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UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

FINAL REPORT

ECONOMIC AND TECHNICAL FEASIBILITY STUDY

BUKOMBE-ISAKA ROAD LINK

TANZANIA

Contract No. AID/OTR-C-1788
Work Order No. 3

Prepared by:

LOUIS BERGER INTERNATIONAL, INC.
100 Halsted Street
East Orange, N.J. 07019

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EXECUTIVE SUMMARY

ECONOMIC AND TECHNICAL FEASIBILITY STUDY

BUKOMBE-ISAKA ROAD LINK

Executive Summary

Rwanda and Burundi have heretofore depended on two surface transport routes to the Indian Ocean. These routes (known as the "northern" route through Uganda and Kenya to the port of Mombasa and the "southern" route across Lake Tanganyika and Tanzania to the port of Dar es Salaam) have become unsatisfactory due to considerable difficulties and delays attributable to deteriorated roadways and railroad service, port congestion and inefficient operations, numerous trans-shipments and border closures. An alternative access route to the Indian Ocean known as the "middle" route, which crosses Tanzania by road to Isaka with a railroad connection to Dar es Salaam, has been proposed.

This report presents the final results of a preliminary economic and technical reconnaissance survey of the Bukombe to Isaka segment of the proposed Rusomo to Isaka road, comprising the roadway segment of the middle route. The study was prepared by Louis Berger International, Inc. under contract to the United States Agency for International Development (IQC contract AID/OTR-C-1788).

The report, presented in six chapters, describes the data collection efforts, field investigations, project description and general background, project issues and objectives, and the economic and technical evaluation of alternative proposed improvements.

Between mid-October and mid-November 1980, the project team, comprised of a highway engineer and transport economist, travelled to Kenya, Rwanda, Burundi, and Tanzania. During this trip, the project team met with regional representatives of USAID; other donor agencies; government officials in Burundi, Rwanda and Tanzania; and Impresa del Benaco, a contractor presently working in the area.

The present road extends from the village of Bukombe to the village of Isaka, a distance of 117.5 kilometers. The city of Kahama, the district capital, is located on the project road approximately 72 kilometers east of Bukombe. The road traverses flat and gently rolling terrain and the land adjacent to the road consists of villages practicing subsistence agriculture and animal husbandry.

The existing 5.5 meter wide Bukombe to Isaka roadway has a generally good horizontal alignment. The vertical alignment is less satisfactory, however, primarily because long sections of the road that are level with the adjacent terrain tend to flood in the rainy season. This condition is further aggravated by a lack of adequate maintenance and the fact that all of the bridges and culverts, although in fair to good condition, are narrower than the present carriageway width.

In addition to the need for roadway improvements, four additional constraints must be resolved if the "middle" route is to properly serve eastern Zaire, Burundi and Rwanda foreign trade: improvements in road maintenance, improved rail services, reduction in transshipment time at the port of Dar es Salaam and provision of an efficient rail/road transfer facility at Isaka.

The present inability of the Ministry of Works (MOW) to maintain the road is inhibited by budgetary, administrative and staffing problems. Several programs, however, are presently under way to improve the road maintenance levels in Tanzania, the most significant among them being the Fourth and Fifth Highway Projects funded by the World Bank.

The prospects of the Tanzanian Railway Corporation (TRC) improving its service for traffic to and from Burundi and Rwanda depend essentially on future operational and management improvements. Since 60 locomotives and 455 wagons were to be delivered to the TRC in November 1980 through international assistance, this should provide sufficient rolling stock to meet the TRC's need. TRC's capacity to handle the ZBR traffic via the middle road will depend also on the timely construction of suitable transshipment facilities at Isaka. Several programs are now under way, however, to strengthen the TRC management staff, modernize its communications system, upgrade its permanent way and improve operations.

In the past, the port of Dar es Salaam has also proved a serious bottleneck. Since late 1980, however, congestion at the port has been alleviated, greatly reducing the transshipment times. Several programs under way to strengthen the port management and improve its operations promise to reduce the transshipment time even further.

The anticipated improvements in railroad and port operations in Tanzania, coupled with lower transport costs for Rwanda and Burundi as a result of a new Bukombe-Isaka road link, are likely to result in a diversion of a significant portion (80 percent) of Rwandan surface foreign trade and a smaller share (10 percent) of Burundi surface foreign trade from the

alternative routes. Estimates of future international traffic diverted to the middle route were derived from forecasts of the future foreign trade demand for Rwanda and Burundi, with 43 trucks per day projected in 1990, increasing to 84 trucks per day in 2004.

Tanzanian domestic traffic on the Bukombe-Isaka road is estimated to grow at an average annual growth rate between 5 and 7 percent. By 1985, Tanzanian traffic is projected to be 120 to 135 vehicles per day with 50 percent heavy trucks. By the year 2004, the Tanzanian domestic traffic is expected to reach 318 to 489 (at 5 and 7 percent traffic growth). Generated traffic is projected to peak in 1985 at 15 percent of the domestic traffic, or 18 to 20 vehicles per day.

In the final economic evaluation, two levels of improvement were considered, a comparison of the existing gravel road (117.5 kilometers, 5.5 meters) to a new gravel road (112.5 kilometers, 6.5 meters) and to a new paved (DBST) road (112.5 kilometers, 6.5 meters), both on new alignment. It was assumed each alternative would be completed by 1985. By the year 2004, traffic for a new gravel road would range between 404 to 592 vehicles per day while for a new paved road traffic would range between 450 and 646 vehicles per day.

The financial costs in 1980 prices for the construction of each alternative would be:

Alternative	Financial Cost		
	Local Currency	Foreign Currency	Total
112.5 km new gravel road	99.43	50.78	150.21
112.5 km new paved (DBST) road	116.33	73.43	189.76

Each proposed improvement was evaluated on the basis of assumed traffic growth rates of 5 and 7 percent for the period 1981-2004, including and excluding a portion of the cost of the proposed improvements to the Isaka rail facility and with and without passenger time savings. Finally, in order to verify whether or not the economic viability of the proposed improvements are significantly affected by changes in the construction costs and economic benefits, a sensitivity analysis was performed. The results are discussed in detail in Article 6.8.

Considering the number of variables and complexity of the analysis required by incorporating traffic volume sensitive maintenance costs, differing levels of generated and diverted traffic and vehicle operating cost variations for road and

shoulder widths, the Consultants developed a computer model for the analysis (see Article 6.8.1).

The economic evaluation of constructing a new 112.5 kilometer, 6.5 meter paved road to replace the existing 117.5 kilometer Bukombe-Isaka highway produced a relatively attractive EIRR (16.0 to 18.1 percent) as shown below:

	Isaka Station Costs	Time Costs	EIRR	B/C 10%	B/C 12%
5% Traffic Growth	w/o	w	16.45	1.66	1.39
	w/o	w/o	16.18	1.64	1.37
	w	w	16.02	1.62	1.36
	w	w/o	15.80	1.59	1.33
7% Traffic Growth	w/o	w	18.08	1.89	1.58
	w/o	w/o	17.81	1.85	1.55
	w	w	17.70	1.84	1.54
	w	w/o	17.45	1.80	1.51

The economic evaluation of replacing the existing gravel road with a new gravel road at 5 and 7 percent traffic growth produced lower EIRRs, as shown below.

	Isaka Station Costs	Time Costs	EIRR	B/C 10%	B/C 12%
5% Traffic Growth	w/o	w	6.40	0.64	0.55
	w/o	w/o	6.28	0.63	0.54
	w	w	6.15	0.62	0.53
	w	w/o	5.02	0.61	0.52
7% Traffic Growth	w/o	w	8.87	0.88	0.73
	w/o	w/o	8.72	0.87	0.72
	w	w	8.52	0.85	0.71
	w	w/o	8.36	0.84	0.69

The reason for the significant differences is that vehicle operating cost savings for traffic transferring from the existing gravel road to a new gravel road were only 9.4 percent, while for traffic transferring from the existing road to a new paved road the savings were 57.05 percent. Therefore, the incremental vehicle operating savings of a paved road compared to a new gravel road significantly exceeded the additional economic construction costs for the paved road, which was only 139 percent of a comparable gravel road.

A final analysis was undertaken based on the fact that despite the 35.6 million T.Sh. investment (in economic costs), the existing gravel road might only sustain a service level comparable to 90 percent of the vehicle operating savings obtained by a new gravel road in comparison to a well-maintained earth road. The finding was an EIRR ranging from 15.9 to 16.3 for the 5 and 7 percent traffic growth rates, as shown below:

	Isaka Station Costs	Time Costs	EIRR
5% Traffic Growth	w/o	w	16.09
	w/o	w/o	15.95
	w	w	16.01
	w	w/o	15.86
7% Traffic Growth	w/o	w	16.28
	w/o	w/o	16.16
	w	w	16.22
	w	w/o	16.10

It is believed that a more detailed analysis of the new gravel road investment could have produced a more attractive EIRR had the Consultant been able to properly inventory the existing 117.5 kilometer road, establish homogeneous link sections, and for each of these sections, compare the feasibility of rehabilitating the existing gravel road link to an improved gravel condition versus the realignment of that section. Given the Consultant's scope of work and time constraints, such an analysis lay outside purview of this study. However, such a study may be merited if budget considerations indicate the need to develop a time-staged solution to the proposed Bukombe-Isaka road improvement.

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OBJECTIVES AND EXTENT OF THE STUDY 1

1. OBJECTIVES AND EXTENT OF THE STUDY

1.1 OBJECTIVES

Rwanda, Burundi, and adjacent provinces of eastern Zaire have depended heretofore on two transport routes to the Indian Ocean. Rwanda's predominant transport route, known as the "northern" route, connects Kigali (in Rwanda) via Kampala (in Uganda) to the port of Mombasa (in Kenya). The transport modes consist either of road transport to Mombasa or mixed road/rail transport, usually from Kigali to Kampala by road and from there by rail to Mombasa. The preferred route for Burundi and eastern Zaire is the "southern" route: by barges from the port of Bujumbura (in Burundi) to the port of Kigoma (in Tanzania), both on Lake Tanganyika, and from Kigoma to the Indian Ocean port of Dar es Salaam by rail.

Both the northern and the southern routes are unsatisfactory due to the considerable difficulties and delays caused by deteriorated roads, slow rail and port services, and unstable political conditions in Uganda. The proposed new road/rail link, the "middle" route (crossing Tanzania by road from Rusumo to Isaka then by rail from Isaka to the Indian Ocean port of Dar es Salaam), will probably provide a viable and more economical alternative to the northern and southern routes.

The objective of this study is to evaluate the economic and technical feasibility of the "middle" route. In particular, the study is concerned with the technical aspects of the Bukombe-Isaka road segment and its construction costs (in terms of 1980 prices). The study examines the present and expected future effectiveness of the middle route: the existing road and rail infrastructure and service from Isaka to the port of Dar es Salaam and their ability to handle the projected tonnages of export/import traffic from Rwanda, Burundi and eastern Zaire.

The study also evaluates the advantages and disadvantages of joint European Economic Community (EEC)/United States Agency for International Development (USAID) financing of the Bukombe-Isaka road segment and examines the requirements and costs of maintenance of the new road as well as the operation and maintenance requirements for the remaining road and rail portions of the middle route. Finally, the study provides the technical and economic inputs for the initial evaluation of the Bukombe-Isaka road segment.

The study was executed in accordance with USAID Work Order No. 3 of the IQC Contract AID/OTR-C-1788 listed below.

1.2 WORK ORDER

The statement of work, contained in the AID/OTR-C-1788 Work Order No. 3 dated September 30, 1980 included the following tasks:

a. Determine economic benefits and feasibility of constructing an all weather road link between Bukombe and Isaka. Project future traffic, estimate traffic growth, including generated traffic.

b. Assess present and future capability of the Tanzania Rail System to transport goods for Rwanda and Burundi between Isaka and Dar es Salaam, including goods transfer. Indicate requirements for upgrading, maintenance, and operation of rail facility.

c. Determine design standards to be incorporated in this road link to adequately serve the traffic projected by the economic study, including the possibilities of staged development, if indicated. Select design for recommended alignment.

d. Project costs of construction to present design standard of Rusumo Falls-Bukombe sections, using existing design drawings and bills of quantities but updating cost data from recent bids in Tanzania.

e. Project cost of construction to recommended design standard, if different from (d).

f. Consider possible staging of new road construction to correspond with available funding; determine feasibility and cost of alternative upgrading of existing road by widening or replacing drainage structures, raising grades, and minimal correction of alignments.

g. Determine feasible degree of development of Bukombe-Isaka section with investment level of not more than $10,000,000.

h. Given operative guidelines of the EEC and of USAID, state advantages and difficulties of a joint EEC/USAID financing approach. Also prepare a recommended draft agreement for operation of such a joint financing arrangement for the entire section of Bukombe-Isaka.

i. Evaluate existing road linkage, Isaka-Dar es Salaam. Determine its capacity to transport all or a portion of the projected Rwanda/Burundi-Dar es Salaam port traffic. Indicate needs in maintenance and operations relative to meeting these traffic projections in addition to traffic loads for other purposes.

j. Provide technical and economic inputs for initial environmental examinations in USAID format for both a new road and an upgraded existing road between Bukombe and Isaka.

k. Analyze existing road maintenance capabilities and procedures of the Government of Tanzania. Determine appropriate measures to be taken and budgetary requirements to provide for the maintenance of the new or upgraded road, Bukombe-Isaka.

l. Indicate possible funding source alternative to USAID.

1.3 FIELD ACTIVITIES

The project team (Mr. Abraham Perera, highway engineer, and Mr. Michael Misaelidis, transport economist) was mobilized on October 16, 1980 and travelled to Nairobi on October 17, 1980. Following meetings in the REDSO offices on October 20 and 21, the project team remained in Nairobi until October 25 to prepare the project itinerary and review reports and data relevant to the project that were available in the REDSO/EA library. The time spent in Nairobi was also utilized to obtain visas for Rwanda and Burundi and to visit the offices of Sir Alexander Gibb and Partners and the EEC.

On October 25 the project team travelled to Kigali, Rwanda. Between October 25 and 29 the project team held meetings with USAID, Direction de la Statistique, Ministry of Planning, U.S. Embassy commercial attache, and Kigera River Basin Commission.

On October 29, the team travelled by car to Tanzania to investigate the project site. Mr. Dennis Light of REDSO/EA, Nairobi joined the project team for the field trip to Rusumo Falls in Rwanda and Rulenge, Nyakahura, Lusahunga, Bukombe, Kahama, Isaka and Shinyanga in Tanzania. During the trip, visits were made to the Impresa del Benaco (Rusumo Falls-Lusahunga) road construction site, to the Bukombe-Isaka project and to the regional Ministry of Works offices in Shinyanga.

The field trip was completed on October 31 and the project team returned to Kigali.

The period between November 1 and November 4, 1980 was spent in Kigali. During this period meetings were held with USAID and Bureau National d' Etudes et des Projets.

On November 5, 1980 the project team travelled to Bujumbura, Burundi. Meetings were held with USAID-Bujumbura, EEC, International Bank for Reconstruction and Development (IBRD), UNDP and the Ministry of Planning on November 5 and 6.

On November 7 the project team travelled to Dar es Salaam, where they remained until November 19, 1980. During this period meetings were held with USAID-Dar es Salaam, Ministry of Finance, Ministry of Works, Ministry of Communications and Transport, Canadian International Development Agency (CIDA), EEC and IBRD. During the same period, the project team began preparing the draft report.

On November 19, 1980 the project team returned to Nairobi via Bujumbura.

The period between November 21 and 27 was spent in the offices of REDSO/EA in Nairobi working on the project draft report. An introduction portion of the draft report was presented to Mr. D. Light of REDSO/EA for his comments.

On November 27 the project team left Nairobi to return to the United States, where the draft report was completed.

A listing of the persons consulted during the field activities in East Africa follows:

In NAIROBI (Kenya):

Mr. Dennis Light, REDSO/EA Engineer
Mr. J.P. Jesse, Delegate of the EEC Commission in Kenya
Mr. R.N. Beatty, Partner of Sir Alexander Gibb and Partners (Africa)

In KIGALI (Rwanda):

Mr. G. Chiavaroli, Director USAID Mission
Mrs. A. Yancey, Economic Affairs Officer, U.S. Embassy
Mr. D.K. Lwehabura, Executive Secretary, Kagera River Basin Commission
Mr. C. Chutt, UNDP Advisor to Bureau National d'Etudes et des Projets
Mr. J.B. Gakwaya, Division Chief, Bureau de la Statistique, Ministry of Finance

In BUJUMBURA (Burundi):

Mr. T. Lambacher, Administrative Affairs Officer, USAID Mission
Mrs. V. Kunkle, Assistant Program Officer, USAID Mission
Mr. B. Egan, Economic Development Officer, USAID Mission
Mr. C. Niragira, Advisor to Ministry of Planning
Mr. M. Boisaubert, Advisor to Ministry of Planning
Mr. A.S. Fawundu, Program Officer, UNDP
Miss L. Gariepy, IBRD Mission Resident Representative
Mr. P. Lesueur, Advisor to EEC Delegation

In NYAKAHURA (Tanzania):

Mr. N. DePianto, Impresa del Benaco

In SHINYANGA (Tanzania):

Mr. L. Kusasa, Assistant Regional Engineer, Ministry of Works

In DAR ES SALAAM (Tanzania):

Mr. B. Riley, Deputy Director USAID Mission
Mr. R. Gilson, Assistant Program Officer, USAID Mission
Mr. M. Vigrass, Consultant to CIDA
Mr. J. Bloemarts, Advisor to EEC Delegation
Mr. S.L. Kathuria, IBRD Engineer, 5th Highway Maintenance Project
Mr. F. Barozi, Director of Roads, Ministry of Works
Mr. F.B. Mtema, Senior Executive Engineer, Ministry of Works
Mr. Kayambo, Planning Economist, Ministry of Works
Mr. F. Byabato, Liaison Officer for World Bank and EEC, Ministry of Finance
Mr. N.M. Mboyi, Liaison Officer for AFDB and BADEA Ministry of Finance
Mr. D.N. Kagazi, Liaison Officer for USAID, Ministry of Finance
Mr. R.M. Minja, Director of Planning, Ministry of Communications and Transport

PROJECT DESCRIPTION 2

2. PROJECT DESCRIPTION

2.1 LOCATION

The Bukombe to Isaka road is located in the northwestern part of Tanzania in the Shinyanga Region. It is part of the overall link from Rusumo Falls to Isaka, by road, and from Isaka to Dar es Salaam, by rail, which will provide access to the Indian Ocean from Rwanda and Burundi. The Shinyanga region is one of the more densely populated regions of Tanzania. The portion of the Shinyanga region traversed by the project road is located in the Kahama district. The area affected by the Bukombe to Isaka road is estimated to contain approximately 210,000 people who are engaged mainly in subsistence agriculture and raising livestock. The terrain is generally flat or gently rolling. The road traverses one town (Kahama), three major villages (Bukombe, Ngogwa and Isaka), as well as several small villages. Several crossroads and trails connect numerous villages, located both north and south of the main road. The distances to these villages vary from a few kilometers to as much as 80 kilometers. Due to the implementation of the Tanzanian Government's UJAMAA village development program many of the small villages in the project road area are in the process of being relocated and concentrated into larger village groupings.

In the regional and international context, the project road will become part of the overall road link from Rusumo Falls to Isaka, providing improved access to the important Tanzanian cities of Kibondo, Biharmulo, Kahama and Shinyanga, as well as to Rwanda and Burundi via their national road networks. The road from Kigali to Rusumo Falls in Rwanda has been completed to bitumen standard and projects are under way that will allow connection to Rusumo Falls on the Burundi road system.

2.2 PRESENT AND FUTURE TRANSPORT ROUTES

The proposed new transport link from Rusumo Falls to Dar es Salaam will constitute a "middle" route from Rwanda and Burundi to the sea. Presently the two landlocked countries use either the "northern" route via Kigali and Kampala to the port of Mombassa or the "southern" route via Bujumbura and Lake Tanganyika to the port of Kigoma and then by rail to the ocean port of Dar es Salaam (see Figure 1). For its export/import traffic Rwanda depends primarily on the northern route while Burundi uses mostly the southern route.

