp't	Local Cur'cy	Total
1. Contractor Construction and Supervision																		
Kayes-Dialaka	--	--	--	1,255	420	1,675	4,128	1,375	5,503	4,540	1,513	6,053	--	--	--	9,923	3,308	13,231
Sandaré-Nioro	--	--	--	968	323	1,291	3,200	1,068	4,268	3,518	1,175	4,693	--	--	--	7,686	2,566	10,252
	--	--	--	2,223	743	2,966	7,328	2,443	9,771	8,058	2,688	10,746	--	--	--	17,609	5,874	23,483
2. Force Account Operations for Dialaka-Sandaré																		
Equipment Procurement	--	--	--	--	--	--	2,085	310	2,395	--	--	--	--	--	--	2,085	310	2,395
Construction & GOM Operations	--	--	--	-	--	--	2,508	838	3,346	2,758	923	3,681	673	223	896	5,939	1,984	7,923
Construction Management	--	--	--	68	--	68	175	--	175	98	--	98	--	--	--	341	--	341
	--	--	--	68	--	68	4,768	1,148	5,916	2,856	923	3,779	673	223	896	8,365	2,294	10,659
3. Consultant Work																		
Design & Photography	870	98	968	958	108	1,066	--	--	--	--	--	--	--	--	--	1,828	206	2,034
Additional Studies	243	--	243	265	--	265	--	--	--	--	--	--	--	--	--	508	--	508
	1,113	98	1,211	1,223	108	1,331	--	--	--	--	--	--	--	--	--	2,336	206	2,542
TOTAL COSTS FOR KAYES-NIORO ROAD	1,113	98	1,211	3,514	851	4,365	12,096	3,591	15,687	10,914	3,611	14,525	673	223	896	28,310	8,374	36,684

CHAPTER 15

CHAPTER 15

CHAPTER 15

RECOMMENDED PROJECT OPTIONS

The two recommended project options are the ones selected through the economic analysis process, since the socio-environmental studies showed no major differences among road improvement alternatives, except to indicate that higher levels of improvements are preferable. A multi-disciplinary decision-matrix was, therefore, not required to carry out the selection among several possible improvement levels.

A description and evaluation of the two recommended project options, i.e.,the optimum two alternatives in multi-disciplinary terms, one for each investment option, follows:

15.1 RECOMMENDED PROJECT OPTION A

Recommended project option A consists of a road and an agricultural component. These are summarized in Table 15.1.

The road component is described below:

- Double surface treated road between Kayes and Dialaka (82 km), with a 7 meter wide platform, of which 5 meters are surfaced at a cost of 3,863 million MF (1979 prices), to be completed by the spring of 1984.
- Laterite/gravel surfaced road between Dialaka and Sandaré (61 km), with a 7 meter wide platform, at a cost of 2,954 million MF (1979 prices), to be completed by the winter of 1984.
- Laterite/gravel surfaced road between Sandaré and Nioro

Table 1.1

Summary Description

Recommended Project Option A

Kayes-Nioro Road, Yélimané Branch and Agricultural Development

PROJECT COMPONENT	DESIGN STANDARDS	MAGNITUDE	DESIGN PROCEDURE	IMPLEMENTATION	DATE OF COMPLETION	COST (Million MF, 1979)
THE KAYES-NIORO ROAD						
Kayes-Dialaka	Double surface treatment, 7 meter platform, 5 meter surfacing	82 km	GRM in-house with Technical assistance	Contractor by International bidding	March 1984	3,863
Dialaka-Yelimané	Minimum cost, 5.5 meter platform	68 km	GRM in-house with Technical assistance	Force account with equipment acquisition	Dec. 1984	1,683
Dialaka-Sandaré **	Laterite/gravel surface, 7 meter platform	61 km	GRM in-house with Technical assistance	Contractor by International bidding	Dec. 1983	2,954
Sandaré-Nioro **	Laterite/gravel surface, 7 meter platform	107 km	GRM in-house with Technical assistance	Contractor by International bidding	May 1985	2,993
						11,493
THE AGRICULTURAL COMPONENT						
Dialaka-Ségala area	Kaarta type strategy for introduction of improved production technology	10,000 ha	Funding Agency	GRM in-house with Technical assistance	Dec. 1984	1,250
TOTAL FOR PROJECT	n.a.*	318 km and 10,000 ha	n.a.*	n.a.*	May 1985	12,743

* n.a., not applicable

** The Dialaka-Sandaré and Sandaré-Nioro sections were combined, in the economic analysis, into one section.

(107 km), with a 7 meter wide platform at a cost of 2,993 million MF (1979 prices), to be completed by the summer of 1985.