An economical transport route to an ocean port is vital to these landlocked countries. Both Rwanda and Burundi are densely populated and these populations are large in comparison

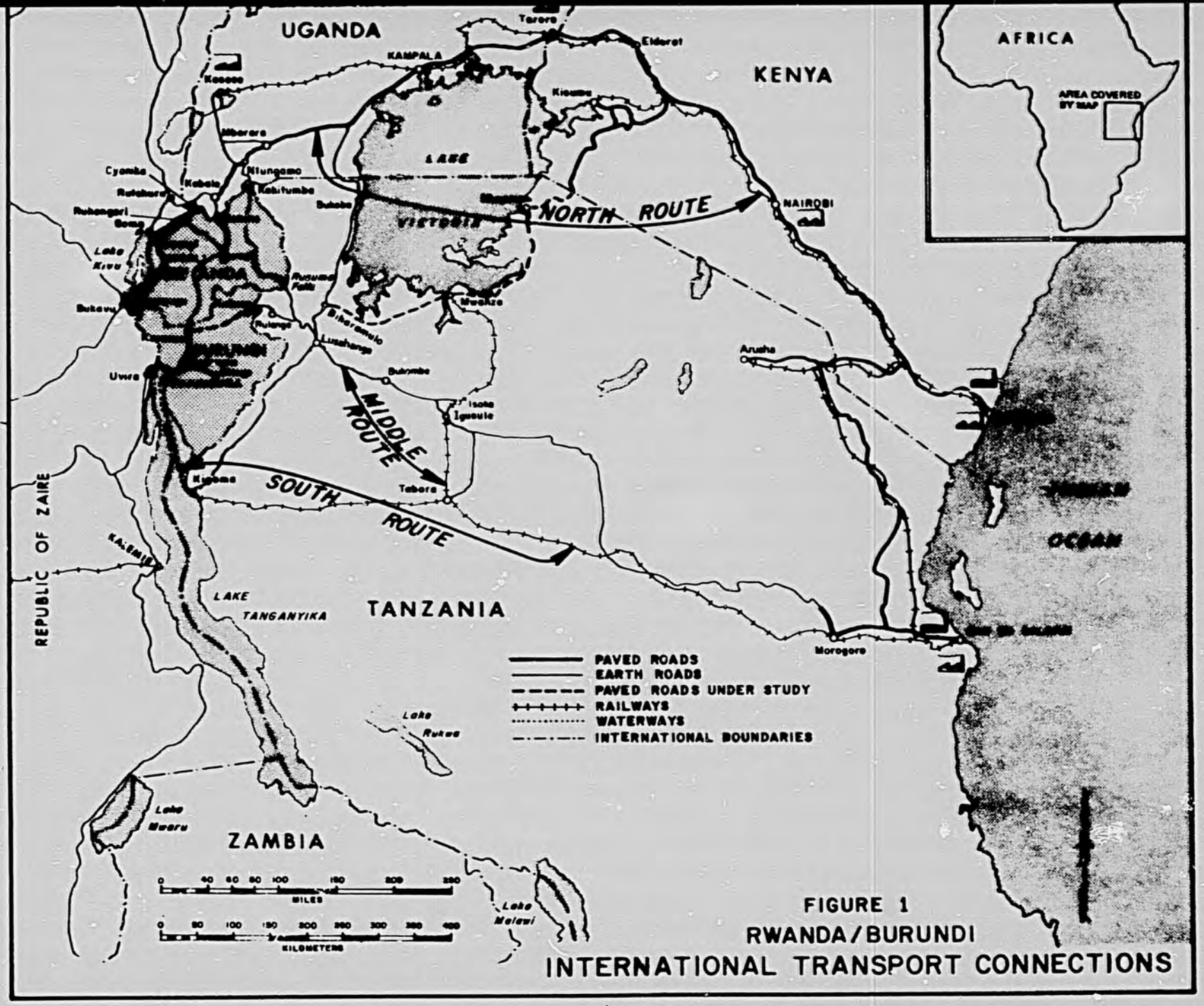

FIGURE 1
RWANDA/BURUNDI
INTERNATIONAL TRANSPORT CONNECTIONS

to their agricultural resources and available arable land. Both nations are heavily dependent on the import of industrial products and a considerable proportion of their primary food needs. Presently, their imports are approximately three times as large as their exports. The existing northern and southern routes present many problems that increase transport costs. The main shortcomings of the existing routes can be summarized as follows:

a. Northern Route:

- Inability to use rail transport due to deterioration of and lack of coordination between the Ugandan and Kenyan railways.

- Consequent shift of the total traffic to road transport and progressive deterioration of the roads in Uganda and Kenya, which is also due (in part) to the overloading of trucks.

- Difficulties and delays due to the fact that three countries and two borders must be crossed, each requiring different and cumbersome customs formalities, axle loading limitations and border crossing charges.

- Frequent delays due to political problems and border closures, particularly in Uganda.

b. Southern Route:

- Antiquated equipment of ARNOLAC, the Lake Transportation Company, providing barge transport between the ports of Bujumbura and Kigoma.

- Inadequate facilities and lack of handling equipment at the port of Kigoma.

- Poorly coordinated Tanzanian railway operations, lack of communications and adequate rolling stock, and deterioration of the permanent way, particularly between Kigoma and Tabora.

- Cargo handling problems and frequent delays in the port of Dar es Salaam.

The proposed middle route, Kigali-Isaka-Dar es Salaam (one transshipment, one border crossing), represents an improvement over the northern route. Its total length (1,478 kilometers consisting of 496 kilometers by road and 982 kilometers by

rail) compares favorably to the existing alternative routes as far as Rwanda's gross surface export/import traffic is concerned.

Northern Route (all road: no transshipments, two border crossings):

Kigali-Kagitumba-Kampala-Mombassa	1,737 kilometers

Northern Route (road/rail: one transshipment, two border crossings):

Kigali-Kampala-Malaba (road)	808 kilometers
Malaba-Mombassa (rail)	1,085 kilometers
Total	1,893 kilometers

Southern Route (road/barge/rail: two transshipments, two border crossings):

Kigali-Bujumbura (road)	285 kilometers
Bujumbura-Kigoma (barge)	175 kilometers
Kigoma-Dar es Salaam (rail)	1,253 kilometers
Total	1,713 kilometers

The middle route, aside from being 235 kilometers shorter than the southern route and 415 kilometers shorter than the northern route for Rwandan traffic, will have less delays en route because only one border crossing and one transshipment will be involved and transport will be via paved highway and an improved railway system. The present problems in the port of Dar es Salaam will also be greatly reduced due to a reduction in Zambian traffic and an anticipated improvement in the evacuation of Zambian imports from the port.

As far as Burundi's gross surface import/export traffic is concerned, the extent of the traffic diversion will depend on the transport cost, distance, number of transshipments and border crossings and time in transit. For Burundi, while the Dar es Salaam-Isaka-Bujumbura route (middle route) is estimated to be a less costly transport route (see Article 4.3.2), the transport cost for this route is only marginally less than the estimated cost of the alternative Dar es Salaam-Kigoma-Bujumbura route (southern route). The transport cost differential between these two routes is probably within the margin of error; consequently, the Dar es Salaam-Isaka-Bujumbura route is not clearly the more economical route. Taking into consideration the comparability of these two routes and the fact that the Dar es Salaam-Isaka-Bujumbura route is 152 kilometers longer and requires an additional border crossing, traffic diversion from Burundi is not likely to be significant unless the transport travel time is reduced.

Thus, with the exception of certain commodities (such as petroleum and coffee) that will continue to be transported on the northern route, the middle route should help considerably to reduce both the costs and delays experienced by the Rwanda gross surface export and import movements, but will have considerably less importance for Burundi's foreign trade.

2.3 PREVIOUS STUDIES

2.3.1 Technical Studies

The preliminary and final design studies for the entire road link from Rusumo Falls bridge to the Isaka railhead were completed by Sir Alexander Gibb and Partners (Africa), Consulting Engineers, in 1975. The total length of the road link is 329 kilometers. Subsequent to completion of the preliminary design the Tanzanian Ministry of Works requested that the project limits be extended from the intersection at Kangogwa, near Isaka, to Nzega. The final design was carried out in four sections, as follows:

Section A: Rusumo Falls-Lusahunga
Section B: Lusahunga-Bukombe
Section C: Bukombe-Isaka
Section D: Kangogwa-Nzega

In general, Section A is on an entirely new alignment and Sections B through D generally follow the alignment of the existing road.

Section A traverses mountainous and densely wooded terrain requiring sizeable cuts and embankments. The other sections generally traverse rolling or flat terrain and therefore involve moderate volumes of earthwork.

The Gibb studies present 1975 construction costs. All sections were designed to a bitumen standard consisting of double bituminous surface treatment. The geometric standards used were those for a two lane road: 6.25 meter wide carriageway and 110 kilometer/hour design speed.

2.3.2 Economic Justification Studies

a. European Economic Commission (EEC)

An economic analysis of the Rusumo-Isaka road was included in the EEC Draft Financial Proposal (1978). Three categories of benefits were identified in this study.

(1) Savings for Rwandan Freight using the Kigali-Dar es Salaam route in 1982 would be $15.00 per ton over the Kigali-Mombasa route. However, this did not take into consideration either the Dar es Salaam or Mombasa port costs and costs caused by delays and the unreliability of present rail service. The net project benefit for Rwandan freight discounted at 10 percent over 20 years was estimated to be $13 million. This assumes that only minor upgrading was required for Section B. In an economic supplement to its financial

proposal, the EEC stated: "inclusion of full capital costs of bitumenising this section...would virtually eliminate the measured net benefits, i.e., reduce the rate of return to zero."

(2) Savings in Vehicle Operating Costs were estimated for only the Bukombe-Isaka section of the road. For 1982 (opening year) the discounted savings were estimated to be $115,000 and expected to increase to $240,000 by the year 2001, with the total discounted savings over 20 years estimated to be $950,000. This report concluded that savings will accrue almost entirely to users of transport for productive or commercial purposes.

(3) Savings in Road Maintenance Costs compared the proposed bitumen road to a gravel road and estimated the 1978 present value to be $2 million, discounting over a 20-year period at 10 percent. The economic internal rate of return for the Bukombe-Isaka section of the project was estimated to be 9.5 percent. The EEC report did not address itself to the question of basic human needs.

b. Rwandaise Ministere des Postes et des Communications

In October 1980, BUNEP (Bureau National D'Etudes et des Projets) completed the phase one report of an economic and technical study entitled "Etude des Installations d'Entreposage a Mombasa." A wealth of economic data and statistics as well as freight rate costs are presented. Detailed port and border crossing time delays and costs are furnished, and port capacities and bottlenecks are also outlined in detail. Primarily, the phase one report is directed towards establishing warehousing facilities at Mombasa for the transportation and storage requirements of Rwanda. However, though mentioned in the report, no economic analysis of the "middle" route was made. It is anticipated that the phase two report (completion date early 1981) will include an analysis of the Rusumo-Isaka link.

c. International Bank for Reconstruction and Development (IBRD)

In early 1980, a report with valuable statistical data was prepared concerning the international transportation bottlenecks affecting Rwanda and Burundi. Basically, the IBRD report was intended to:

(1) Identify all transport studies that could be relevant in identifying external transportation possibilities.

(2) Identify areas where no information is available and where additional information is needed.

(3) Make recommendations to the two governments on the steps they should take to alleviate the existing transport problems.

While the study evolved into a more action-oriented document than a review of other studies, it still did not examine all facets of the subject at hand. This more extensive study was expected to be completed by UNCTAD by the end of 1981.

The IBRD report contains statistical transport cost data and an assessment of all the possible external transport alternatives--on the least-cost basis.

An economic analysis of the Rusumo-Isaka link was performed assuming that the road will be completed by 1985, that the concurrent improvements will be made on the connecting transport links, and that 45 percent of Rwanda's total external traffic will be diverted to the new road. The estimated level of diverted traffic reflects: (a) the anticipated rehabilitation of the Ugandan economy and consequently also its road infrastructure and Uganda's eventual ability to supply some of Rwanda's import needs, and (b) the possibility that oil traffic (originating in Nairobi) may not be diverted to the Isaka route, especially if the Mombasa-Nairobi pipeline is extended. It was therefore estimated that 20 percent of the import traffic from Nairobi, 70 percent of the import traffic from Mombasa and 50 percent of all export traffic will be diverted to the Rusumo-Isaka route.

The Rwanda traffic on the route was projected to increase 5 percent annually through 1985, while local traffic was projected to increase 4 percent per year. The estimated costs consist of construction costs for reconstructing the Rusumo-Isaka road to paved standards ($78 million) and maintenance and resealing costs ($3.8 million). Benefits consist of freight cost savings for Rwanda traffic, maintenance cost savings attributable to improvement of the road surface (from gravel to bitumen) and vehicle operating cost savings for local traffic also resulting from upgrading the road. The results obtained from this analysis were EIRR 9.9 percent and a benefit/cost ratio of 1.2 at an 8 percent discount rate and 1.0 at a 10 percent discount rate.

d. European Economic Commission (EEC)

In July 1980, the EEC performed a study on the middle route (Rusumo-Isaka). Economic internal rates of return (EIRR) had been calculated on two different bases:

(1) On a road user savings calculation, i.e., a comparison of vehicle operating costs on actual and improved roads.

(2) On a cost comparison calculation based on a reduction of length of the middle route in comparison to the northern route. There is also a cost evaluation of road and rail transport between Mombasa and Kampala.

The comparison calculation has been limited to the northern route only. There are two estimated EIRRs. A 5 percent EIRR is arrived at by calculating the benefits of a new road surface alone, and a 13.2 percent EIRR is arrived at by calculating the benefits of a new road and comparing it with two alternative routes: north to Kampala and thereafter by road and rail to Mombasa versus southwest to Kigoma and the railroad connection to Dar es Salaam.

2.4 CONSTRUCTION AND FUNDING

2.4.1 Present Status

a. Design and Construction

As indicated in Article 2.3.1, the design for the entire length of road from Rusumo Falls bridge to the railhead at Isaka (Sections A, B and C) has been completed. Only the first section (Section A) is presently under construction. All three sections were designed as paved roads (double bituminous surface treatment - DBST).

The bids for Section A were submitted at the end of 1977 and the construction contract was awarded in mid 1978 to Impresa del Benaco. Subsequent to the start of construction, Ital-consult, the consultant selected to supervise the construction, determined that there was an insufficient number of drainage structures. Consequently, the drainage was redesigned and the number of reinforced concrete box culverts was increased fourfold. Due to the problems in obtaining additional cement and reinforcing steel, it is anticipated that the completion of the construction of Section A will be delayed by two years. Because of this delay it is anticipated that the construction costs will increase from 134 million T.Sh. to over 200 million T.Sh.

It is expected that the call for bids on Section B will be launched in early 1981, with construction scheduled to start in the summer of that year. The EEC approved total funding for Section B in November 1980.

The status of the planning and design of the new terminal facilities that will be required at Isaka for the transshipment of commodities from road to rail transport is discussed in Article 5.9.6.

b. Funding

The road, for funding purposes, has been divided into three sections, as shown in Table 2.1. Section C of the route was initially budgeted as an improvement of the existing 5.5 meter deteriorated gravel road to an all-weather DBST surfaced road with a 6.5 meter wide carriageway constructed on a new alignment.

This multi-donor project involves the Government of Tanzania, the African Development Bank and the EEC and a proposed contribution by the United States Agency for International Development. Another donor interested in participating in financing the project is the Arab-African Bank (BADEA), however no commitment has been offered.

Table 2.1

RUSUMO - ISAKA ROUTE AND SOURCE OF FUNDING

	KMS	SOURCE OF FUNDING	EST. COST $ MILLION
A. Rusumo -Lusahunga	90.0	African Development Bank (ADB)	10.0
		Government of Tanzania	13.3
B. Lusahunga-Bukombe	126.5	European Economic Comission (EEC)	27.6
C. Bukombe-Isaka	112.5	Agency for International Development (AID)	10.0
		European Economic Comission (EEC)	13.7

Source: USAID/Nairobi
Note: Preliminary estimate for a bitumen surfaced 6.5 meter road.

2.5 POTENTIAL BENEFICIARIES

The prime beneficiaries of the Rusumo-Isaka link are the rural populations of both Rwanda and Burundi and the transport sector itself.

For Rwanda and Burundi, in addition to the vital alternative routes, increased net revenues from exports and the decreased cost of transporting imports would directly benefit the rural population. The road would bring in much needed agricultural inputs to small farmers who would also benefit from the more efficient marketing of agricultural products. Delivery of needed services to the rural population would also be a benefit.

For the transport sector, both Rwanda and Burundi would benefit from savings in total transport costs as well as vehicle operating cost savings. Tanzania would benefit by increased revenues derived from transport and import license fees as well as direct vehicle operating cost savings. Such benefits would be offset by increased maintenance costs (Rusumo-Isaka link) and added congestion to already congested railway and port facilities.

It is not possible to precisely quantify the indirect benefits that would accrue to transit countries (Tanzania, Kenya, Uganda) due to a lack of accurate statistical data plus the time limitation of this study. However, a gross estimate of their transport-related earnings from Rwanda and Burundi (such as custom duties and haulage costs) indicates that in 1977 Kenya earned $21.3 million, Uganda $5.5 million and Tanzania $5.9 million. In addition, earnings to transit countries from goods exported to Rwanda and Burundi were $18.5 million for Kenya, $9.5 million for Tanzania and $1.2 million for Uganda (see Tables 2.2 and 2.3).

The reliance of Rwanda and Burundi on Kenya, Uganda and Tanzania is most evident, but it should also be pointed out that this relationship is not without benefit to the three countries. The types of quantifiable benefits are dual: a) those related to providing transport services, and b) those derived from supplying goods to Rwanda and Burundi. The most proper valuation of these benefits would be the value added computations in the various transport and export activities. Though this was not possible within such a relatively short study, especially in light of data limitations, some idea of the nature of benefits can be obtained from examining gross benefits gained by the transit countries, as presented in Tables 2.2 and 2.3.

Table 2.2

TRANSPORT RELATED EARNINGS FOR TRANSIT TRANSIT COUNTRIES, 1977
(million U.S. dollars)

	From Rwanda	From Burundi	Total
I. Kenya			
Port of Mombasa	4.2	0.3	4.5
Transshipment Mombasa	2.2	0.2	2.4
Road Transport	10.2	1.8	12.0
Customs Bonding	1.5	0.1	1.6
Fees and Licenses	0.6	-	0.6
Airlanding Charges	0.2	-	0.2
II. Uganda			
Road Transport	1.6	0.5	2.1
Fees and Licenses	1.9	0.2	2.1
Customs Bonding	1.2	0.1	1.3
III. Tanzania			
Dar es Salaam	1.1	0.1	1.2
Railway	0.3	3.5	3.8
Kigoma Port	0.8	0.1	0.9

Source: IBRD report, 1980

Table 2.3

EXPORT EARNINGS FOR TRANSIT COUNTRIES, 1977
(million U.S. dollars)

	From Rwanda	From Burundi	Total
I. Kenya			
Exports:			
Petroleum	5.8	0.6	6.4
Cement	0.8	0.1	0.9
Other	7.5	3.7	11.2
Total	14.1	4.4	18.5
(% of Total)	(1.2)	(0.4)	(1.6)
II. Tanzania			
Exports:			
Total	1.3	8.2	9.5
(% of Total)	(0.3)	(1.6)	(1.9)
III. Uganda			
Exports:			
Total	0.5	0.7	1.2
(% of Total)	(-)	(-)	(0.2)

Source: IBRD report, 1980

PROJECT ISSUES AND OBJECTIVES 3

3. PROJECT ISSUES AND OBJECTIVES

3.1 REGIONAL AND NATIONAL OBJECTIVES

The Rusumo-Isaka road link must be viewed primarily as a regional project. The prime beneficiaries are the rural populations of Rwanda and Burundi and northwestern Tazania. Even in this regional context, the road is consistent with Tanzanian national objectives, one of which is the fostering of regional cooperation. This is a proud tradition in Tanzania and one that should not be underestimated. A few examples might illustrate the point are:

- Tanzania was the first country in East Africa to be granted independence, but wished to postpone the date so that it might federate with Kenya and Uganda.

- Tanzania was the prime mover in the formation of the East African Community (EAC).

- Tanzania, at great expense to itself, has for the last 12 years been supplying Zambia with access to the sea. It has also assisted other southern African countries.

Furthermore, Tanzania believes it will benefit substantially, from the development of the Kagera River Basin, in which the road could have a significant role. This subject is covered in detail in Article 3.4 of this report.

Finally, one of Tanzania's objectives is equality in the development of the various regions. The area through which the Rusumo-Isaka road link passes (the Shinyanga Region) has been relatively less developed than other regions of the country.

3.2 PROJECT IMPACT ON BASIC HUMAN NEEDS

The isolation of Rwanda and Burundi is one of the primary constraints to development. The impact of a dependable international link on basic human needs are extremely difficult to quantify.

The purpose of the road link is to increase net profits from exports and decrease the cost of imports. In terms of income generating activities, the project directly addresses basic human needs. In other contexts, such as food/nutrition and shelter, the linkages are either indirect or unquantifiable.

3.2.1 Income Generation

A very strong and direct linkage can be identified between the economics of Rwanda and Burundi and a dependable, efficient route to the sea. The present high transport cost and unreliability of shipment means that consumer items, if available at all, are priced beyond the reach of many.

Lower transportation costs might lead to more essential commodities at more reasonable prices reaching the rural population. Any reduction in transportation cost means greater income to many. Lower transport costs are directly related to the growth of income-generating activities created through the following:

- increased competition due to generated traffic
- stimulus to the growth of rural industry
- increased opportunities for employment outside the agricultural sector
- reduced retail prices for consumer goods and increased crop prices
- increased opportunity for entrepreneurial activity

3.2.2 Food, Nutrition, and Agriculture

Rwanda and Burundi are nations with food deficits; they must import foodstuffs. Both countries have the potential to increase agricultural production in order to keep pace with the growing population. Fertile soil and a favorable climate permit double cropping. However, most farms are less than one hectare and improved farming techniques are practically non-existent. Delivery of agricultural inputs and extension and marketing services are serious constraints to increasing production. Soil erosion is acute. Potentially productive

areas become available when recovered from deforestation, swamps and flooded bottom lands.

There are a number of projects addressing the above problems in Rwanda. A group of donors is assisting in the improvement of the rural roads. USAID is being asked to help reclaim large tracts of land and is also assisting in the extension of rural fish ponds. Other projects deal with agricultural research and extension, credit, food storage and marketing.

In Burundi, USAID is assisting with a seed multiplication project. Future projects in the area of food production are suggested in the USAID-CDSS. Other donor efforts are in the areas of fishing, research and agricultural planning.

In Tanzania, IBRD is assisting the Government of Tanzania in developing the Shinyanga, West Lakes and Kigoma regions. The road will certainly play a role in the delivery of development assistance. The Mwanza/Shinyanga Rural Development Project focuses primarily on increased food production. The $3.6 million agricultural production component will assist with technical packages, village verification trials, research and extension. In addition, the Fifth Highway Project will be involved in upgrading rural roads in these areas.

The Kagera River Basin Organization plans to focus on increasing food production by 3 percent. Among other things, the organization's Phase III report projects that in order to increase food production by 3 percent, 135,000 tons of fertilizer will be required annually. The report states that "a reliable transport link with attendant reduced costs would greatly assist in making large quantities of fertilizer available...at reasonable prices."

The linkages between the road and some of the projects cited above are indirect. The upgrading of rural roads in Rwanda will require equipment and materials delivered from Dar es Salaam. An efficient cost-effective link would be a definite plus. The improved rural roads, in turn, have a direct impact on delivery of technical assistance, credit and inputs such as fertilizer, pesticide and improved seed, distribution and marketing.

Importation of foodstuffs will also be more cost effective with an efficient dependable link to all three areas. The north-western part of Tanzania suffers from periodic drought. The project could facilitate delivery of famine relief to the area. Finally, a road is required for improved distribution from the production point to the consumption point.

3.2.3 Housing

All these areas import construction materials. While available data do not specify the type, these materials probably include cement, metal roofing sheets and nails. It is not possible to specify the extent to which these materials are used for family shelter rather than public and commercial buildings, nor the extent to which these materials are used by the rural poor to improve their dwellings. Most of the rural poor use local materials for construction of shelter and the road would affect this only in as much as lower commodity prices would allow for the substitution of imported building materials.

3.2.4 Health

Rwanda is launching three pilot family planning clinics and plans at least one health center in each of the ten communes or districts. The country promotes preventative (rather than curative) medicine and improved sanitation. The extent to which the availability of building materials for health centers would be facilitated by an improved transport link cannot, however, be accurately quantified.

Improved all-weather roads would provide improved access to medical facilities throughout the year. In areas where public transportation is not available or is limited, it is often because the roads are in such poor condition that buses either cannot or do not pass through the villages on a regular basis. Improved roads would also make it possible to provide medical facilities and supplies on a regular basis to dispensaries, clinics and hospitals located in remote areas. In addition, medical personnel from major hospitals who oversee smaller clinics and dispensaries must now spend a good deal of effort travelling from place to place. Improved roads would reduce travel time and thus improve medical care.

3.2.5 Education

Improved roads would not so much facilitate the access of the population to schools as it would provide a certain and steady means of linking the local primary schools and adult education facilities with their supply centers. The problems of obtaining supplies and of transporting teachers into and out of the villages are the most serious problems concerning the relation of roads with educational facilities. It is believed that improved roads would indirectly lead to higher quality education for both children and adults.

3.3 PROJECT IMPACT ON THE TRANSPORT SECTOR

3.3.1 Rwanda

Prior to 1977 virtually all of Rwanda's external trade was transported overland to the Indian Ocean port of Mombasa via road and railroad through Kenya and Uganda. As a consequence of the war in Uganda, this vital trade route was severed. Costly air transport was instituted as a practical alternative to the surface route to Dar es Salaam by rail to Kigoma, Tanzania then across Lake Tanganyika to Bujumbura, Burundi where transport bottlenecks (at Kigoma port and the Tanzanian railroad) plagued service along this route.

The proposed Isaka-Rusumo road would benefit Rwanda's transport sector by providing access to a second Indian Ocean port (Dar es Salaam) via an alternative surface route. Costly air transport would not be as critical to Rwanda for external trade. Rwanda's dependence on the northern route would also be diminished.

3.3.2 Burundi

The proposed Isaka-Rusumo road is not expected to have a very significant impact on the Burundi transport sector. Presently, the majority of Burundi's external trade is transported across Tanzania from Dar es Salaam to Kigoma. The proposed road would provide an alternative overland route from Bujumbura to Dar es Salaam, bypassing Kigoma port. Because the proposed overland route does not decrease Burundi's dependence on the port at Dar es Salaam and the Tanzanian railroad, this route is not expected to significantly impact the Burundi transport sector.

3.3.3 Tanzania

The most significant impact of the proposed Rusumo-Isaka road will be on the Tanzania transport sector. The proposed road will provide an alternative east-west trunk route enhancing development opportunities in Kihana and the Kagera River Basin. International traffic from Rwanda and Burundi will provide an additional incentive to improve railroad and port operations in Tanzania. The international traffic resulting from the proposed road will increase revenues to Tanzania.

3.4 PROJECT IMPACT ON KAGERA RIVER BASIN

There is no doubt that the Rusumo-Isaka link could have a significant impact on the organization and development of the Kagera River Basin. The Kagera River Basin (an economic grouping of Tanzania, Rwanda and Burundi for regional development, headquartered in Kigali) is planning to develop the land and water resources of this area and train personnel to carry out this development. Potential projects include a hydropower dam at Rusumo Falls, nickel mining on the Tanzania-Burundi border, agricultural projects to increase food production by 3 percent, a fertilizer plant, disease and pest control, agricultural and technical training institutes, the Kagera Sugar Estate and the Kyaka/Kahono Irrigation Project.

The region is landlocked and traffic links with the outside world are long, complicated and very costly. Transport within the Basin is by road, yet most of the existing roads are earth and gravel and are generally very poorly maintained

The Kagera River Basin occupies an area of 60,000 square kilometers--13,300 square kilometers of which are in Burundi, 19,800 square kilometers in Rwanda, and 20,800 square kilometers in Tanzania. The remaining 6,100 square kilometers are within Uganda. The Basin represents about 22 percent of Burundi, 33 percent of Rwanda and 35 percent of West Lake in Tanzania. In that context the project area borders Zaire to the west, Tanzania to the south and east and Uganda to the north. The Basin area is approximately 1,000 kilometers from the Indian Ocean and about 1,900 kilometers from the Atlantic Ocean. The population of the area is estimated to be 6.5 million.

The economy of the Basin is dominated by subsistence agriculture and ranks among the poorest regions of the world. Over 95 percent of the population is engaged in agriculture, largely in the production of food crops. The principal food crops are bananas, beans, maize, cassava and potatoes. The principal cash crops are coffee and tea.

The area has a main road network of some 9,000 kilometers with road densities of 1,600 meters of road per 1,000 population.

There are many long-range plans, such as an extension of the railway from Tabora to the nickel area in the Burundi-Tanzania area and a railway connection between Arusha and Musoma on Lake Victoria, among other regional plans. Most of these ambitious programs will probably not materialize before 1990 or even 2000. Yet there is no doubt that the Rusumo-Isaka link would accommodate plans for the development of the Kagera River Basin without any heavy investment in railway extension lines.

4

GENERAL ECONOMICS, TRAFFIC AND VEHICLE OPERATING COSTS

4. GENERAL ECONOMICS, TRAFFIC AND VEHICLE OPERATING COSTS

4.1 ECONOMIC PROFILE OF RWANDA AND BURUNDI

Efficient and economic external transport is vital to the small landlocked countries of Rwanda and Burundi, both of which have large populations in relation to their agricultural resources and limited industrial production. These countries export only about a third as much as they import.

In this section the most important economic trend of the two countries is outlined. The outlined parameters will be the basic data required to identify the transport demand as well as the future trends and capabilities.

4.1.1 Rwanda

a. General

Rwanda has a population of 4.8 million people, 16,365 square kilometers of land, a population density of over 293 inhabitants per square kilometer and an overall average population growth rate of 3.1 percent per annum. Increased agricultural production just keeps pace with population growth in years of normal harvest. The country is located approximately 1,600 kilometers from the Indian Ocean, which is also an obstacle to its development. Rwanda is mostly hilly country with few flat areas. Marketable resources are limited and few. These facts have created a major dependence on imported goods. National income is derived from exports of coffee, tea, pyrethrum, tin and tungsten. All of these commodities are bulky raw materials requiring special containers or handling.

Table 4.1 indicates Rwanda's estimate of cultivated land and agricultural production for the period 1972 to 1977, as well as the annual average percentage growth rates for the same period. On an overall basis, the growth rates of the agricultural products and the exportable items were both 4.5 percent. Similarly, in terms of land (hectares) farmed, the growth rate was 5.1 percent for agricultural products and 5.0 percent for exportable items. Agricultural products in 1977 are dominated by bananas, followed by sweet potatoes and potatoes, while exported agricultural products are dominated by coffee, tea and pyrethrum.

b. Exports/Imports

The most important export crop is Arabian coffee, accounting for over 50 percent of Rwanda's trade revenue in recent years.

Table 4.1

RWANDA'S ESTIMATE OF CULTIVATED LAND AND AGRICULTURAL PRODUCTION FOR THE PERIOD 1972-1979
(000 hectares and tons)

ITEM	1972 HA.	1972 TONS	1977 HA.	1977 TONS	ANNUAL AVERAGE % GROWTH RATE, 1972-77 HA.	ANNUAL AVERAGE % GROWTH RATE, 1972-77 TONS
AGR. PRODUCTS						
Sorghum	131.0	144.1	145.3	163.8	2.1	2.4
Rice	.6	1.6	1.2	3.3	14.9	15.6
Maize	49.9	49.9	70.0	77.2	7.0	9.1
Potatoes	18.8	131.4	26.8	177.3	7.4	6.2
Sweet Potatoes	72.5	413.6	91.8	702.4	4.8	11.2
Beans	154.6	131.4	213.3	171.6	6.6	5.5
Pears	69.2	55.3	69.4	55.6	.1	.1
Bananas	152.8	1680.6	208.2	1896.3	6.4	2.4
Soya	1.4	1.1	5.7	4.5	32.4	32.6
Other	50.6	393.0	68.9	490.4	6.4	4.5
TOTALS:	701.4	3001.0	900.6	3742.4	5.1	4.5
EXPORTABLE ITEMS						
Coffee	26.9	14.1	28.6	20.7	1.2	8.0
Cotton	.3	.2	.4	.2	5.9	-
Pyrethrum	2.3	1.2	2.5	1.1	1.7	-1.7
Tea	2.5	2.4	5.1	5.4	15.3	17.6
Cinchona	.5	.2	.7	.6	7.0	24.6
TOTALS:	32.5	18.1	37.3	28.0	2.8	9.1
OVERALL:	733.9	3019.1	937.9	3770.4	5.0	4.5

ote: HA. = Hectare, TONS = Metric Tons

ource: Bulletin de Statistique, Ministere Du Plan, Kigali, Rwanda, January 1978.

Table 4.2 indicates the 1975 and 1979 volume of exports by type of commodity. In terms of volume, coffee accounts for 67 percent of the 1979 figures, followed by tea and minerals. On an overall basis, exports increased at a rate of 25.2 percent per annum.

The volume of exports by area of destination for the period 1977 to 1979 is shown in Table 4.3. The 1979 trade indicates that 8 percent of all exports were destined for Europe (Belgium and Luxemburg). However, about 90 percent of the exportable items are auctioned in Mombasa port for various destinations, including the United States.

Imports by area of origin are shown in Table 4.4. Europe and Africa are the principal areas of origin for imports, excluding the petroleum products coming from Middle Eastern countries.

Rwanda's volume of imports by commodity type for the years 1975 and 1979 are shown in Table 4.5. Intermediate goods dominate, accounting for 50 percent of the total imports in 1979, with petroleum comprising 51 percent followed by cement products at 44 percent. Food products equaled 30 percent of the total 1979 import commodities. The annual percentage growth rate for the period 1975 to 1979 was 4.8 percent per annum.

c. External Trade

Rwanda's external trade is shown in Table 4.6 for the period 1970 to 1979. Also, the percentage of total external trade attributable to imports and exports is shown in this table as well as average annual percentage growth rates for the periods 1970-1979 and 1975-1979. On an overall basis for the period 1970 to 1979, imports consisted of almost 80 percent of the total tonnages. Rwanda's imports in 1977 were approximately 160,000 tons while exports were about 46,000 tons.

Total external trade (and consequently transport demand) increased at a rate of 7.1 percent in Rwanda during the period 1970-1979 and 5.2 percent for the period 1975-1979 (see Table 4.6). However, most of the increase has resulted since 1975 with an annual average growth rate of 5 percent in imports since that year. Although both Rwanda and Burundi would like to decrease the growth of imports by means of import substitution, possibilities for realizing this goal are limited due to: a) the small size of domestic markets, b) Rwanda's limited absorptive capacity because of the low level of domestic savings and lack of skilled labor, and c) the limited amount of available natural resources.

The Rwandan Government is interested in expanding the agricultural sector for the purpose of decreasing imports and

Table 4.2

RWANDA'S VOLUME OF EXPORTS BY COMMODITY TYPE, 1975 AND 1979
(000 metric tons)

COMMODITY	1975	1979	PERCENTAGE OF 1979
Coffee	20.1	31.5	67
Tea	3.1	5.0	11
Minerals	2.5	2.9	6
Hides	0.5	0.8	2
Others	0.2	6.7	14
TOTAL:	26.6	46.9	100

Table 4.3

RWANDA'S VOLUME OF EXPORTS BY AREA OF DESTINATION, 1977 AND 1979

(000 metric tons)

DESTINATION	1977	1979	PERCENT OF 1979
UROPE	5.6	3.9	8
FRICA	1.3	0.4	1
MERICA	0.1	0.2	-
THERS	24.1	42.4	3
NNOMINATY TO OMBASA 1/	22.4	41.1	88
TOTAL:	31.1	46.9	100

Table 4.4

VOLUME OF IMPORTS BY AREA OF ORIGIN, 1977 AND 1979

(000 metric tons)

	1977	1979	PERCENT OF 1979
UROPE	36.5	47.8	30
FRICA	39.3	46.9	30
MERICA	8.1	6.2	4
SIA	53.1 2/	55.9 2/	36
THERS	-	.4	-
TOTAL:	137.0	157.2	100

1/ Auctioned in Mombasa and shipped mainly to the United States.

2/ Petroleum products shipped indirectly through Kenya.

Source: Ministere Du Plan, Kigali

Table 4.5

RWANDA'S VOLUME OF IMPORTS BY COMMODITY TYPE, 1975 AND 1979
(000 metric tons)

		1975		1979		PERCENT OF 1979
Food Products		40.3		47.2		30
Textiles		6.8		7.7		5
Miscellaneous		4.9		6.3		4
Capital Goods		13.5		17.3		11
Intermediate Goods		64.9		78.7		50
Cement	17.2		34.4		44	
Petroleum	30.5		40.2		51	
Other	17.2		4.1		5	
TOTAL:		130.4		157.2		100

Source: Ministere Du Plan, Kigali

Table 4.6

EXTERNAL TRADE OF RWANDA,
1970 - 1979
(000 metric tons)

YEAR	IMPORTS	PERCENTAGE OF TOTAL EXTERNAL TRADE	EXPORTS	PERCENTAGE OF TOTAL EXTERNAL TRADE	TOTAL
1970	89.3	81	20.9	19	110.2
1971	89.7	80	22.4	20	112.1
1972	97.8	84	18.8	16	116.6
1973	78.1	74	27.6	26	105.7
1974	97.2	73	36.7	27	133.9
1975	130.4	78	36.1	22	166.5
1976	141.5	75	47.6	25	189.1
1977	137.0	81	31.1	19	168.1
1978	181.8	86	30.0	14	211.8
1979 1/	157.2	77	46.9	23	204.1
AVERAGE ANNUAL GROWTH RATE (in percent)					
1970 - 1979	6.5		9.4		7.1
1975 - 1979	4.8		6.8		5.2

1/ Estimates

Source: Ministere Du Plan, Kigali

increasing exports. Food imports now account for 30 percent of the total imports (see Table 4.5), whereas agricultural exports constitute almost 80 percent of the total exports (see Table 4.2). However, it will not be easy to change the existing situation because almost all potential agricultural land is already utilized and any increase in agricultural production would result from either improved yields and/or multiple cropping. Furthermore, given the rapid population growth rate, domestic agricultural production would have to increase dramatically before imports would decline.

Other than agricultural products, the only other important exports are minerals. Production of cassiterite, a tin ore, has been stable at approximately 2,000 metric tons per year since 1976. There are plans to construct a 3,000 metric ton facility by the year 1981 to handle initial processing of the ore in order to export a higher value ore of less volume with subsequent transport savings. Additional mineral production is uncertain because there has not been a complete mineral survey.

Certain regional developments could affect Rwanda's demand for external transport, but this is not likely to occur in the near future. Reconstruction and stabilization of the Uganda economy could obviously be of major importance, i.e., rehabilitation of the cement plant at Hima (western Uganda) would alter current traffic flows. On the other hand, Tanzania's plans for industrialization of the Lake Victoria region could be significant, especially with development of the Rusomo-Isaka route. However, this is extremely uncertain within the near future. Under the existing circumstances, external traffic levels will continue to be low in absolute terms and also will continue to be highly unbalanced with imports far exceeding exports.

d. Existing Transportation

All Rwanda's external traffic is now carried either on the northern route or by air transport. However, none of these alternatives is without major problems.

(1) Northern Route. The northern route through Uganda and Kenya to Mombasa presently carries 75 percent of Rwanda's trade (although in 1977 more than 80 percent was transported over this route).

Goods are shipped all the way by road (1,740 kilometers to Mombasa from Kigali), although a partial rail link between Kampala and Mombasa exists (rail link 1,337 kilometers, total Kigali-Mombasa 1,845 kilometers). A railway line running more or less parallel to this road exists between Mombasa and Kampala. The Mombasa-Kampala railway is, at present, hardly

used, with almost all of the total cargo being transported by truck. This route is not obstacle free (for example, road sections in Uganda need improvement, there are long waits at customs on the borders and there is poor security within Uganda).

Table 4.7 shows the external trade as the percent of total international traffic transported via different routes for the period 1973-1979. Through 1977, Rwanda's trade was transported over the northern route. However, during the years 1978 and 1979, the percentage of cargo transported over this route dropped due to the political situation in Uganda. Consequently, there was an increase in air freight tonnage from 12.3 metric tons in 1977, to 22.3 metric tons in 1979, representing almost a 35 percent growth rate increase per annum.

(2) Traffic Handling and Road Transport. International transport to Rwanda from Mombasa and Nairobi is handled by forwarding companies that negotiate contracts with individual truckers. The international trucking fleet by ownership is as follows:

Country of Ownership	Percent to Rwanda	Percent to Burundi
Kenya	65	80
Uganda	10	
Rwanda	25	
Burundi	-	20

The most important carriers are KENTACO (a Kenyan company) and STIR (a Rwandan company), each of which carries about 25 percent of the traffic on this route. Several small Ugandan and Kenyan operators also operate on the northern route.

The Societe des Transports Internationaux de Rwanda (STIR) was created in 1974 and has a fleet of 110 trucks, including 58 tankers, which carry Rwanda's oil imports. Although the company is managed well, it faces problems, such as obsolete equipment, lack of spare parts, inadequate maintenance facilities, and other related problems. Distribution within Rwanda is performed by medium size indigenous trucking companies.

(3) Air Freight Traffic. Air freight traffic for Rwanda was relatively insignificant until the last few years when events beyond the country's control resulted in a modal diversion with air transport becoming the alternative to surface transportation. Air Rwanda, the state-owned airline, purchased a used Boeing 707 cargo plane from Air France. This cargo plane makes an average of 10 trips per week to Mombasa transporting coffee exports and durable goods imports. Table 4.8 presents Rwanda's external traffic by mode for the period

Table 4.7

EXTERNAL TRADE TRANSPORTED
VIA DIFFERENT ROUTES, 1973-1979
(as percentage of total transport)

ROUTES	1973	1974	1975	1976	1977	1978	1979
NORTHERN	86.3	85.9	83.9	81.9	80.2	72.3	74.9
SOUTHERN	10.6	9.2	7.7	7.8	5.0	3.6	1.1
OTHER	2.4	2.8	2.8	5.2	2.5	2.3	1.7
AIR	0.7	2.1	5.6	5.1	12.3	21.8	22.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Ministere Du Plan, Kigali
Rapport sur les goulets d'etranglement
dans les transports internationaux
dont suffrent le Rwanda et Burundi, Vol. II, 1980,
International Bank for Reconstruction and Development

Table 4.8

RWANDA'S AIR VS. COMMERCIAL TRANSPORT, 1975-1979
(000 metric tons)

	IMPORTS		EXPORTS	
YEAR	SURFACE	AIR	SURFACE	AIR
1975	130.4	2.2	36.1	3.4
1976	141.5	2.1	47.6	3.0
1977	137.0	3.0	31.1	9.3
1978	181.8	10.0	30.0	11.8
1979	157.2	10.8	46.9	11.5

Source: Etude des Installations d'Entreposage à Mombasa, BUNEP, Kigali.

1975-1979. Since 1975, Rwanda's total air freight (both imported and exported) has increased almost fivefold, largely due to the coffee airlift to Mombasa, which began in 1977. In 1979, the proportion of imported cargo via air was 7 percent of the total imported tonnage, while for the exported cargo the proportion of air versus commercial was 25 percent (see Table 4.8).