- Minimum standard road between Dialaka and Yelimané (68 km), with a 5.5 meter wide platform, at a cost of 1,683 million MF (1979 prices), to be completed by the winter of 1985.

The agricultural component of this project option consists of an investment of 1,250 million MF (1979 prices) in the Yélimané and Ségala areas aiming mainly at the creation of extension services and farm credits to improve production technology on 10,000 hectares, using the strategy adopted by the Kaarta project. Also, the recommended investment in agriculture provides for a feeder road component and the construction of physical facilities. A three-year funding program, ending by 1985, is suggested.

The implementation of this project option includes the establishment of two technical assistance teams to coordinate the two components of the project. The improvement of the Kayes-Nioro road in its three sections would be undertaken by contractors selected by international bidding, while the Yelimané branch would be constructed by force account. The equipment to be procured for the latter's construction would insure, for a time at least, that the constructed network is somewhat adequately maintained.

The budgeting requirements for this project option are placed at 17,150.5 and 1,835.0 million MF for the road and agricultural components, respectively, for a total of 18,985.5 million MF, in current prices; these costs include an estimated ten percent inflation per annum. The funding for this project option is scheduled to start in 1981 and end in 1985. The local currency component of costs is estimated at close to 30 percent.

15.2 RECOMMENDED PROJECT OPTION B

Recommended project option B consists of the Kayes-Nioro road only. The components of this project option are summarized in Table 15.2 and are described below:

- Double surface treated road between Kayes and Dialaka (82 km), with a 7 meter wide platform, of which 5 meters are surfaced at a cost of 3,863 million MF (1979 prices), to be completed by the end of 1984.
- Laterite/gravel surfaced road between Dialaka and Sandaré (61 km), with a 7 meter wide platform, at a cost of 2,954 million MF (1979 prices), to be completed by the winter of 1985.
- Laterite/gravel surfaced road between Sandaré and Nioro (107 km), with a 7 meter wide platform at a cost of 2,993 million MF (1979 prices), to be completed by the end of 1984.

The implementation of this project option includes the use of an A/E consultant for the road design work. The improvement of the Kayes-Nioro road would be carried out by a mix of contractor and force account construction. One, instead of several contractors, can be selected for the work, including the Dialaka-Sandaré section which is slated for force account construction,provided road maintenance issues in the First Region are resolved independently of this project.

The budgeting requirements for this project option are placed at 14,670 million MF, in current prices; these costs include an estimated 10 percent inflation per annum. Funding for this project option is scheduled to start in 1981 and end in 1985. The local currency component is estimated at close to 23 percent.

Table 15.2

Summary Description

Recommended Project Option B

Kayes-Nioro Road

PROJECT COMPONENT	DESIGN STANDARDS	MAGNITUDE	DESIGN PROCEDURE	IMPLEMENTATION	DATE OF COMPLETION	COST (Million MF, 1979)
Kayes-Dialaka	Double surface treatment, 7 meter platform, 5 meter surfacing	82 km	A/E Consultant	Contractor by International bidding	December 1984	3,863
Dialaka-Sandaré*	Laterite/gravel surface, 7 meter platform	61 km	A/E Consultant	Force account with equipment acquisition**	February 1985	2,954
Sandaré-Nioro*	Laterite/gravel surface, 7 meter platform	107 km	A/E Consultant	Contractor by International bidding	December 1984	2,993
TOTAL FOR PROJECT	n.a.***	250 km	One A/E Consultant	One or several Contractors	February 1985	9,810

* The Dialaka-Sandaré and Sandaré-Nioro sections were combined, in the economic analysis, into one section.

** The Dialaka-Sandaré section could also be carried out using contractor construction, provided road maintenance issues in the First Region are resolved independently of this project.

*** n.a.: not applicable

15.3 COMPREHENSIVE SUMMARY OF PROJECT IMPACTS

The project impacts of the two recommended options are similar, the difference being in the magnitude of the impacts and the extent of the population which is reached.