4.1.2 Burundi

a. General

Burundi is a small landlocked country located in Central Africa, 1,400 kilometers from the nearest port, Dar es Salaam, on the Indian Ocean. It has a land area of slightly over 25,000 square kilometers and a population of 3.9 million people. Along with Rwanda, it is one of the most densely populated countries in Africa with 156 inhabitants per square kilometer.

The country is divided into three main ecological zones. The most densely populated and important area is the central plateau with a range of 1,500 to 1,900 meters altitude. The second zone includes the plains and intermediate zone with altitudes of 700 to 1,500 meters. The third zone is the high Zaire-Nile Crest with altitudes of 1,900 to 2,500 meters.

Very little reliable data are available about Burundi and few statistical series have been constructed to show trends. However, estimates have been made by various foreign and domestic specialists, including the Burundi Planning Ministry, which prepared the 1978-1982 Plan Document. Population during the same period has been variously estimated to have risen at a rate of 2.2 percent to 2.6 percent per year.

Burundi is essentially an agricultural country with 90 to 95 percent of the population actively participating in agriculture and livestock. The economy of Burundi is dominated by subsistence agriculture. The total tonnage of exports represents far less than one-third of import tonnage. The only urban area in Burundi is the capital, Bujumbura, with an approximate population of 155,000. It is also the center for manufacturing, food processing and trade.

Table 4.9 presents the land use of various surfaces of the country and its development. In 1978, of the total 2.7 million hectares (about 200,000 are lake), about 1.4 million were considered suitable for cropping and the remainder for forest,

Table 4.9

BURUNDI'S LAND USE
1978 TO 1982
(000 hectares)

DISTRIBUTION	1978	1979	1980	1981	1982
Non-arable land	163.5	166.0	167.5	168.8	170.0
Forests	89.0	95.0	102.0	109.0	117.0
Export Cropland	57.0	63.1	69.9	74.7	75.3
Food Crops	1220.9	1231.6	1242.1	1252.4	1276.3
Available land	139.2	123.5	118.0	107.7	83.8
Grassland	867.9	853.9	838.6	825.6	815.8
Cultivated Ha. for Food Crops	659.9	652.3	664.9	677.7	690.6

Source: Ministere Du Plan, Annexe III du Plan Quinquennal, 1978 - 1982.

waste or urban and village use. Of the potentially arable land, about 57,000 hectares were in export crops (coffee, tea and cotton), about 1.2 million in food crops and about 140,000 uncultivated.

While the population has been increasing at a fairly rapid rate, agricultural production appears to have stagnated during the last few years. The pressure of population on available resources is becoming increasingly severe, nutrition levels are deteriorating and the land is being over-exploited.

Finally, while the agricultural sector accounts for 90 to 95 percent of the employment, it generates only about 65 percent of the Gross Domestic Product (GDP). Except for a few export crops (coffee, tea and cotton), the agricultural sector is almost entirely at the subsistence level.

Like Rwanda, Burundi is particular interested in further developing the agricultural sector in order to decrease imports and expand exports. However, it will not be easy to change the existing situation because almost all potential agricultural land is already utilized.

Agricultural products are dominated by bananas, sweet potatoes, manioc and maize, while the principal agricultural exports are dominated by coffee, tea and cotton. Generally, agricultural exports have not been increasing significantly in total tonnage exported over the period 1973 to 1978 (see Table 4.10). The total estimated production, farm use and marketable quantities show a 1.3 percent annual growth rate.

b. Exports/Imports

Practically all of the exports from Burundi are agricultural products. Even before the recent upsurge in coffee prices, coffee alone accounted for about 85 percent of all export earnings, while tea, cotton and hides together accounted for only 6 to 10 percent. Future export earnings and Burundi's balance of payment clearly will be heavily dependent on future coffee prices.

The volume of exports by commodity type for 1975 and 1979 is shown in Table 4.11. As noted in the table, 81 percent (or 27 of the 33 metric tons exported in 1979) is coffee. Cotton is the next most significant export followed by tea. Overall exports have increased at the rate of 1.43 percent annually.

The volume of exports by area of destination for the period 1977 to 1979 is shown in Table 4.12. The 1979 trade indicates that 52 percent of the exportable commodities were destined for Europe (Federal Republic of Germany and France).

Table 4.10

BURUNDI'S AGRICULTURAL PRODUCTION FOR THE PERIOD 1973-1978
(000 metric tons)

COMMODITY	1973	1974	1975	1976	1977	1978	1973-78 VERAGE ANNUAL PERCENTAGE GROWTH RATE
Coffee	21.5	28.1	16.9	21.2	21.4	22.7	1.1
Tea	0.7	0.9	0.8	1.1	1.4	1.3	13.2
Cotton	4.6	4.5	3.8	3.0	5.2	3.6	- 4.8
Haricots	291.1	232.1	294.0	300.4	307.0	220.0	- 5.5
Bananas	1250.1	1242.0	1262.8	1290.5	1320.0	1200.0	- 0.8
Manioc	386.8	389.4	390.6	393.4	396.0	450.0	3.1
Potatoes	35.5	28.4	35.9	36.6	37.0	30.0	- 3.3
Sorghum	20.9	16.7	21.1	21.5	32.0	33.0	9.6
Sweet Potatoes	398.6	318.6	402.6	411.4	420.5	564.0	7.2
Maize	135.8	108.9	137.1	138.5	140.0	160.0	3.3
Rice	4.8	6.2	6.7	6.7	7.0	6.3	5.6
Dates	9.4	10.5	11.6	11.6	11.5	16.0	11.2
Other	236.2	179.1	247.0	249.1	237.0	279.1	3.4
Production:	2796.0	2565.4	2830.9	2885.0	2936.0	2986.0	1.3
Farm Use:	559.2	513.1	565.2	577.0	587.2	597.2	1.3
Marketable:	2236.8	2052.3	2265.7	2308.0	2348.8	2388.8	1.3

Source: Ministere Du Plan, Donnees Macro-Economiques 1974-1979, Bujumbura.

Table 4.11

BURUNDI'S VOLUME OF EXPORTS BY COMMODITY TYPE, 1975 AND 1979
(000 metric tons)

COMMODITY	1975	1979	PERCENTAGE OF 1979
Coffee	26.5	26.8	81
Tea	0.9	1.5	5
Cotton	0.8	1.8	6
Asbestos	1.2	0.2	1
Other	1.4	2.3	7
TOTAL:	30.8	32.6	100

Source: Ministere Du Plan, Bujumbura

Table 4.12

BURUNDI'S VOLUME OF EXPORTS
BY AREA OF DESTINATION, 1977 AND 1979
(000 metric tons)

DESTINATION	1977	1979	PERCENTAGE OF 1979
EUROPE	10.9	16.9	52
AFRICA	1.5	2.6	8
AMERICA	6.6	10.2	31
OTHERS	1.8	2.9	9
TOTAL:	20.8	32.6	100

Source: Ministere Du Plan, Bujumbura

Imports by commodity and by area of origin are shown in Tables 4.13 and 4.14. Intermediate goods dominate with 65 percent of total imports (in 1979), out of which cement and petroleum products accounted for 27 percent and other intermediate goods for 38 percent. Food products follow with 26 percent of 1979 imports. The annual percentage growth rate for the period 1975 to 1979 was 14.32 percent per annum.

c. External Trade

Burundi's external trade is presented in Table 4.15, which covers the period 1970 to 1979. Over the 10 year period imports represented 76 percent of the total tonnage of external trade. However, for the past three years (since 1977) the imports represented 80 percent of the total external trade tonnage. Burundi's imports in 1979 were 140,000 tons while exports were about 33,000 tons.

Total external trade or transport demand grew at a rate of 5.8 percent in Burundi during the period 1970-1979, and 10.6 percent for the period 1975-79 (see Table 4.15). However, most of the increase has occurred since 1977, and has largely been due to an annual average growth rate of 7 percent in imports since that year. The Burundi Government is interested in decreasing the growth of imports by means of import substitution. However, such possibilities are limited, mainly due to the small size of domestic markets, lack of skilled staff and limited available resources. Burundi is also anxious to produce cement locally since external sources of supply are erratic and high transport costs add to price increases. A preliminary geological survey by UNDP has revealed some limestone deposits, but further studies are needed to determine commercial viability of these deposits. While surveys and studies will continue it is unlikely that Burundi will attain self-sufficiency in the near future.

Burundi is very interested in developing the agricultural sector in order to decrease imports and increase exports. However, this will not be easily accomplished because almost all potential agricultural land is already utilized. Furthermore, domestic agricultural production would have to increase dramatically before imports would decrease.

The only other non-agricultural exports are mineral products. No complete mineral surveys have been carried out and so far the only potentially exploitable mineral resources are the nickel deposits in southeastern Burundi. Actual project implementation is unlikely for several years.

Certain regional developments could affect Burundi's demand for external transport. Reconstruction and stabilization of the

Table 4.13

BURUNDI'S VOLUME OF IMPORTS
BY COMMODITY TYPE, 1975 AND 1979
(000 metric tons)

		1975	1979		Percent of 1979
Food Products		24.5	36.6		26
Textiles		3.6	5.1		4
Other Consumption Goods		4.9	7.3		5
Capital Goods		5.0	6.3		4
Intermediate Goods		44.6	92.3		65
Cement	19.0			26.8	
Petroleum	18.7			27.2	
Other	6.9			38.3	
Total:		82.6	141.2		100

Source: Ministere Du Plan, Bujumbura

Table 4.14

VOLUME OF IMPORTS BY AREA OF ORIGIN, 1977 AND 1979

(000 metric tons)

	1977	1979	Percent of 1979
EUROPE	35.4	39.6	28
AFRICA	33.3	28.2	20
ASIA	38.1	52.2	37
- Percent oil products	(24.6)	(33.7)	-
AMERICA	6.3	8.5	6
OCEANIA	0.1	11.3	8
OTHERS	2.0	1.4	1
TOTAL:	115.2	141.2	100

Source: Ministere Du Plan, Bujumbura

Table 4.15

EXTERNAL TRADE OF BURUNDI
1970-1979
(000 metric tons)

YEAR	EXPORTS	PERCENT OF TOTAL	IMPORTS	PERCENT OF TOTAL	TOTAL
1970	31.4	30	73.6	70	105.0
1971	30.2	25	90.2	75	120.4
1972	34.7	26	98.2	74	132.9
1973	30.8	28	80.2	72	111.0
1974	27.1	23	89.8	77	116.9
1975	30.9	27	85.1	73	116.0
1976	27.7	25	85.0	75	112.7
1977	20.8	15	115.2	85	136.0
1978	32.1	20	125.4	80	157.5
1979	32.6	19	141.2	81	173.8
AVERAGE ANNUAL GROWTH RATE (in percent)					
1970 - 1979		0.4	7.5	5.8	
1975 - 1979		1.4	13.5	10.6	

Source: Ministere Du Plan, Bujumbura

Ugandan economy would obviously be significant. Rehabilitation of the cement plant at Hima (in western Uganda) may divert current traffic flows for certain commodities, such as cement, from the Rusumo-Isaka route.

d. Existing Transportation

All of Burundi's external traffic is now transported either overland by the southern route or by air. However, these routings present some major problems.

(1) Southern Route. The southern route consists of transport by barge from Bujumbura to Kigoma, Tanzania (175 kilometers) and by rail from Kigoma to Dar es Salaam (1,255 kilometers). About 76 percent of Burundi's external traffic was transported via this route in 1979.

Service on the southern route is constrained by three bottlenecks:

(a) The low productivity of the port of Dar es Salaam causes lengthy delays in cargo handling. Furthermore, if Zambian traffic flows were redirected to Dar es Salaam, the port's capacity would again be overtaxed (presently Zambian traffic is diverted to South African ports).

(b) The most severe bottleneck on this route is the rail line crossing Tanzania. Inadequate capacity of the line is in part attributable to management, a shortage of rolling stock and poor communications.

(c) Operations at Kigoma port have suffered from the port's layout and lack of equipment, which cause periodic congestion and backups. These problems have been exacerbated by the lack of coordination among the railway, AMI (which operates the port) and ARNOLAC, the lake transportation company. The performance of ARNOLAC is hampered by an obsolete barge fleet and managerial and operational difficulties.

Table 4.16 shows the 1979 external trade transported via the different routes. Table 4.17 indicates the 1978 and 1979 imports transported via different routes. As noted in Table 4.17, air freight has increased by more than 50 percent.

(2) Traffic Handling and Road Transport. International traffic to Burundi is handled by forwarding companies that negotiate contracts with individual trucking companies. The trucking fleet by country of ownership is dominated by Kenya and Uganda with 80 percent, followed by Burundi with 20 percent. INTRACO, a Burundi transport firm owned in part by the government, has a fleet of 20 trucks with an additional

Table 4.16

BURUNDI IMPORTS - 1979 EXTERNAL TRADE
TRANSPORTED VIA DIFFERENT ROUTES
(as percentage of total transported)

ROUTES	FUEL	FOOD & CONSUMPTION GOODS	EQUIPMENT	CAPITAL GOODS
Kigoma	76	74	76	50
South(Kalemi)	1	-	-	33
North	22	9	12	14
Air	-	12	4	1
Other	1	5	8	2
Tota	100	100	100	100

Source: Ministere Du Plan, Bujumbura

Table 4.17

BURUNDI'S 1978 AND 1979 IMPORTS
TRANSPORTED VIA DIFFERENT ROUTES
(as percent of total transported)

ROUTES	1978	1979
Kigoma	77.6	64.0
South(Kalemi)	10.5	15.1
North	8.2	14.8
Air	1.4	2.2
Other	2.3	3.9
Total:	100.0	100.0

Source: Ministere Du Plan, Bujumbura

37 trucks on order. Domestic transport is performed by indigenous operators.

(3) Air Freight Traffic. Air transport for Burundi was relatively insignificant until the last few years when events beyond the country's control forced them to turn to air as an alternative to surface transport. Air freight traffic for Burundi for the period 1974 to 1979 is shown in Table 4.18. On an overall basis, 2 percent of the total external traffic was carried by air, of which 2 percent were imports and 5 percent were exports. During the last five years air freight traffic increased almost 400 percent.

Table 4.18

BURUNDI'S AIRFREIGHT TRAFFIC
FOR THE PERIOD 1974-1979
(000 metric tons)

YEAR	IMPORTS	PERCENT	EXPORTS	PERCENT	TOTAL
1974	0.6	55	0.5	45	1.1
1975	0.6	60	0.4	40	1.0
1976	0.8	67	0.4	33	1.2
1977	1.2	67	0.6	33	1.8
1978	1.6	53	1.4	47	3.0
1979	2.2	58	1.6	42	3.8
	(2.0) 1/		(5.0) 1/		(2.0) 1/
AVERAGE ANNUAL GROWTH RATE (IN PERCENT)					
1974 - 1979	29.7		26.2		28.1
1977 - 1979	35.4		63.3		45.3

Represents percentage of total transport in the country

Source: Ministere Du Plan, Bujumbura

4.1.3 Northwestern Tanzania

A brief economic profile will be given for the project area "Zone of Influence," which is mostly within the regions of Shinyanga and West Lake.

a. Shinyanga

This region does not have a large agricultural output. The main crop is cotton, followed by rice, coffee, sorghum, onions, groundnuts and livestock. There are also cultivated areas of woodlands on the Lusahunga-Biharamulo area. Generally, the Shinyanga Region is one of the poorest in Tanzania. The region has three districts: Kahama, Maswa, and Shinyanga. The total land area is 31,536 square kilometers (Kahama 12,389; Maswa 13,274; and Shinyanga 5,873). There are no watersheds in the province and the average rainfall is about 975 millimeters.

Of the total population in northwest Tanzania, about 200,000 people reside within 20 kilometers of the Rusumo-Isaka route. Most of the road corridor has a population density of less than 35 persons per square kilometer because the area west of Kahama is infested with tsetse. Kahama is the main commercial city in the area and it would benefit from the road improvement.

b. West Lake

West Lake Region is situated in the northwest corner of Tanzania and is the major producer of cotton, coffee, bananas and plantains; it is the second major producer of rice, cured tobacco, sweet potatoes and sugar. It also produces pyrethrum.

West Lake Region has four districts: Bukoba, Ngara, Karagwe and Biharamulo. The total land area is 17,860 square kilometers (Bukoba 4,988; Ngara 1,770; Karagwe 4,334; and Biharamulo 6,758). The total water area consists of 6,758 square kilometers.

The Rusomo-Isaka road will benefit West Lake although it is likely that cotton will continue to be shipped via Mwanza. Imports, however, may be transported via Isaka.

4.2 PROJECTED FOREIGN TRADE TRANSPORT DEMAND FOR RWANDA AND BURUNDI

4.2.1 Methodology

Both for Rwanda and Burundi a series of growth rates have been received from their Economic Planning Office. Also, in Burundi and Rwanda several recent macro-economic internal studies have been completed. All the available material has been reviewed by the study team. Forecast growth rates on imports and exports have been treated with caution. The main approach used in projecting the transport demand for the countries involved was to apply an average of the high and the low growth rates, for purposes of this study.

4.2.2 Rwanda

The basic and historical analysis of the economy of Rwanda is discussed in Article 4.1.1 of this report.

Average annual growth rates for imports have been estimated based on information obtained from various reports and interviews conducted by the project team. Total imports are projected to increase at the following average annual rates:

1979 - 1985	6%
1985 - 1990	5%
1990 - 1995	5%
1995 - 2004	5%

It is anticipated that transport of cement and fuel will continue to be routed through the northern route. This is based on several factors: a) the planned westward extension of the Mombasa-Nairobi white-oil pipeline and b) reconstruction of the Hima cement plant in western Uganda and plans for a cement plant in Rwanda. It is estimated that fuel and cement imports will account for the following percentage of total imports:

1979 - 1985	33%
1985 - 1990	25%
1990 - 1995	25%
1995 - 2004	25%

Air transport will also continue to provide an alternative mode of transportation for imports and exports. However, because of high aircraft operating costs, in comparison with surface transport costs, it is anticipated that only 2.5 percent of the import traffic will be transported by air.

Exports comprise approximately one-third of the import tonnage with agricultural products (coffee and tea) accounting for 63 to 77 percent of the total tonnage. Most export commodities are transported to Mombasa where the products are sold at auction on the international market. It is anticipated that most agricultural commodities will continue to be sold through the Mombasa market, and consequently, transport of agricultural exports will continue either via surface transport along the northern route or air transport. Minerals and other non-agricultural commodities may be exported either via Dar es Salaam or Mombasa. These commodities are estimated to comprise from 22 to 30 percent of the total exports.

Exports are projected to increase at an average annual growth rate of 4 percent through 1990, then remain relatively constant through 2000. Projected population increases, resulting in an increased demand for foodstuffs, may inhibit any increase in cash crops produced for export.

A summary of the projected transport demand for Rwanda is presented in Table 4.19.

4.2.3 Burundi

Like Rwanda, imports comprise the majority of Burundi's international transport demand. The growth rate of imports has substantially exceeded the growth rate of exports. This trend is expected to continue well into the future subject to continued foreign development assistance.

Based on information obtained from various recent reports and interviews conducted by the project team, imports are estimated to increase at an average annual growth rate of 4 percent per year throughout the forecast period.

While virtually all of the import tonnage will continue to be transported over land, air transport will remain a viable alternative that attracts a minor percentage of the import tonnage. During the past few years approximately 2 percent of the import tonnage was transported by air. It is anticipated that 2 percent of the future import tonnage will also be transported by air. Consequently, it is likely that the balance of the import tonnage will be transported overland on the most economical and expedient route.

While exports are projected to increase somewhat over the short term, the rate of growth is expected to be substantially less than the import growth rate. This is attributable to the high percentage of agricultural products among the commodities exported, the limited crop land available for planting, and the uncertainty regarding development of nickel deposits in southeastern Burundi. Over the long term it is likely that the

Table 4.19

RWANDA TRANSPORT DEMAND FORECAST

	Imports (in thousand metric tons)				Exports (in thousand metric tons)		
Year	Total	Air	Fuel & Cement	Gross Surface Imports 1/	Total	Agricultural 2/	Gross Surface Non-Agricultural 3/
1979	157.2	10.8	74.6	71.8	46.9	36.5	10.4
1985	225.0	5.6	74.2	145.2	75.0	52.5	22.5
1990	285.0	7.1	71.2	206.7	90.0	63.0	27.0
1995	365.0	9.1	91.2	264.7	90.0	63.0	27.0
2000	465.9	11.6	116.5	337.8	90.0	63.0	27.0
2004	566.3	14.2	141.6	410.5	90.0	63.0	27.0

1/ Indicates import tonnage, which could potentially be diverted to the proposed route through Tanzania.

2/ Agricultural commodities are anticipated to continue to be sold through the Mombasa market; they are therefore not likely to be transported via the proposed route through Tanzania.

3/ Indicates export tonnage, which could potentially be diverted to the proposed route through Tanzania.

export tonnage will stabilize as agricultural production reaches peak crop production levels. On this premise, it is estimated that the export tonnage will increase at an average annual rate of 2 percent per year through 1990, at which time peak production is projected. Thereafter, the export tonnage should remain relatively constant.

Because of the high proportion of agricultural products among the exports and the characteristics of the world coffee market, some export crops will continue to be transported by air. In recent years, approximately 4 percent of the export tonnage was transported by air. For purposes of this report, it is estimated that 3.5 percent of the export tonnage will be transported by air with the balance transported by surface modes.

A summary of the projected transport demand for Burundi is presented in Table 4.20.

Table 4.20

BURUNDI TRANSPORT DEMAND FORECAST

IMPORTS (000 metric tons)				EXPORTS (000 metric tons)		
			GROSS SURFACE			GROSS SURFACE
YEAR	TOTAL	AIR	IMPORTS 1/	TOTAL	AIR	EXPORTS 2/
1979	141.2	3.1	139.1	32.6	0.5	32.1
1985	180	3.6	176.4	35.0	1.2	33.8
1990	220	4.4	215.6	45.0	1.6	43.4
1995	265	5.3	259.7	45.0	1.6	43.4
2000	324	6.4	317.6	45.0	1.6	43.4
2004	379	7.6	371.4	45.0	1.6	43.4

1/ Indicates import tonnage, which potentially could be diverted to proposed alternate route.

2/ Indicates export tonnage, which potentially could be diverted to proposed alternate route.

4.3. PRESENT TANZANIA TRAFFIC

4.3.1 General

In Tanzania the Ministry of Communications and Transport has the responsibility for undertaking traffic counts. A relatively good traffic counting system existed in the past and fairly reliable and detailed traffic count information is available for the entire trunk road network up to 1974. However, the system has deteriorated, and traffic counts are now undertaken only sporadically.

4.3.2 Rusumo-Isaka Existing Traffic

In 1974 Sir Alexander Gibb and Partners conducted three-day, 24-hour vehicle counts. These traffic counts were carried out at the junctions at Masumbwe, Bukombe, Kangongwa and Busoka. The results were as follows:

Road Section			Vehicles Per Day (vpd)
Masumbwe	to	Kahama	22
Masumbwe	to	Bukombe	22
Masumbwe	to	Mbogwe	0
Bukombe	to	Kahama	15
Bukombe	to	Mbogwe	0
Bukombe	to	Biharamulo	15
Kangongwa	to	Isaka	57
Kangongwa	to	Nzega	31
Kangongwa	to	Kahama	84
Busoka	to	Kahama	80
Busoka	to	Bukombe	39
Busoka	to	Geita	41

Sir Alexander Gibb's traffic analysis concludes that of the estimated 80 vpd travelling between Kahama and Isaka, 60 percent consist of heavy vehicles (of which 40 percent are country buses) and 40 percent are light vehicles (of which 70 percent are Land Rovers or similar vehicles). Between Kahama and Bukombe a 60 vpd was considered near the average (1973-1974) daily traffic.

The Gibb report occasionally contradicts itself concerning traffic flows. In one chart it shows traffic for Section I at 20 vpd and 40 vpd for Sections II and III. In other places Section II has 20 vpd and Section III has 60 to 80 vpd. It projects 50 vpd for Section I and II for the year of opening, divided evenly between light and heavy vehicles, and 75 to 100 vpd (60 percent heavy vehicles) for Section III for the year of opening. It also projects a 9 percent per year growth in total

traffic and 5 percent per year growth rate for heavy vehicles or truck traffic.

The EEC has estimated the Average Daily Traffic (ADT) for the route to be:

Trucks, 12 tons	8 vpd
Buses	4
Cars/Land Rovers	12
Pickups	5
Total	29 vpd

It also projects a 7 percent per year growth in local traffic. Generated traffic is assumed to be 20 percent of the existing traffic in 1983, 40 percent in 1984 and 60 percent from 1985 onwards.

The Consultant conducted a two-day traffic count on October 29 and 30, 1980. The results were as follows:

Location	Date & Time	Trucks	Buses	Land Rovers	Pick-up Trucks	Cars	Total
Border to Rulenge	10/29/80 1130-1450	6 (HV = 67%, LV = 33%)	2	3	-	1	12
Rulenge to Lusahunga	10/29/80 1520-1900	3 (HV = 56% LV = 44%)	2	2	2	0	9
Lusahunga to Kahama	10/30/80 0600-1200	20 (HV = 60%, LV = 40%)	6	13	2	2	43
Kahama to Isaka	10/30/80 1400-1600	5 (HV = 50%, LV = 50%)	2	1	2	4	14

HV = Heavy Vehicles
LV = Light Vehicles

These counts were taken for only two days and cannot be considered as representative of the AADT for each section of the road. However, they give the order of magnitude to establish the basic traffic.

As mentioned earlier, the Ministry of Communications and Transport in Tanzania is responsible for traffic counts, which are now taken sporadically. Traffic counts were obtained for only

several links for 1978 and 1979. These were two- and three-day, 16-hour counts, unadjusted and for a total of 28 stations (20 for 1978 and 8 for 1979). However, no growth rate trends can be determined since the 1979 counts apply to different stations than those furnished for the year 1978. Out of the nine links requested, traffic counts were obtained for only one link, Kahama-Nyanganazi (5 Land Rovers, 1 bus, 14 trucks: total ADT equals 20 vpd).

4.3.3 Base Year Traffic Estimate (1980)

Given the inadequacy of EEC and MOW traffic data, it was deemed best to establish the 1980 traffic on the basis of the Gibb traffic surveys expanded by an overall average percentage growth rate of 2 percent per annum, reflecting the relatively poor condition of the existing road and recent socioeconomic conditions of the region.

The available traffic count information on the Rusumo-Isaka route and the Consultant's estimates for 1980 can be tabulated as follows:

	Consultant			
	Gibb 1974	EEC 1980	MOW 1979[1]	Estimated 1980 Existing Traffic
Rusumo/ Lusahunga	20			23
Lusahunga/ Kahama	40		20	45
Bukombe/ Kahama	60			68
Kahama/ Isaka	80			90
Overall Route		29		

[1] MOW, Dar es Salaam, Tanzania. The MOW traffic figure is for the road link from Kahama up to Nyanganazi, located 6 kilometers from Lusahunga City. The traffic projections beyond 1980 are discussed in Article 6.4.

The vehicle mix along the Bukombe-Isaka section of the Isaka-Rusumo road, based on traffic counts conducted by the project team, is estimated to be 50 percent heavy vehicles (of which 60 percent are country buses and 40 percent are 12-ton trucks) and 50 percent light vehicles (principally Land Rovers and pickup trucks).

The projection of traffic after 1980 is discussed in Article 6.4.

4.4 VEHICLE OPERATING COSTS

Representative vehicle operating costs (VOC) for Tanzania have been obtained from a recent transport and logistics study of Dodoma, Tanzania.[1] Financial and economic vehicle operating costs by cost component for representative vehicle types and road surface conditions were obtained. These costs are summarized in Table 4.21 for five representative light and heavy vehicles and three road surface conditions (earth road facilitating an overall average speed of 48 kilometers/hour, gravel at 56 kilometers/hour and bituminous paved surface at 72 kilometers/hour).

Components included in developing these vehicle operating costs were:

- fuel consumption
- oil consumption
- tire consumption
- maintenance and spare parts
- maintenance and labor
- depreciation
- interest
- insurance
- crew time (commercial vehicles)

In reviewing the Dodoma study vehicle operation cost methodology, it is found that the following parameters were considered:

- Consideration was given to the price distortions arising from overvalued exchange rates, duties, tariffs, legislated minimum wages and unrealistic interest rates and other distortions of the equilibrium price structure.

- A shadow costed foreign exchange rate is taken at 20/75 T.Sh. per U.S. dollar. This reflects the consultant's estimate of the extent of the devaluation (2.5) that would be necessary (defined as non-capital goods imports equals exports plus debt service on borrowed money) if the Tanzania shilling was freely exchanged.

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[1] Dodoma Transport and Logistics Study, the United Republic of Tanzania, Capital Development Authority, prepared by Brokonsult AB for the United Nations, Vol. III, Annex V, 1977.

Table 4.21

VEHICLE OPERATING COSTS - TANGENT TWO-LANE ROAD

(T.Sh./Km)

VEHICLE TYPE	ECONOMIC GRAVEL 1/	ECONOMIC PAVED
Automobile	6.41	4.38
Light van	8.64	7.34
45-seat bus	17.87	11.09
12-ton truck	20.62	12.34
32-ton truck trailer	29.30	17.58
	FINANCIAL	
Automobile	3.90	2.80
Light van	4.92	4.16
45-seat bus	10.07	6.84
12-ton truck	10.96	6.59
32-ton truck trailer	15.23	9.21

Note: All costs updated to 1980 prices assuming an annual inflation rate of 15 percent.

1/ Upgraded existing road VOC adjusted to reflect difference with ΔL for less than adequate surface width (see Article 4.5)

Source: Dodoma Transport and Logistics Study, The United Republic of Tanzania, Capital Development Authority, prepared by Brokonsult AB for the United Nations, Vol. III, Annex V, 1977.

- Taxes and duties are excluded from the economic vehicle operating costs.

- Unskilled labor wage rates are adjusted downward to 60 percent of the minimum wage, reflecting the opportunity cost and economic cost of unskilled labor in Tanzania.

Based on the above considerations, adjustments were made by Brokonsult AB to establish a more realistic estimate of the scarcity value of capital, labor and foreign exchange resources in Tanzania. These adjustments were necessary to properly reflect the existing condition of the Tanzanian economy, where there is an acute shortage of foreign exchange and investment funds are limited.

In view of the fact that this Consultant found the approach reasonable, the methodological procedures followed in the Dodoma study were adopted for this study. The existing vehicle operating cost was updated to reflect 1980 costs in Tanzanian shillings with an assumed average annual inflation rate of 15 percent.

The main vehicle operating cost components (as of December 1980) as well as the consumption figures used are summarized as follows:

1. FINANCIAL AND ECONOMIC VEHICLE OPERATING COST COMPONENTS, T.Sh.

ITEM		FINANCIAL	ECONOMIC
Fuel:			
Gasoline		7.74/lt.	11.18/lt.
Diesel		4.30/lt.	7.88/lt.
Oil		22.12/lt.	37.61/lt.
Tires and Tubes:			
Car, 4		452	961
Pick-up, 4		1,350	2,868
12-ton truck, 6		5,350	11,370
32-ton truck, 16		5,380	11,400
Bus, 6		6,121	13,000
Insurance/Year:			
Car		5,830	5,830
Pick-up		9,450	9,450
12-ton truck		25,950	25,950
32-ton truck		42,240	42,240
Bus, 45 seats		47,470	47,470
Driver Salary/Year:			
Pick-up		12,000	12,000
12-ton truck	12,000	33,268	33,268
Assistant	9,200		
+ 10 nights/month @ 50.28	12,068		
32-ton trailer	12,000	42,100	42,100
Assistant	12,000		
+ 15 nights/month @ 50.28	18,100		
Bus	14,520	38,180	38,180
Conductor	9,180		
+ 12 nights/month @ 50.28	14,480		
Mechanics Hourly Wage:		40.23	40.23

2. VEHICLE PRICES, T.Sh.

Vehicle Type	Financial Cost	CIF Value	Local Completion	Mark-Up	Economic Cost
Car	158,898	65,370	-	31,780	195,100
Pick-up	251,420	148,840	-	72,410	444,510
12-ton truck	854,825	562,840	50,285	201,135	1,546,730
32-ton trailer	1,307,380	684,000	122,700	364,050	2,369,370
Bus	879,000	261,480	281,590	283,600	1,430,690

Note: Tires and tubes excluded from calculations.

Financial Cost = CF value + 20 percent duty and local completion and mark-up - except for automobiles for which duties and taxes are T.Sh. 61,000.

Economic Cost = 2.5 x foreign exchange component (CIF price + 50 percent of local completion) + local component (50 percent of local completion cost + 100 percent mark-up).

3. ANNUAL KMS - PAVED ROADS

Car	20,000
Pick-up	25,000
12-ton truck	35,000
32-ton truck	35,000
Bus	35,000

4. VEHICLE CHARACTERISTICS

Type	Typical Make/Model	Kms/Lifetime, Paved Roads
Car	Datsun 1600	150,000
Pick-up	Landrover	200,000
12-ton truck	Fiat	600,000
32-ton trailer	Fiat	600,000
Bus	Leyland	450,000

CONSUMPTION FIGURES

	EARTH(48km/hr)	GRAVEL(56km/hr)	PAVED(72km/hr)
Fuel			
Car, lt/km	.1310	.1105	.1000
Pick-up, lt/km	.1695	.1755	.1500
12-ton truck, lt/km	.4182	.3612	.2800
32-ton trailer, lt/km	.5526	.4773	.3700
Bus, 45 seats, lt/km	.4168	.3225	.2500
Oil			
Car, lt/km	.0008	.0006	.0006
Pick-up, lt/km	.0023	.0018	.0013
12-ton truck, lt/km	.0083	.0056	.0040
32-ton trailer, lt/km	.0125	.0084	.0060
Bus, lt/km	.0064	.0043	.0031
Tirewear			
Car	7.70	4.40	2.00
Pick-up	6.25	3.20	1.60
12-ton truck	12.57	5.71	2.86
32-ton trailer	20.11	9.14	4.57
Bus	7.59	3.46	1.71
Maint. and Labor(Hrs/Km)			
Car	.0016	.0011	.0007
Pick-up	.0035	.0017	.0017
12-ton truck	.0069	.0035	.0021
32-ton trailer	.0092	.0046	.0028
Bus	.0139	.0069	.0042

TECHNICAL ANALYSIS 5

5. TECHNICAL ANALYSIS

5.1 PHYSICAL CHARACTERISTICS OF THE PROJECT AREA

5.1.1 Location

The project road, from Bukombe to Isaka, 112.5 kilometers long, is located within the Kahama District of the Shinyanga Region of Tanzania. The new road, as designed by Sir Alexander Gibb and Partners (Africa), Consulting Engineers, follows the existing road very closely. The project traverses a region where the predominant activity is subsistence agriculture (sorghum, corn, bananas and livestock). The project begins 1 kilometer southeast of the village of Bukombe, passes through the city of Kahama and terminates 350 meters east of the railroad tracks near the Isaka railway station.

5.1.2 Topography

The project traverses either gently rolling or flat terrain. Of the total length of 112.5 kilometers, approximately 57.5 kilometers consist of rolling and 55.5 kilometers of flat terrain. The elevations vary from 1,140 to 1,260 meters above sea level. In general, the western half (kilometer 0 to 65) drains in a southerly direction (Lake Tanganyika drainage basin), and the easterly half (kilometers 65 to 112.5) drains in a northerly direction (Lake Victoria drainage basin).

5.1.3 Climate

The climate of the project region is characterized by temperatures which do not change annually and vary from a maximum of 28 degrees Centigrade during the day to a minimum of 17 degrees Centigrade at night. The mean annual rainfall varies from 800 to 1,000 millimeters and occurs mainly from November to April.

5.1.4 Geology

The geological formations vary along the project road. From Bukombe to Kahama the rocky substrata consist of granites of Plutonic origin with banded ironstone of the Musoma series found mostly north of the road. From Kahama to Isaka one finds decomposed and weathered materials of recent and Pleistocene periods, such as Kanozoic sand, silt, limestone and mud in the low-lying drainage zones.

5.1.5 Soils and Construction Materials

The project area consists of weathered phylite and quartzite soils as well as black silty clays. The silty clays occur

mostly in swampy areas and at valley bottoms. There are frequent areas where gravel can be found, suitable for use as roadway subbase.

Rock outcrops are available for use as a source of crushed stone aggregates for surfacing and base course. The natural gravels are phylitic, quartzitic or lateritic. The rock is granite or granite gneiss.

The subgrade CBR values (based on the materials report by Sir Alexander Gibb) range from less than 4 percent to more than 25 percent, the low values being in silty clay soils. Of the total of 80 samples taken at approximately 1.5 kilometer intervals in the course of Sir Alexander Gibb's studies, only 23 had a CBR of less than 4 percent.

5.1.6 Drainage

The proposed project road is crossed by numerous water courses, most of which flow only during the rainy season. The existing road has one 16 meter span bridge, eight bridges having spans ranging from 6 to 1.25 meters, seven small box culverts and numerous pipe culverts. Except for bridges, the location of cross drainage is not well defined due to frequent long stretches of flat terrain. There is only one major watercourse crossing at kilometer 8+800 (Kigoji River). This stream was also dry during the site visit on October 29, 1980.

5.2 DESCRIPTION OF EXISTING ROAD

5.2.1 Alignment

The horizontal alignment of the existing road is quite good and only a relatively short portion (several stretches, totalling approximately 14.3 kilometers) needs to be realigned. The horizontal alignment needs improvement primarily between kilometers 0 to 8, 56 to 58, 65 to 69 and 99 to 101, as well as at several other segments.

The vertical alignment is also generally good, and improvements are needed only at drainage structures, usually where a "bump" exists because the roadbed was built close to the adjacent terrain and insufficient cover exists over the drainage structures. In general the vertical grades are flat (1 percent or less) and only at one location (kilometer 4) does the grade attain 5.7 percent. At several stretches where existing road is too close to the elevation of adjacent terrain, the profile grade should be raised to improve its condition with respect to drainage.

5.2.2 Roadway Surface

The road surface exhibits a lack of adequate maintenance and considerable erosion due to traffic wear. The roadway cross section shows the typical Tanzanian road features: edge of road ridges behind which are the parallel drainage ditches and the herringbone outlet ditches. The herringbone outlet ditches serve to reduce the runoff accumulation in the parallel ditches and thus reduce erosion in them, particularly on steep downgrades. Due to excessive wear and lack of regravelling, the existing roadway surface, for most of the project length, consists of two deep tracks and a central ridge, which frequently is high enough to drag against the bottoms of passenger vehicles. The surface appeared to be very rough from kilometer 0 to kilometer 3. For the rest of the project length it was possible to maintain an average speed of 60 kilometers/ hour. At most culverts it was necessary to slow down to avoid "flying over" the sudden bump in the profile grade. The central and roadway edge ridges consist mostly of loose gravel and fines, while the material in the travelled track "grooves" was mostly laterite and accumulated fines. Thus, a dangerous situation occurs every time it is necessary to pass a vehicle, whether one is coming from the opposite direction or trying to pass a slower moving vehicle. The cloud of dust severely curtails vision and the loose central and edge ridges, which must be mounted to change lanes, make it difficult to control the vehicle. Although the roadway width averages between 6 and 7 meters, the condition of the road surface (travelled grooves) essentially reduces road operations to one lane.

The roadway surface is somewhat better between Kahama and Isaka than between Bukombe and Kahama. A short length of the road within the Kahama city limits (western half) is paved but the pavement looked considerably deteriorated.

5.2.3 Drainage and Drainage Structures

As mentioned earlier, the road was constructed close to the adjacent ground for most of its length. With the wear due to traffic and due to the lack of periodic regravelling, the roadway surface is frequently below the adjacent ground. It thus becomes a drainage ditch during the rainy season. This condition further reduces the already inadequate road conditions.

Most of the drainage structures were found to be in fair to good condition. Only the smaller diameter corrugated metal pipe (CMP) culverts, which for the most part did not have any endwalls, appeared from time to time to be damaged where the pipes protrude into the side ditch. The locations of most of the pipe culverts were indicated by vertical wood posts. The bridges and the box culverts were generally narrower than the graded roadway width (3.5 to 4 meters at bridges and approximately 5 meters at box culverts).

5.2.4 Present Maintenance

The road did not appear to have been recently regravelled, although gravel material piles were noted all along the project length, particularly west of Kahama. A few of the gravel piles (small mounds spaced approximately every 3 to 4 meters along one of the road edges) appeared old and eroded by the rains. A few labor crews were noted cutting vegetation and cleaning ditches. During the visit to the Shinyanga regional road maintenance facilities the Consultant was informed by the Assistant District Engineer that the following maintenance was performed in the area of the project road:

- Regravelling from Ushirombo (25 kilometers west of Bukombe) to Kahama in 1977, approximately.
- Regravelling from Kahama to Isaka in 1979.
- Routine maintenance, approximately every six months, usually after the rainy season, from Ushirombo to Isaka.

It was observed during the visit to the Shinyanga facilities that several pieces of road construction equipment parked in the yard appeared to be inoperable. The Consultant was told of problems faced by the regional authorities: lack of spare

parts, extreme scarcity of experienced and skilled personnel, lack of operating funds, etc. Even the funds needed to pay the personnel were frequently delayed. The Shinyanga Region is very large (50,790 square kilometers) and much too wide spread for the regional maintenance authorities to handle with the personnel and equipment at their disposal. The only shop capable of maintaining the equipment is in the city of Shinyanga. The equipment, when it needs maintenance work, must frequently be sent a considerable distance to be serviced. Due to a lack of spare parts, equipment repair takes a long time; often, spare parts are cannibalized from other equipment and adapted for use.

The Consultant also observed the only piece of equipment stationed near the project road: a scraper at the Comworks shed at Ushirombo.

5.3 POPULATION AND ECONOMIC ACTIVITIES

5.3.1 Population Density and Growth Rate

Based on the 1978 Tanzania Population Census (the results of which were published in November 1980), the Shinyanga and the West Lake (Kagera) regions are among the more densely populated areas of Tanzania. The results of the census for the Shinyanga Region, where the project is located, as well as of some of the adjacent regions, are shown in Table 5.1.

5.3.2 Population in the Zone of Influence of the Rusumo-Isaka Road

Of the three road segments from Rusumo to Isaka, the first and the last segments are the most densely populated. The estimated population of the road's zone of influence (the area adjacent to the road approximately 10 kilometers wide on each side of it) is shown in Table 5.2.