15.3.1 ECONOMIC IMPACTS

Project option A has an internal rate of return of 16.4 percent and a net present value, i.e., the discounted value of the difference between total benefits and total costs, of 7,261 million MF, at a 10 percent opportunity cost of capital. Project option B has an internal rate of return of 13.0 percent and a net present value of 2,288 million MF, at a 10 percent opportunity cost of capital. The above feasibility of the two project options is due mainly to two major factors: the reduction in the transport costs, and the spreading of effects generated by the agricultural development projects, the latter being the more significant.

The two project options will each significantly improve many of the economic conditions prevalent in the northern part of the First Region of Mali. Following are some indicators which portray the type and direction of anticipated improvements:

- The affected population is the rural farmer as well as the trucker/merchant, with a total population of about 190,000 and 173,000 persons for project options A and B, respectively. Furthermore, all services in the area will also be beneficially impacted.
- Transportation costs will be reduced from an average of about 12,000 MF/ton to about 5,000 MF/ton for agricultural produce moving on the Kayes-Nioro road. For normal non-agricultural traffic, the corresponding reduction is from about 270 MF/veh-km to 120 MF/veh-km. Said reductions in transport costs are marginally larger for project option A than for project option B.

- About 20 percent of the rural families will adopt an improved production technology as a result of spread effects due to road improvements; this technology is being introduced by the Kaarta project and would be appropriate for introduction through the recommended additional agricultural investment under project option A. This spread effect translates into the reaching of about 35,000 to 40,000 and 32,000 to 37,000 persons for project options A and B, respectively. An additional 10,000 to 15,000 persons would adopt improved production technology if the agricultural investment under project option A is made.

- A modest increase, over normal increases, in the area under cultivation will take place. This increase when combined with the spreading of improved production technology and the change in crop patterns and increases in ex-farm prices, will result in close to a fourfold increase in the net agricultural production value from 1.3 to 5.0 billion MF, in constant 1979 prices, by the year 1995, for project option A. The corresponding increase in net agricultural production value is close to a threefold increase from 1.3 to 3.3. billion MF, for project option B. The projected increases in net agricultural production value are due to the combined effects of the proposed projects and the ongoing development programs.

- The increases in net agricultural production value imply commensurate increases in per capita income; i.e., close to four and threefold increases in the P.C.I. by the year 1995 for the area of influence as a whole for project options A and B, respectively. Furthermore, for those farmers who will adopt improved agricultural production technology and changes in crop patterns, the corresponding increase in P.C.I. should be about fivefold for either project option.

15.3.2 SOCIO-ENVIRONMENTAL IMPACTS

The investment in infrastructure and agriculture can bring about significant socio-economic change. To do so, however, the project does not require the restructuring of traditional society nor large-scale alteration of the environment. Instead, the investment will improve existing conditions and thus permit gradual ripple effect changes to build over a period of years. This type of intervention works in concert with ongoing development efforts and will help to achieve a more integrated form of economic and social development in the First Region. From a social and environmental standpoint, the proposed project options can be evaluated as follows:

- An improved road will be a visible demonstration of efforts to unlock this isolated region and will help to create a different social-psychological climate.

- Beneficial impacts on the human environment are anticipated. By improving access to services, by making service delivery less costly, and by raising per capita income, the road brings improvements to the productivity of human lives and expands the range of options available to the population. With increased commercialization, however, the active role of women in the production and marketing of vegetable crops could change.

- Receptivity of villagers to improved access is positive with regard to obtaining services such as medical care and reaching markets. Furthermore, receptivity to increased cultivation, especially cash crops, will be enhanced by the road improvement which provides the necessary but not sufficient economic incentives for expanded production. Since incentives and receptivity to increase the production of grains and to alter management of herds for maximum off-take were not high, these activities are not projected to undergo as much change.

- Few adverse effects on the natural environment are likely, and care could be exercised during construction and steps taken to alleviate the effects of unauthorized wood-cutting for commercial purposes once access is improved. A program of reforestation along the route could be undertaken as a means to mitigate such effects. During construction of the road, care could be taken in the placement of work camps to avoid competition with villagers' resources, especially water, and to minimize destruction of trees and vegetative cover.

15.3.3 CONCLUSIONS

The results of the study indicate that the recommended project options meet the goals of improved access and the "opening-up" of an isolated region which is presently dependent upon subsistence agriculture.

The recommended project options generate significant economic benefits to be derived by the rural poor as well as less easily quantifiable social benefits. Adverse socio-environmental impacts, if any, will be of a limited nature. Therefore, the project improves the standard of living of the rural population and enhances the quality of life in the First Region.

Thus, the region offers an attractive overall return on either of the two recommended investment options.