The zone of influence (ZI) would further extend along the connecting main and feeder roads, as illustrated in Figure 2. The distance can be assumed to be a function of the convenience to travel via the new road to the larger centers of economic activity, such as the city of Kahama, Isaka railhead, and the cities of Nzega and Shinyanga. It is logical to assume that the road's ZI would extend along the entire length of the road connecting Kibondo to Biharamulo (160 kilometers) since both cities, although important local economic centers, are presently difficult to access. With an approved road, Kibondo and Biharamulo will be able to access Kigali and Shinyanga with an estimated travel time saving of 2.5 hours each.[1] Similarly, both centers will be able to access Shinyanga with a saving in time of at least 2 hours.[2]

If one assumes that the population of Rwanda and Burundi benefitting from the Rusumo-Isaka road is equal to the population of the portions of the two countries included in the Kagera Basin territory, another 5.86 million people would be included in the population ultimately benefitting from the Rusumo-

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[1] Time savings on the Rusumo-Lusahunga segment, which takes four hours by old roads and one hour by the new road.

[2] Approximately 260 kilometers to Isaka by existing road (Lusahunga-Isaka), which presently takes five hours and which by new road (240 kilometers) would take three hours at most.

Table 5.1

POPULATION DENSITIES AND GROWTH RATES
IN SELECTED AREAS OF TANZANIA, 1978

AREA	DENSITY(INHAB/KM^2)	ANNUAL GROWTH RATE (%) (AVG. LAST 5 YEARS)
Tanzania (entire country)	19.8	3.3
Shinyanga Region	26.1	3.6
West Lake Region	35.5	4.0
Tabora Region	10.7	4.5

Table 5.2

POPULATION IN THE ROAD'S ZONE OF INFLUENCE
RUSUMO TO ISAKA ROAD

ROAD SEGMENT	AREA (Sq. Km)	POPULATION (1978)	
		DENSITY(INHAB./KM^2)	TOTAL
Rusumo - Lusahunga	8,000	27	216,000
Lusahunga - Bukombe	3,400	10	34,000
Bukombe - Isaka	7,300	30	219,000
Rusumo - Isaka	18,700	25.08	469,000

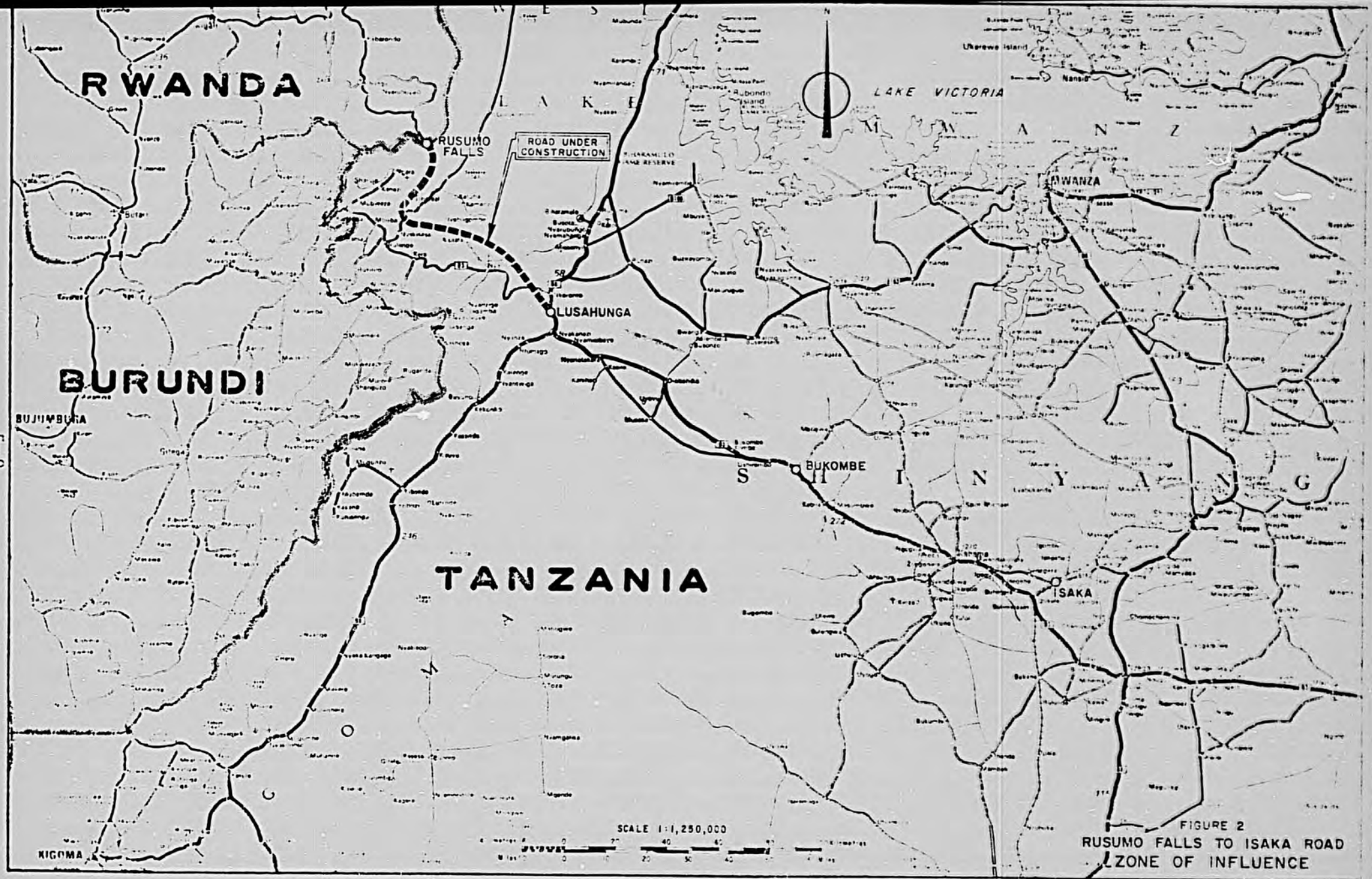

FIGURE 2
RUSUMO FALLS TO ISAKA ROAD
ZONE OF INFLUENCE

Isaka road.[1] Thus the total area and population benefitting from the road would be as follows:

Year	Area (Sq. Km)		Population	
	(A)	(B)	(A)[1]	(B)[2]
1978	51,840	7,300	6,330,000	219,000
1990	51,840	7,300	8,610,000	314,000
2000	51,840	7,300	11,020,000	414,000

(A) Entire ZI of Rusumo-Isaka road Tanzania plus Kagera Basin portions of Rwanda and Burundi.

(B) Bukombe-Isaka segment ZI (Tanzania only).

5.3.3 Economic Activities and Land Use

a. Kagera Basin (Rwanda and Burundi Portions)

The economy is dominated by subsistence agriculture. The principal food crops are bananas, beans, rice, maize, cassava and potatoes. The principal cash crops are tea and coffee. At present there are no export or cash producing activities in the basin except for coffee and tea.

The Kagera Basin has potential for future development of energy resources (wood, peat, hydropower and methane), mining (nickel ore in Burundi), agriculture (by fertilization and irrigation), agro-industry (due to plentiful labor force), tourism (game reserves) and fishing (in rivers and reservoirs if hydropower is developed).

b. Tanzania Portion of the Road's Zone of Influence

The Tanzanian portion of the ZI is characterized by subsistence agriculture and livestock production. A considerable portion of the ZI consists of woodlands: along the Rusumo-Lusahunga segment and occasionally along the Lusahunga-Bukombe segment.

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[1] Based on 1973 census figures increased by estimated growth rates by the Secretariat of the Kagera Basin Organization (KBO): 2.8 percent for 1973-1978, 3 percent for 1978-1990 and 2.8 percent for 1990-2000.

[2] Using Tanzania 1978 census data and an average growth rate of 3.6 percent until 1990 and 3.1 percent from 1990 to 2000.

In the first 35 kilometers of the Bukombe to Isaka segment, the soil has medium to low fertility and the principal food crops are groundnuts, sorghum, maize, bananas and cassava beans. The principal cash crops are sisal and cotton, although these are not cultivated extensively.[1]

From kilometer 35 to Kahama the soil has extremely low fertility and livestock production predominates. From Kahama to Isaka the soils are alluvial and colluvial and have considerable agricultural potential; however, they are in need of runoff control and drainage management. A dam near Kahama exists but its function is drinking water impoundment rather than flood control.

In the western segment of the ZI (west of Lusahunga) there is the potential for timber exploitation (Muninga hardwood). Near Biharamulo (north of Lusahunga) and along the Kigosi and Moyowasi rivers (south of Lusahunga) there are game reserves that could be exploited for tourism development.

Due to the Tanzania Government's UJAMA villagization program, the population has been relocated in recent years from their small villages to larger villages in the same general region. The effect of the UJAMA program was particularly noticeable along the Bukombe-Isaka road segment where many villages that were shown to be adjacent to the road on the 1975 plans of Sir Alexander Gibb were no longer where indicated when the Consultant visited the project.

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[1] Cotton predominates in the West Lake Region. In the general area near the road, cultivation activities are very limited due to village relocation caused by the in-progress UJAMA village program.

5.4 ROAD DESIGN STANDARDS

5.4.1 Ministry of Works Design Standards

The Tanzanian Ministry of Works (MOW) classifies its roads primarily in accordance with their administrative and regional importance and to a lesser degree on the basis of their functional and traffic volume characteristics. Technical standards are not tied to the official classification but tentative design requirements, based on the road classification, are given in the MOW Roads Manual, which is presently being drafted.

The Rusumo-Isaka road is classified as a trunk road or a road serving as an international and main internal through route.

Based on this classification, the tentative MOW design standards call for:

Carriageway Width (m)	Shoulders (m)	Bridge Loading	Right-of-Way Width (m)
6.5	1.5	BS 153 HA or AASHO HS 20-44	45

The minimum design speed depends on the terrain characteristics. For rolling to flat terrain, which is the case of the Bukombe-Isaka segment, a 100 kilometer per hour design speed is recommended. No requirement exists as to whether a trunk road should be paved or not. Geometric design criteria are tied to design speed. The question of road surface type is discussed further in Article 5.7.

5.4.2 Design Standards for the Rusumo Falls to Bukombe Road Segments

The design standards used for the entire length of the road from Rusumo Falls bridge to Isaka and from the Kangogwe intersection, 22 kilometers west of Isaka, to Nzega include:

- Paved carriageway, 6.5 meters wide, with 1.5 meters gravel shoulders.

- Geometric standards (horizontal and vertical) consistent with 110 kilometers per hour design speed, except at major intersections and within the Kahama city limits.

- Drainage standards based on the rainfall intensities corresponding to one in five years (pipe and box culverts) and one in 25 years (bridges) storms and floods.

- Box culverts and bridges designed to British Standards BS 153 Part 3, Section A (1954) and/or American Standards H-20-516-44 loadings, whichever governs, with 7.5 meter carriageways and two 0.75 meter wide sidewalks.

- Paving consisting of double bituminous surface treatment. The first seal coat consists of 80/100 penetration grade bitumen applied at an average rate of 1.7 liters/square meter and stone chippings spread at the rate of 60 square meters/cubic meter. The second seal coat consists of the same components spread at 1.1 liters/square meter and 82 square meters/cubic meter, respectively.

- Base course 15 centimeters deep and 6.7 meters wide.

- Subbase 20 centimeters deep and 7.0 meters wide.

The same standards are used by Sir Alexander Gibb and Partners for the design of the Bukombe-Isaka and Kangogwe-Nzega sections.

5.4.3 Design Standards Selected for Study

Due to the fact that the Bukombe-Isaka road is a segment of an international road link as well as part of the Tanzanian national trunk road system, and at the direction of the Client, road design standards similar to those of the Rusumo to Lusahunga section have been selected for final analysis.[1]

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[1]The Rusumo Falls to Lusahunga segment is already under construction to bitumen standard and the funds for the construction of the Lusahunga-Bukombe segment, also to bitumen standard, were approved by EEC in October 1980. Both segments have present and projected traffic significantly lower than that projected for the Bukombe-Isaka segment.

5.5 ROAD CONSTRUCTION COSTS

5.5.1 Construction Alternatives

Because of the relatively low traffic volume anticipated for the Bukombe to Isaka road, it is appropriate to consider the economic advantages of a lower standard construction or staged construction in order to minimize the initial investment and insure that investment costs will be commensurate with the user and maintenance cost savings to be obtained from the road improvement or from each increment that the road's carriageway surface is upgraded.

For final analysis, the following construction alternatives have been selected for evaluation:

- Alternative No. 1: Upgrade the existing road to its original gravel standard without changing either its alignment or drainage but including in the construction cost the required routine maintenance of slopes, drainage ditches and drainage structures. The existing road has a 5.5 meter wide carriageway and is 117.5 kilometers long.

- Alternative No. 2: Construct a gravel road on new alignment (112.5 kilometers in length) with a 6.5 meter wide carriageway.

- Alternative No. 3: Same as Alternative No. 2 but with the carriageway surface paved with double bituminous surface treatment.

5.5.2 Estimate of Construction Quantities

For the purposes of determining the construction quantities, or of establishing the Bill of Quantities, simplified procedures have been used by taking advantage of the design plans and the Bill of Quantities for the Bukombe-Isaka road as prepared in March 1975 by Sir Alexander Gibb and Partners (Africa), Consulting Engineers. In fact, their design constitutes Alternative No. 3.

Thus it may be stated that the Bill of Quantities for Alternative No. 2 is quite accurate since it is a simple matter to subtract the paving quantities from Alternative No. 4 to obtain the cost of Alternative No. 2 and, of course, allow an adjustment in the mobilization and other items.

For the estimate of quantities of Alternative No. 1, judgmental factors were used from data available in Sir Alexander Gibb's plans and knowledge of the conditions of the existing road,

obtained during the site visit in November 1980. The Bill of Quantities for Alternative No. 2 is the same as that of Alternative No. 3, increased by the paving quantities. Thus, the only approximate Bill of Quantities is the one for Alternative No. 1. The rest of the Alternatives are a matter of simple additions or subtractions using Sir Alexander Gibb's data.

a. Road Treatment within Kahama City Limits

It was assumed that in the case of all alternatives the road within the Kahama city limits (2 kilometers) would be paved. At present the road is paved except for a length of approximately 0.9 kilometers in the western part of the city. The total additional investment represents an insignificant percent of the total cost.[1]

b. Upgrading of Existing Road

The existing road, in its present condition, cannot be properly maintained because its surface is heavily rutted. In order to improve the existing road to a maintainable condition, it is necessary to excavate what is left of its pavement structure down to subgrade and reconstruct the gravel base (5.5 meters wide). The work would include the following:

- excavation of the existing base
- blading and shaping the subgrade
- construction of a new base
- routine maintenance of drainage structures and ditches
- resealing of 2 kilometers of paved road within the Kahama city limits

5.5.3 Updating of Unit Prices

a. Sources of Construction Cost Data

The original project cost estimate dates from 1975. During the field visit to the project, the Consultant made a field reconnaissance of the Rusumo-Lusahunga project under construction by the Italian contractor Impresa del Benaco. During the visit with Benaco, construction problems, imported material supply difficulties, general logistics and construction prices were discussed. Benaco has kindly provided the Consultant with the unit prices and other cost details as bid by Benaco in 1978. Benaco has also provided 1980 costs for petrol, bitumen,

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[1] Approximately 480,000 T.Sh. (in 1975) or 0.3 percent of the total gravel road cost.

cement, reinforcing bars, etc., which, when compared to the costs of the same materials in 1978, provided a guideline for the estimation of the rate of increase in construction materials from 1978 to 1980.

During the Consultant's meetings with the MOW in Dar es Salaam, construction costs were obtained from bids for several recent road construction projects. Unfortunately, it was not possible to compare these costs to those of Sir Alexander Gibb in the Bill of Quantities for the Bukombe-Isaka project, in part because of a different type of base course and paving and in part because of a lack of detailed cost data. These costs were used mainly to indicate the approximate cost/kilometer of road construction.

b. Comparison of Sir Alexander Gibb and Benaco Unit Prices

Six principal (in terms of percent of total cost) prices of certain Bills of Quantities were compared:

- Bill No. 4, Drainage
- Bill No. 5, Earthworks
- Bill No. 6, Shoulders, Subbase
- Bill No. 7, Crusher Run Base Course (BC)
- Bill No. 8, Bituminous Surfacing (DBST)
- Bill No. 9, Bridge Work and Culverts

From these, certain representative groups of items of work were compared and the percent increase per year was calculated. The results are as follows:

(1) Bill No. 4: Corrugated Metal Pipes, 0.61, 0.91, 1.22 and 1.52 meter diameter: no increase.

(2) Bill No. 5: Fill from cut (classes 1, 2 and 3); cross fill from cut (classes 1, 2 and 3); and spoil from cut (classes 1, 2 and 3): 16 percent per year increase.

(3) Bill No. 6: a. Excavation of subbase materials from borrow pits and cuttings (13 percent of total Bill No. 6 cost): no increase.

b. Stabilization materials - cement and hydrated lime - (65 percent of total Bill No. 6 cost): 16 percent per year increase.

(4) Bill No. 7: 15 centimeter crusher run base course: 8 percent per year increase.

(5) Bill No. 8: Provide, heat and spray MCO and 80/100 bitumen; provide, spread and compact chippings: 15 percent per year increase.

(6) Bill No. 9: Concrete, classes A, B and C; reinforcing bars: 10 percent per year increase.

The increases in material costs from 1978 to 1980 as experienced by Benaco were as follows:

	1978 Cost	1980 Cost	Percent Increase Total	Percent Increase Per/Yr.
1. Petrol (T.Sh./liter)	2.50	6.31	152	76
2. Diesel (T.Sh./liter)	1.52	2.52	66	33
3. Cement (per bag)	36.00	52.00	44	22
4. Armco Pipes	-	-	50	25
5. Reinforcing Bars	-	-	30	15

c. Construction Costs of Recent Road Projects in Tanzania

The information provided by the MOW in Dar es Salaam was as follows:

Project	Length(km)	Type of Terrain	Cost (million T.Sh.)	Year Bid
1. Morogoro-Dodoma	260	Rolling/flat	450	1978
2. Songea-Makumbaka	155	Hilly/rolling	285	1980
3. Mwanza-Musoma	184	Flat	251	1979

Additional data on the above are as follows:

Type of Roadway Pavement	Constr. Period	Financed by	Taxes
1. Cement Stab. Laterite B.C. & DBST	1980-82	Brazil	Exempt
2. Lime Stab. Laterite B.C. & DBST	1980-82	O.D.A. (UK)	Exempt
3. Crusher Run B.C. & DBST	1979-82	EEC	Included

5.5.4 Calculation of Construction Cost (Alternative No. 3)

Comparing various project costs, after update to 1980, on the basis of cost/kilometer, the following is obtained:

Project	Description of Cost Update	Cost/Km (million T.Sh.)
Rusumo-Lusahunga	1978-80: 2 X 15%	1.88
Morogoro-Dodoma	1978-80: 2 X 15%	2.25
Songea-Makumbaka	(1980 cost used)	1.84
Mwanza-Musoma	1979-80: 1 X 15%	1.57
	Average	1.89 1/

1/ This average is probably high with respect to the costs of a road in the Bukombe-Isaka region because the Rusumo-Lusahunga road included heavy cuts in mountainous terrain, the Morogoro-Dodoma link was a main truck route with several long bridges and the Songea-Makumbaka road was in hilly/rolling terrain.

In discussions with Benaco, as well as with staff of the MOW in Dar es Salaam, it has been determined that the inflation rate of construction projects has been escalating in the last two years and it is projected to be as high as 30 percent in the next few years. This is probably correct; in 1980 the economic value of the Tanzanian shilling was approximately 27 to one U.S. dollar versus the official rate of 8 to 1. If two different rates of inflation are used (for example, the percent increase as experienced by Benaco for the period 1975-1978 and double that rate for the period 1978-1980), the following results would be obtained:

Bill Number and Description	Sir A. Gibb Cost, 1975 (million T.Sh.)	Percent/Year Increase (to 1980)		1980 Cost (million) T.Sh.)
		1975-78	1979-80	
1. Preliminary and Gen'l Items	16.52	10	20	29.74
2. Passage and Control of Traffic	0.56	10	20	1.01
3. Site Clearance	4.34	10	20	7.81
4. Drainage	2.31	10	20	4.16
5. Earthworks	13.07	16	32	29.80

Bill Number and Description	Sir A. Gibb Cost, 1975 (million T.Sh.)	Percent/Year Increase (to 1980)		1980 Cost (million) T.Sh.)
		1975-78	1979-80	
6. Shoulders and Subbase	19.07	16	32	43.48
7. Base Course	15.48	8	16	25.39
8. Bituminous Surfacing	11.18	15	30	24.60
9. Bridges and Box Culverts	4.14	10	20	7.45
10. Finishing, Work	0.90	10	20	1.62
11. Engineers' Accommodations	3.16	15	30	6.95
12. Schedule of Dayworks	1.42	15	30	3.12
Subtotal	92.15			185.13
2.5% Contingencies	2.31			4.63
TOTAL	94.46			189.76

The cost/kilometer in 1980 of the project road is thus 1.69 million T.Sh. This is comparable to the average of the per kilometer costs of the other current road projects in Tanzania. In dollar terms the project cost would be $23.72 million (at the official exchange rate of $1.00 = 8 T.Sh.).

5.5.5 Construction Cost of Various Alternatives

a. Alternative No. 1

The cost of construction of Alternative No. 1 (upgrading of the existing road) has been estimated as follows:

- Excavation, Blading and Changing of the Subgrade: It was assumed that this cost is equivalent to three times the cost of blading work during routine maintenance of gravel roads.[1] It was assumed that blading represents 40 percent of the total routine maintenance costs.

Thus, 0.40 x 0.0156 x 117.5 kilometers = 0.73 million T.Sh. The cost of this operation is therefore: 3 x 0.73 = 2.19 million T.Sh.

- Routine Maintenance (Exclusive of Blading): This includes cleaning of ditches and pipe culverts as well as reshaping of slopes and vegetation control.

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[1] See Article 5.7.4 for costs of gravel road maintenance.

The cost is 0.60 x 0.0156 x 117.5 kilometers = 1.10 million T.Sh.

- New Gravel Base: This includes providing a new 15 centimeter thick gravel base course, 5.5. meter wide. The cost (financial) is derived from the cost of Bill No. 7, shown in Article 5.5.4. It is first calculated on a per square meter basis and then adjusted to exclude taxes and convert the financial cost to the economic cost.[1] Thus we obtain:

$$25.39 \times \frac{10^6}{112.5 \times 6.5} = 34.73 \text{ T.Sh./m}^2 \text{ (financial cost)}$$

This cost is first subdivided into local currency and foreign currency portions; taxes are then deducted and then the each component is adjusted to reflect the economic cost.

	Local Currency Component (80%)	Foreign Currency Component (20%)	Total
Taxes (%)	27.78 (8.5)	6.94 (10.35)	
Taxes			
Total Less Taxes (financial cost)	25.42	6.22	
Total Less Taxes (economic cost)	27.22	15.55	42.77

The total cost is then calculated as follows:

42.77 x 117,500 x 5.5 = 27.64 million T.Sh.

- Resealing of 2 Kilometers within Kahama City Limits (presently paved): This cost is calculated using the cost from Table 5.6:

0.1159 x 2.0 = 0.23 million T.Sh.

- Mobilization: This cost is calculated as 15 percent of the total cost less routine maintenance:

(27.64 + 2.19) x 0.15 = 4.45 million T.Sh.

The total economic cost of Alternative No. 1 is therefore:

(4.45 2.19 + 27.64 + 1.10 + 0.23) = 35.61 million T.Sh.

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[1] For procedure to calculate taxes and convert to economic cost, see Table 6.1.

The equivalent financial cost is calculated by using the proportion of financial to economic cost of Alternative No. 2, or:

(150.21/220.10) x 35.61 = 24.30 million T.Sh.

b. Alternatives No. 2 and No. 3

The cost of Alternative No. 2 is obtained from the costs of Alternative No. 3 (paved road) by adjusting the costs of certain Bills (Nos. 1, 2, 6, 11 and 12) and by subtracting the cost of Bill No. 8, Bituminous Surfacing, which gives the following financial costs (in 1980 prices):

Alternative	Cost (million T.Sh.)
No. 2	150.21
No. 3	189.76

The cost of Alternative No. 2 reflects, in addition to a deduction from the cost of Alternative No. 3 of 24.60 million T.Sh. for bituminous surfacing, a deduction of 14.95 million T.Sh. for reduced costs of mobilization, a reduction in construction time (which affects the cost of Bills No. 2 and 11), a reduction of thickness of the subbase (from 20 centimeters to 15 centimeters) and an adjustment of the cost of Bill No. 12 due to the elimination of paving.

5.5.6 Length of Road Within the Budget of $10 Million

In order to be able to evaluate the extent of construction feasible within the AID funds available for the project, the financial costs of the various alternatives were translated into per kilometer costs (in 1980 dollars using the official exchange rate of 1.00 U.S. dollar = 8.0 T.Sh.):

Alternative	Financial Cost/Km (000 U.S. dollars)	Percent of Cost of Alternative No. 3
No. 1 - Upgrading existing road	(24.30/117.5) x 8.0 = 25.85	12.26
No. 2 - Gravel road on new alignment	(164,540/112.5) x 8.0 = 182.82	86.71
No. 3 - Paved road on new alignment	(189,760/112.5) x 8.0 = 210.84	100.00

Thus, for $10 million, the following lengths of the project (in rounded kilometers) could be constructed:

Alternative	Length (km) 1980	(1983)*
No. 1 - Upgrade existing road	389	242
No. 2 - New gravel road	55	34
No. 3 - New paved road	47	29

*Assuming 20 percent per year inflation to year 1983 (median construction year).

5.5.7 Local and Foreign Currency and Tax Components of the Construction Costs

a. Local and Foreign Currency Components

The division of costs between local and foreign currencies varies for each of the Bills of Quantity. To arrive at the overall percentage of these components of cost for the Bukombe-Isaka road project, it is necessary to perform a calculation shown in the Table 5.3. The various percentages have been derived based on the discussions held with Impresa del Benaco during the visit to their construction site.

Table 5.3

LOCAL AND FOREIGN CURRENCY COMPONENTS OF FINANCIAL COSTS
(Alternative No. 3, 1980 prices)
(million T.Sh.)

Bill No.	Local Currency %	Local Currency Cost	Foreign Currency %	Foreign Currency Cost	Total Cost
1	30	8.92	70	20.82	
2	90	0.91	10	0.10	
3	90	7.03	10	0.78	
4	30	1.25	70	2.91	
5	80	23.84	20	5.96	
6	80	34.78	20	8.70	
7	80	20.31	20	5.08	
8	40	9.84	60	14.76	
9	40	2.98	60	4.47	
10	80	1.30	20	0.32	
11	20	1.39	80	5.56	
12	30	0.94	70	2.18	
		113.49		71.64	185.13
Cont. (2.5%)		2.84		1.79	4.63
Subtotal		116.33		73.43	189.76
% of Total Cost		61.3		38.7	

The local and foreign currency distribution obtained when the financial costs are converted to economic costs is shown in Table 5.4.

Table 5.4

LOCAL AND FOREIGN CURRENCY COMPONENTS OF ECONOMIC COSTS 1/
(Alternative No. 3, 1980 prices)
(million T.Sh.)

Bill No.	Local Currency		Foreign Currency		Total Cost
	%	Cost	%	Cost	
1	14	8.50	86	52.47	
2	76	0.87	24	0.27	
3	75	6.70	25	2.28	
4	14	1.17	86	7.33	
5	59	22.72	41	16.02	
6	59	33.15	41	23.38	
7	59	19.36	41	13.65	
8	20	9.38	80	37.36	
9	20	2.84	80	11.32	
10	59	1.24	41	0.86	
11	9	1.32	91	13.97	
12	14	0.89	86	5.49	
		108.14		184.40	292.54
		2.70		4.61	7.31
		110.84		189.01	299.85 2/
		37.0%		63.0%	

1/ Assuming 4.7 percent of local costs are imported intermediate goods, and that the free market exchange rate is $1.00 = 20 T.Sh. See also Article 5.7.4.

2/ Includes taxes. For total less taxes see Table 6.1.

b. Taxes

The proportion of taxes levied on construction contracts was discussed with Impresa del Benaco and the following data were obtained:

Tax on corporate profit:	45%
Tax on expatriate salaries:	33%
Tax on local salaries:	14% (average)

Taxes are also paid indirectly through the price of local procurement, but these are reimbursed to the contractor. Such reimbursements apply primarily to petrol and cement.

Reimbursement of taxes for other miscellaneous local supplies and food is not feasible, however, due to the difficulties in obtaining the required documentation for reimbursement of taxes.

It was estimated that foreign and local currency components of the construction costs include the following proportions of taxes:

<u>Foreign Costs</u>:			
Corporate profit:	12%	0.12 x 0.45 =	5.40%
Expatriate salaries:	15%	0.15 x 0.33 =	4.95%
<u>Local Costs</u>:			
Local salaries:	25%	0.25 x 0.14 =	3.5%
Misc. supplies and food			5.0%

Thus taxes represent the following proportion of the total project financial cost:

$$0.613 \times 0.085 + 0.387 \times 0.1035 = 9.2\%$$

5.6 PROJECT FINANCING CONSIDERATIONS

5.6.1 Financing by AID of a Separate Road Segment

Within the budget limits of the $10 million to be contributed by AID towards the financing of the construction of the Bukombe to Isaka road, between 29 and 242 kilometers of road could be constructed depending on the construction alternative adopted (see Article 5.5.6). This length represents approximately 26 to 215 percent of the total length. The recommended alternative is the one including the construction of a new paved road, as recommended by Sir Alexander Gibb. Thus, at the most, 29 kilometers could be built under separate financing. Due to duplication of mobilization costs, it would not make good financial sense to split the project into two separately financed portions, one 83.5 kilometers and the other 29 kilometers long.

If a separate project under AID financing were to be considered, it would be more sensible to divide the project at the intersection at Kangogwe and to include in the AID financed project the railhead facilities at Isaka, which would accomplish the following:

a. Reduce the EEC project costs and bring them closer to the original 1975 estimate for the entire project. It is estimated that a total project length of approximately 91 kilometers would represent at least an 18 to 20 percent reduction in cost.

b. Increase the "visibility" of the AID project in that it would provide railhead facilities offering permanent employment opportunities to the population of Isaka and insure that the transshipment facilities are designed and built without undue delay (see Article 5.9.6).

The financial construction costs under (b) above were estimated as follows:

- Road from Kangogwe intersection to Isaka (21.8 kilometers): $4.6 million

- Isaka transshipment facilities: $4 million. Total: $4.6 million + $4 million = $8.6 million in 1980 and $12 million in 1982.

The above costs include design and construction supervision costs.

5.6.2 Joint Financing EEC/AID

a. Operative Guidelines and Feasible Options

In general terms, the guidelines of EEC and those of AID for the participation in and eligibility for the construction contracts financed by them have very little common grounds. EEC limits the participation to contractors who are legal persons or nationals of the European Economic Community (EEC) and the African Caribbean and Pacific States (ACP states). AID Code 941 guidelines exclude EEC countries but allow most of the African countries. EEC excludes U.S. contractors, thus clashing with AID, which gives preference to them. Similar restrictions govern procurement of construction materials and equipment. Under these constraints the following options for joint EEC/AID financing must be considered:

(1) Waivers: EEC admitting U.S. Code 941 contractors and AID admitting European ones.

(2) Procurement: EEC agreeing to require acquisition of imported construction materials (reinforcing steel) and new construction equipment from U.S. sources adding up to $10 million. EEC regulations would then govern the construction of the project and the construction supervision.

(3) Construction Supervision: EEC agreeing to let AID select a U.S. consultant to supervise construction on joint funded project.

(4) AID and EEC in parallel financing.

Items (2) and (3) above could be combined to a total anticipated cost equal to $10 million.

b. Advantages/Disadvantages of Joint Financing

The principal advantages of joint financing, provided the needed waivers can be arranged, are the following:

- Increased competition for the project and, therefore,

- Potential economies in the eventual project cost, and particularly economies in mobilization costs, overhead and profit.

The disadvantages are:

- Delays to the project due to time required to obtain the required waivers and draft and sign joint EEC/AID financing agreement.

- Difficulties in implementing procurement restrictions, particularly those pertaining to the acquisition of new construction equipment.[1]

- Complications relative to the administration and disbursement of funds by EEC and AID and verification of contractor's invoices.

c. Suggested Clauses for Joint Financing Agreement

The purpose of this article is not to spell out in detail the text of the various clauses for a joint EEC/AID financing agreement or to cover various areas having to do with the legal aspects relative to the responsibility for the administrative control of the project or disbursement of payments and coverage of cost contingencies. It is limited instead to a suggestion of points relative to the technical and administrative aspects having to do with clauses governing the rules for the participation in bidding and the use of AID funds in the project. Among the points that should be covered are:

- Definition of the joint financing as to areas (services and procurement) to be covered by AID funds.

- Definition of eligibility clauses and the origin of supplies and new equipment, including spare parts, to be acquired for the project, and authorization of necessary waivers.

- Use of FIDIC Conditions of Contract as "General Conditions."

- Definition of packaging and marking of AID financed procurement of supplies and equipment.

- Consideration given to requiring that all construction equipment, at the end of construction, be overhauled and delivered in good operating condition to the Government of Tanzania, with the provision that the Tanzanian MOW use this equipment to maintain the road. This is subject to type of equipment and its value at completion of the project.

- Definition of the format for submission of bids and of the rules for acceptance, rejection and award of contract, acceptable to both EEC and AID.

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[1] This would, for instance, put Impresa del Benaco or the contractor building the Lusahunga-Bukombe section at an advantage because they would have the majority of needed construction equipment already near the project site. Thus, these potentially low bidders would tend either not to bid or bid much higher prices.

- Definition of the Disputes and Arbitration clauses, acceptable to both EEC and AID.

- Definition of the format for invoicing by the contractor such that various services, construction items and materials are clearly segregated according to the local or foreign currencies and sources of funding.

- Definition of the requirements for contract guarantees acceptable to both EEC and AID, guarantee periods and conditions for acceptance of procurement items and finished works.

- Definition relative to the exclusion or inclusion of local taxes into the project costs and if necessary authorization of the necessary waivers.

- Definition of obligations of EEC and AID vis-a-vis the Tanzanian Government relative to coverage of cost escalation during construction (inflation, unforseen field conditions, force account work, etc.).

Finally, as a function of the above, it will be necessary to check and revise the project specifications prepared by Sir Alexander Gibb to reflect clauses in the joint financing agreement pertaining to the requirements for participation, submission of bids, invoicing of the furnished work and supplies, etc.

5.6.3 Recommendations

One obvious option is to admit both EEC/ACP and Code 941 countries' contractors to submit bids for the entire road project after appropriate waivers are granted by EEC and AID. The risk, however, is that the low bidder may be a non-Code 941 country contractor. It is for this reason that it seems preferable that the "procurement" clause (for materials, equipment and services) approach be used if joint financing is preferred by AID.

Separate AID project financing, for a project as described in Article 5.6.1, would offer the most visibility together with the least "red tape" complications. For this reason it is recommeded that separate AID financing be implemented in preference to joint EEC/AID financing. It is likely that EEC may also prefer not to get involved in the complications of the joint financing. The advantages are obvious: a) EEC project costs are reduced, b) Isaka railhead is included in the AID project, thus completing the transport link to the Tanzanian Railways and c) delays of the project, because of agreement conditions, development and authorization by AID and EEC, are avoided.

5.6.4 Potential Funding Sources Alternative to AID

Project financing was discussed in Bujumbura and Dar es Salaam with the local representative of EEC. They have confirmed to the project team that EEC headquarters in Brussels had authorized the funds for the construction of the Lusahunga to Bukombe road segment. Their expectation was that EEC would probably also finance the Bukombe to Isaka road whether or not AID or any other financing agency participates.

During a meeting in the Ministry of Finance in Dar es Salaam, the project team was informed that the Tanzanian Government would prefer to call for bids on both road segments from Lusahunga to Isaka simultaneously in the hope of generating more interest among the prospective bidders. They would prefer to take this approach even though the financing for the Bukombe to Isaka segment was not yet assured. They felt that such an approach would produce significant cost savings and felt confident that the financing would be obtained. One alternative source indicated during the meeting at the Ministry of Finance was the Arab African Development Bank (AADB) in Khartoum, Sudan. They indicated that AADB had expressed a strong interest in the project and might contribute up to $8 million. The EEC representative in Dar es Salaam was also aware of AADB interest in the project, but thought AADB would limit its participation to only $3 million.

5.7 ROAD MAINTENANCE

5.7.1 Present Maintenance Situation in Tanzania

Tanzania's system of classified roads includes approximately 45,000 kilometers of roads, of which 7 percent are paved and 93 percent are gravel or earth. In 1978 there were 3,024 kilometers of paved (bitumen) and 41,976 kilometers of gravel or earth roads.[1] During 1979 and 1980 several trunk road projects were undertaken, which, when completed by the end of 1982, will add another 700 kilometers of paved roads to the system.[2] Of the total of approximately 42,000 kilometers of gravel and earth roads (in 1978) only 900 kilometers have been engineered. In 1978 the Tanzanian road system was as shown in Table 5.5.

Table 5.5

TANZANIA ROAD SYSTEM

Type	Classification		
	Primary Roads (Trunk Roads)	Secondary Roads (Local Main Roads)	Tertiary Roads (Regional and District Roads)
Gravel or Earth	6,656 km	7,330 km	27,990
Bitumen	2,660 km	364 km	
Total	9,316 km	7,694 km	27,990

Source: Ministry of Works

Out of 338 million T.Sh. for the 1976-77 fiscal year the MOW had budgeted 190 million T.Sh. for road investment and only 12 million T.Sh. for road maintenance. Using the costs of 8,500 and 10,000 T.Sh./kilometer for the routine maintenance for gravel and bitumen roads, respectively (see Article 5.7.4.c), in 1978 the MOW would have needed 83 million T.Sh. for only the routine maintenance of the trunk roads. To perform the periodic maintenance on the trunk roads in 1978, the MOW would have needed 606 million T.Sh.

The maintenance of the trunk and other main roads in Tanzania during the period 1974 to 1980 has been very infrequent. The MOW, which is responsible for the maintenance of the trunk road

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[1] Ministry of Works

[2] The projects include: Morogoro-Dodoma, Songea-Bakumbaka, Mwanza-Musoma and Rusumo-Lusahunga road projects.

system, and the regional districts, which are responsible for the maintenance of the rest of the road system, have suffered chronically from insufficient funds, equipment, shops and personnel.

Consequently, due to the lack of maintenance, and in the case of the Tanzania highway, due to overloading of trucks, the roads in Tanzania are generally in very poor condition and are deteriorating at an alarming rate.

5.7.2 Existing Constraints

a. Administration

In 1974 the Ministry of Communications and Works (Comworks) was split into two ministries: the Ministry of Communications and Transport (MCT) and the Ministry of Works (MOW). The MCT is responsible for planning, while the MOW is responsible for design, construction and maintenance. The MOW is responsible for the maintenance of trunk roads only. The maintenance of the rest of the road network is the responsibility of the regional authorities. Although the MOW provides the funds for the maintenance of the trunk roads the actual maintenance work on these roads is performed by the regional authorities' forces. In some cases, agricultural authorities provide the maintenance on feeder roads. Thus, although the funds are provided by separate authorities, it is the regional authorities who bear the brunt of executing the maintenence on practically the entire national road system. Yet it is the regional authorities who most lack trained and experienced staff, shops and equipment. Faced with an extreme dearth of funds, personnel and equipment the regional authorities frequently respond first to the orders given by their immediate superior, the Regional Development Director. Thus the regional engineers are often left with no choice but to use MOW funds and resources to be responsive to the demands of the regional authorities.

The MOW recognizes the inadequacy of the present organizational structure and the urgency to reorganize it so that it could have better control over the use of its funds and resources and provide better maintenance of the trunk roads. To date the progress towards an administrative reorganization has been slow.

b. Staffing and Training

The shortage of qualified personnel has been a constant (and probably the most critical) problem of all MOW divisions. The void that was created in 1970, when Comworks lost a considerable number of its expatriate staff, has never been adequately filled due to a shortage of qualified national personnel. The Tanzanian Government's effort since 1974 to hire Indian

engineers has helped, but most of these engineers have filled the design, construction and materials sections. The maintenance section, therefore, has not benefited from this effort and to date most of the vacancies remain unfilled.

Although the Fourth Highway Project of the World Bank included training, progress has been inhibited by the inability of the MOW to appoint local staff to be trained.

The Morogoro Training School, constructed in 1974, provides training for field crew personnel. The school has the capacity to handle 120 students at one time. A great deal of credit is due the school for improvements in the performance of road maintenance since mid 1977 (notably in the case of the Tanzam Highway). However, in the short term, over 1,000 field crew vacancies will need to be filled. Yet, to date, the recruitment of trainees remains below the capacity of the Morogoro school.

c. Planning

Highway planning is presently the responsibility of the MCT. It is also the responsibility of the MCT to collect data needed for planning purposes, such as traffic counts and other statistics. However, with very few exceptions, the systematic collection of data has been lacking since 1974. In order to have a planning capability, the MOW created its own Planning Division in 1977. Its staff at present is small; it must be expanded and include outside technical assistance if the planning responsibilities are to be adequately fulfilled. The IBRD Fifth Highway Project includes financial assistance for this purpose. The present objective of the MOW Planning Division is not to duplicate or supersede the data collection responsibilities of the MCT. Its staff does not include one person experienced in road maintenance needs, funding or operations planning. In the medium term, therefore, it will difficult for the MCT or MOW to adequately perform road maintenance planning.

d. Operations

Maintenance operations suffer from administrative problems described in Article 5.7.2.a. The maintenance operations also suffer from an extreme shortage of skilled personnel and adequate equipment. Equipment, besides being in short supply, is for the most part inoperable due to inadequate maintenance and a shortage of spare parts. The lack of skilled equipment operators contributes to a high incidence in equipment breakdowns. The maintenance operations are therefore reduced to labor intensive tasks such as vegetation control and ditch and culvert cleaning. The lack of funds and lack of equipment contribute to very infrequent periodic maintenance, such as re-gravelling or re-sealing of roadway surfaces.

5.7.3 Future Prospects

Recognizing the critical nature of and the need to improve road maintenance in Tanzania, the World Bank, USAID and other donors have financed several studies and programs aimed at training local personnel and improving the administration and planning of road maintenance. The World Bank's First Highway Project was started in 1974, and subsequently other programs (Second through Fourth Highway Projects) have been implemented. The results to date have been encouraging. Several problems have slowed progress, including difficulties in recruiting expatriates, cultural and language problems, and a shortage of local staff. A shortage of housing for expatriate staff has added to other problems and contributed to a two-year delay in the completion of the Fourth Highway Project, which was aimed at developing a Trunk Road Maintenance (TRM) organization for the southern half of the country. The Fifth Highway Project similarly is aimed at the development of a TRM organization for the northern portion of Tanzania.

While the Fifth Highway Project should be completed well ahead of the anticipated opening to traffic of the entire middle route (expected in 1985) many risks remain and will need to be solved before regular and adequate maintenance can be executed on the trunk roads by the MOW. Among the more critical problems will be:

- Adequate yearly budgets to pay the salaries of the TRM staff and to cover operating costs of the shops and equipment.

- Sufficient foreign currency funds to insure acquisition of spare parts and the replacement or addition of maintenance equipment.

- Implementation of administrative procedures to insure that equipment provided for trunk road maintenance is not diverted for other purposes.

Further, the MOW's ability to develop sufficient and qualified staff in the medium term to plan and execute the maintenance on both a routine and periodic basis may be a problem. Inherent in the planning process are systematic traffic counts; road condition inventories; and the determination of necessary personnel, road and equipment maintenance materials, and spare parts and equipment replacement. These needs should be projected sufficiently in advance so that the necessary funds can be allocated and provided, both as part of the national highway budget and through loans or grants from international donor agencies. To achieve this ability, the MOW will need recognition of the importance of maintenance at the highest level of the Tanzanian Government to safeguard the road

investments already made. Such a recognition will constitute the key factor in the future improvement of the road infrastructure in Tanzania. It is hoped this will be achieved in the medium term.

5.7.4 Road Maintenance Costs

Due to the fact that no systematic maintenance or maintenance planning is done, accurate data on maintenance costs are not available. Some cost data, which could not be substantiated and which were used by MOW staff to prepare economic data in connection with financing by EEC of the Lusahunga to Bukombe section of the Rusomo to Isaka road, were available. To determine road maintenance costs several sources were checked. Among them were studies by Brokonsult and Lyon Associates and the World Bank data on the anticipated cost of the Fifth Highway Project. The problem was complicated by the fact that the data were for different years. In some cases, financial rather than economic costs appeared to have been used. The distinction between financial and economic costs is particularly important because in the Tanzanian economy economic costs for imported materials and services are considerably higher than financial costs. Thus, based on 1977 Brokonsult studies, a comparison of the two costs (in percent) for maintenance of 7 meter wide gravel roads follows:[1]

	Financial	Economic
Routine Maintenance (yearly)	100	191
Periodic Maintenance (every 10 years)	100	252

In order to compare the disparate costs from the various studies and sources, it was necessary to update all costs to 1980 by using an average inflation factor of 10 percent per year from 1975 to 1978 and 15 percent per year from 1978 to 1980. Furthermore, when only financial costs were available, it was assumed that economic costs would be obtained by multiplying the financial costs by factors similar to those given by Brokonsult in the Dodoma Transport and Logistics Study. Finally, the resulting economic costs were then averaged for each type of maintenance or rehabilitation.

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[1] Dodoma Transport and Logistics Study (1977) in which foreign currency was shadow priced at 20.75 T.Sh. = $1.00.

Although in most cases details on included work were not given (except in the Brokonsult and Lyons Associates studies) it was assumed that routine and periodic maintenance would include:

a. Routine Maintenance (Gravel and Bitumen Roads):

- At least every six months: vegetation control, ditch and culvert cleaning.

- Once a year: gravel surface blading, filling or patching of potholes and repair as needed of embankment slope erosion.

b. Periodic Maintenance (Gravel Roads):

Re-gravel and re-shape the road crown and compact the roadway and shoulders (once every three years).

c. Periodic Maintenance (Double Bituminous Surface Treatment Paved Roads):

Re-seal (oil and chip) the roadway surface and re-shape and compact gravel or earth shoulders (once every five years).

The maintenance cost data obtained and compared were as follows (in T.Sh./kilometer):

Source No. 1: MOW (1978) - economic costs

	Gravel Roads	Bitumen Roads
Routine maintenance (cost per year)	8,500	10,000
Periodic Maintenance	55,000(1)	90,000(2)
(1) regravelling every three years		
(2) resealing every five years		
Upgrading to maintainable standards	63,200	

Source No. 2: MOW (1980) - economic cost (assumed)

Routine maintenance of gravel roads: 14,200 per year

Source No. 3: Lyons Associates (1980)
(Shadow price: $1.00 = 27 T.Sh.)

Rehabilitation of existing gravel roads (T.Sh./kilometer)

	Financial	Economic
Clearing and Shaping	9,700	32,700
Embankment and Surfacing	24,100	81,300
TOTAL	33,800	114,000

Source No. 4: IBRD, Fifth Highway Project (1978) - financial costs

Total cost of program: $60 million over six years, (60 x 8)/6 = 80 million T.Sh. (average) per year.

Using type and kilometers of roads included in the maintenance program of the Fifth Highway Project and applying economic costs of Source No. 1, the total cost per year would be approximately 142 million T.Sh. per year. Using a shadow price of 21.00 T.Sh. = $1.00 the ratio is (10 x 21)/142 = 1.479. This yields the following economic costs for the Fifth Highway Project (in T.Sh./year/kilometer):

	Gravel Roads	Bitumen Roads
Routine Maintenance	12,570	14,790
Periodic Maintenance	27,350	26,620

Source No. 5: IBRD, Rwanda/Burundi Transport Bottlenecks Study (1980), Rusumo-Isaka road maintenance costs (in 1979) - bitumen road, financial costs (T.Sh./km)

Routine Maintenance	4,838 (per year)
Periodic Maintenance (re-sealing)	18,820 (each five years)

Using a shadow price of 25 T.Sh. (in 1979) to $1.00, the following economic costs result:

Routine Maintenance (each year)	15,120 T.Sh./km periodic
Maintenance (Re-sealing every five years)	58,800 T.Sh./km

Source No. 6: Brokonsult, Tabora Region-Development Study (1975) - financial costs

	Gravel Roads	Bitumen Roads
Routine Maintenance (each year):	8,600 T.Sh./km	11,800 T.Sh./km

Source No. 7: Brokonsult, Dodoma Transport and Logistics Study (1977) - costs of maintenance of gravel roads (T.Sh./km)

	Financial	Economic
Regravelling:	23,600	59,650
Routine Maintenance:	9,240	17,656

A comparison of these economic costs updated to 1980 is shown in Table 5.6.

Table 5.6

COST OF ROAD MAINTENANCE IN TANZANIA, 1980
(000 T.Sh./km)

Source	1	2	3	4	5	6	7	Avg.
A. Gravel Roads								
Routine Maint.1/	10.7	14.2	-	15.8	-	13.4	24.0	15.6
Periodic (Regravelling2/	69.4	-	-	102.5	-	-	81.1	84.3
B. Bitumen Roads3/								
Routine Maint.	12.6	-	-	18.6	17.1	18.4	-	16.7
Re-Sealing4/	113.5	-	-	167.8	66.4	-	-	115.9
C. Rehab. Gravel Roads5/	79.6	-	114.0	-	-	-	-	96.8

1/Each year.
2/Every three years.
3/Double bituminous surface treatment paving.
4/Every five years - single bituminous surface treatment.
5/Cost in thousand T.Sh./kilometers.

Although no traffic data were available to tie the above maintenance values to corresponding traffic levels, it was determined on the basis of types of roads involved that the cost data correspond, on the average, to levels of approximately 200 ADT. In order to derive maintenance costs corresponding to traffic levels other than 200 ADT, relationships of maintenance costs for similar type roads in Uganda were used.[1]

[1] Louis Berger International, Inc. for the Government of Uganda, Ministry of Works, Communication and Housing in cooperation with the International Development Association. Highway Investment, Maintenance and Organization Study, Chapter B-III, Section 9, "Road Maintenance Workloads and Costs," October 1972.

For the maintenance of the upgraded existing road, maintenance costs were used for a processed gravel road surface 5.5 meters wide.[1] The cost formulas were as follows:

Routine Maintenance: Mr = 2,338 + 3.25 (ADT)
Periodic Maintenance: Mp = 182 + 9.69 (ADT)

When Mr and Mp are put equal respectively to 1.83 and 7.47 for an ADT of 200, the following is obtained:

Routine Maintenance: Mr = 1.432 + 0.00199 (ADT)
Periodic Maintenance: Mp = 0.85076 + 0.045296 (ADT)

For the maintenance of new gravel road, maintenance costs were used for a processed gravel surface 6.5 meters wide. Thus, by proceeding in the same manner as described above, the following is obtained:[2]

Routine Maintenance: Mr = 2,366 + 3.00 (ADT)
Periodic Maintenance: Mp = 129 + 9.48 (ADT)

Using Mr = 1.76, Mp = 11.21 and ADT = 200 we obtain:

Routine Maintenance: Mr = 1.404 + 0.00178 (ADT)
Periodic Maintenance: Mp = 0.7155 + 0.05248 (ADT)

For the paved road, the following was obtained:[3]

Routine Maintenance: Mr = 5,792 + 5.66 (ADT) + 1.34 (ADT = 800)

Periodic Maintenance: Mp = 1,820 + 2.25 (ADT) + 1.19 (ADT = 800)

Setting Mr = 1.88, Mp = 13.04 and ADT = 200, the following is obtained:

Routine Maintenance: Mr = 1.5726 + 0.001537 (ADT)
Periodic Maintenance: Mp = 10.455 + 0.012925 (ADT)

These relationships were used for the calculation of maintenance costs as a function of the projected ADT.

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[1]See Table 9-13(a) of the Berger Highway Investment, Maintenance and Organization Study for Uganda.

[2]Using Table 9-13(a) of the Berger Uganda Highway Study.

[3]Using Table 9-11 of the Berger Uganda Highway Study.

5.7.5 Potential Maintenance Savings

The comparison of potential maintenance savings for the Bukombe to Isaka road segment (112.5 kilometers) based on whether a gravel road or paved road is constructed can be made as follows:

a. Existing Road (5.5 meters wide, 117.5 kilometers long)

The existing road must first be upgraded to a condition that can be maintained. Thus the overall maintenance costs must include an initial rehabilitation of the road surface to a properly shaped profile grade and cross section (see Article 5.5.2.b).

Subsequently, the existing road would be maintained in the same manner and with the same frequency as a new gravel road (see case b, below).

b. New Gravel Road (6.5 meters wide, 112.5 kilometers long)

When a new gravel road is constructed on an entirely new alignment the routine maintenance costs per kilometer of road remain the same as those for Alternative No. 1. The new road alignment, however, is 5 kilometers shorter than that of the existing road; thus, the savings in routine maintenance derive from maintaining 5 kilometers less. The periodic maintenance costs, however, must be adjusted for both the width (6.5 meters instead of 5.5 meters) and length (112.5 kilometers rather than 117.5 kilometers). Thus, the total periodic maintenance cost for new gravel road is higher than that for the existing road (6.5/5.5 x 112.5/117.5 = 1.13).

c. Paved Road (6.5 meters wide, 112.5 kilometers long)

Although the per kilometer costs are higher the savings are obtained from shorter length as well as longer intervals between periodic maintenance (5 years for paved road instead of 3 years for gravel road).

5.7.6 Measures and Budgetary Requirements for the Maintenance of the Bukombe-Isaka Road Segment

The present institutional framework, organization and equipment available in Tanzania to perform road maintenance is by far

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[1] The original period of six years is reportedly now shortened to only four years due to a delay suffered by the Fourth Highway Project.

insufficient to take care of even the primary road system. The various programs under way and the prospects for improving the MOW's maintenance capabilities have been discussed in Articles 5.7.1 through 5.7.3. The Fifth Highway Project of the World Bank includes the Rusumo-Isaka road in its program of maintenance. However, assuming that the Fifth Highway Project gets under way in 1981 and that it will be completed by 1985, there should be in place a Trunk Road Maintenance (TRM) Group in the Shinyanga Region. Its only responsibility will be to maintain the trunk roads.[1] The Bukombe to Isaka segment, being part of the Rusumo-Isaka road, is on the trunk road system. A lot depends, then, on the success of the Fifth Highway Project. Under its financing TRM Groups will be provided with shops and equipment as well as work camp living accommodations so that they can operate within reasonable proximity to the area of responsibility.

The Fifth Highway Project will be updated yearly to reflect changes in the priority rating and condition of the trunk roads included in the program. It would be desirable that no rehabilitation and maintenance work be performed during the period of the Fifth Highway Project on the Lusahunga to Isaka segments and that the TRM Groups be equipped to perform bitumen road maintenance (routine and periodic) and provided with funds (until 1985) to maintain the Rusumo-Lusahunga segment, anticipated to be open to traffic in October 1982. It would also be desirable that the donor agencies financing the construction of the three segments of the Rusumo-Isaka road monitor, through IBRD, the performance of the MOW's TRM Group in Shinyanga Region as well as the program of the general restructuring of the MOW's trunk roads management system. Even if the Fifth Highway Project achieves all of its objectives, it will be necessary to evaluate the MOW needs in terms of funds, maintenance materials and equipment as well as personnel for the Shinyanga Region TRM Groups, and provide the necessary funds and technical assistance to carry on the maintenance of the Rusumo-Isaka road.

The budgetary requirements in terms of financial costs of routine and periodic maintenance (in 1980 prices) for the period 1985-1990 for the Bukombe-Isaka segment (bitumen standard) are estimated as follows (assuming 5% traffic growth):

- Routine Maintenance: performed once a year (1985-1990) costs 11.3 million T.Sh. for 112.5 kilometers.

- Periodic Maintenance: resealing, performed in 1990 costs 13.3 million T.Sh. for 112.5 kilometers.

5.8 EXISTING ROAD LINKAGE ISAKA-DAR ES SALAAM

5.8.1 Topography and Present Conditions

The road linkage from Isaka to Dar es Salaam can be divided into five segments:

(a) From the intersection at the village of Kangogwe (kilometer 90.7 of the Bukombe-Isaka segment) to the city of Nzega, a distance of 60 kilmeters.

(b) From Nzega to Singida, a distance of 220 kilometers.

(c) From Singida to Dodoma, a distance of 224 kilometers.

(d) From Dodoma to Morogoro, a distance of 283 kilometers.

(e) From Morogoro to Dar es Salaam, a distance of 196 kilometers.

Segments (a) through (d) are gravel roads and segment (e) is a bitumen paved road. Short lengths (2 to 6 kilometers) of the segments within the cities of Singida and Dodoma are also paved. In general, the terrain varies from hilly (from Singida to 70 kilometers east of Singida) to rolling and flat. Rolling terrain is located from 80 kilometers west of Morogoro to 40 kilometers west of Dodoma and from kilometer 150 to 70 kilometers east of Singida as well as from Singida to Nzega. The terrain is flat between Dar es Salaam and 80 kilometers west of Morogoro and from 40 kilometers west of Dodoma to 150 kilometers east of Singida, a generally swampy area that becomes impassable occasionally during heavy storms in the rainy season.

The conditions of the roads (in 1980) are as follows:

Kangogwe-Nzega: Poor

Nzega-Singida: Mostly poor, occasionally fair. Bituminous section (2 kilometers) in poor condition.

Singida-Dodoma: Poor to very poor (in the swampy zone). Bituminous sections, Singida (3 kilometers), in poor and Dodoma (6 kilometers) in fair condition.

Dodoma-Morogoro: Very poor condition. Under construction (260 kilometers) as a new bitumen paved road, partly on new bitumen paved road, and partly on new alignment.

Morogoro-Dar es Salaam: Fair condition, frequent potholes.

5.8.2 Future Improvements and Maintenance

Under the program established for the World Bank's Fifth Highway Project most of the Kangogwe (21.8 kilometers west of Isaka) to Dodoma linkage is included for upgrading and subsequent maintenance. One segment, from Nzega to the Wambare River, is omitted because in 1978, when priorities for the Fifth Highway Program were determined, this segment was in good condition and therefore deemed low priority for improvement. The remainder of the linkage, with the exception of the Morogoro-Dar es Salaam segment, was included for rehabilitation or upgrading. All segments were included for rehabilitation work in the last four years of the program. Given the two-year delay in the start of the Fifth Highway Project and past experience with the Fourth Highway Project, it is fair to assume that the various road segments will not be rehabilitated before the years 1984 to 1986. By 1986 or 1987 it may be assumed that between Rusumo and Dar es Salaam, of the total length of 1,271 kilometers, 571 kilometers will be paved and in good condition, 196 kilometers paved and in fair to good condition (assuming some maintenance by the MCW's TRM groups) and 504 kilometers will be gravel road in fair condition, following rehabilitation and maintenance work under the Fifth Highway Project. If financing is found, the Kangogwe-Nzega segment (60 kilometers, may also be paved, since its construction on new alignment was also completed by Sir Alexander Gibb in 1975.

5.8.3 Capacity to Transport the Projected Rwanda/Burundi Traffic

After 1985 the road from Isaka to Dar es Salaam will consist of approximately 60 percent paved and 40 percent gravel road. The entire length will be of "trunk road" standard: it will have a two-lane carriageway of 6.5 meter width. It will therefore be capable of handling all of the projected Rwanda/Burundi traffic, including additional local and inter-regional Tanzanian traffic.

5.9 CAPABILITY OF THE TANZANIAN RAIL SYSTEM TO TRANSPORT RWANDA/BURUNDI EXPORT/IMPORT TRAFFIC

5.9.1 History and Description of the System

The rail system in Tanzania consists of two single track railway lines: one known as TAZARA (Tanzania-Zambia Railway), constructed with the help of the Chinese Government (Mainland China) from 1970 to 1974, and the other known as TRC (Tanzania Railway Corporation), created in 1977 after the breakup of the former EARC (East Africa Railway Corporation). TAZARA's main purpose is to serve Zambian transport needs while TRC essentially serves Tanzania. The main technical data of the two lines are as follows:

		Length (km)	Gauge (m)	Year Constructed
TAZARA:	In Tanzania	970	1.067	1970 - 1974
	In Zambia	890	1.067	1970 - 1974
TRC:	Dar es Salaam-Tabora	825[1]	1.00	1905 - 1911
	Tabora-Kigoma	430[1]	1.00	1911 - 1914
	Tabora-Mwanza	380[2]	1.00	1914 - 1928

The track of the TRC lines was relaid (mainly replacement of rail) in later years as follows:

Section	Weight of Rails (pounds) Initial Construction	New Rail	Year Relaid
Dar es Salaam-Kilosa	50, 55 & 56	60	1957 - 1978
Kilosa-Tabora	50, 55 & 56	--	-
Tabora-Kigoma	50, 55 & 56	--	-
Tabora-Mwanza	55	60	1957 - 1978

In general, the ballast consists of relatively thin gravel cover over earth core. This has caused track problems due to faulty ballast drainage. Although both the track and most of the rolling stock are old and worn out, the low traffic density has prevented long-lasting disruptions of the rail traffic.

5.9.2 Present Situation and Operations

Operations of both the TAZARA and the TRC lines have not been satisfactory during the last three years. The TAZARA has

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[1] The Dar es Salaam-Kigoma line has an additional 190 kilometers of siding tracks.

[2] The Tabora-Mwanza line has 36 kilometers of additional siding tracks.

suffered from an unusual frequency of locomotive breakdowns, which have been to a large extent the cause of congestion in the port of Dar es Salaam. TRC has problems on all fronts but suffers primarily from a lack of experienced technical and management personnel. After the breakup of EARC, TRC was left with reduced management cadres and inadequate maintenance facilities since EARC rolling stock repairs were done mainly in Nairobi. TRC's operations suffer also from its old rolling stock, permanent way (tracks) and communication system as well as its lack of adequate repair facilities and procedures.

Although a number of new locomotives and rolling stock have been furnished to the TRC during the last few years with the help of foreign assistance, bringing the total fleet to 116 locomotives and 3,800 wagons, the rate of utilization remains a low 35 percent.[1] The main constraints plaguing TRC operations can be summed as follows:

a. Under utilization of fleet due to:

- inadequate communications facilities
- inadequate equipment and maintenance facilities
- below average productivity of staff and management
- weakness of track system (mainly ballast)
- congestion in the ports of Kigoma and Mwanza[2]

b. Insufficient rolling stock (mainly wagons).

c. Severe shortage of fully qualified and experienced staff at middle and senior management level

d. Impact of present salary structure and foreign exchange regulation on the ability to hire management personnel, buy spare parts and other imported materials.

Consequently, the tonnage transported by TRC has been steadily declining since 1972, in spite of increases in the demand:

Year	Demand (106 Tons)	Transported (106 Tons)
1972	1.80	1.68
1975	1.85	1.60
1978	1.95	1.06
1979	2.00	0.85
1980	2.05	0.90*

*Estimated

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[1] Sixty locomotives (24 from Germany, 15 from Canada, 21 from England) and 455 wagons of various types had been delivered as of November 1980.

[2] Congestion in the port of Dar es Salaam is beginning to clear and had been greatly lessened in late 1980 (see discussion in Article 5.10.1).

Although the TRC is the fifth largest railroad in Africa in terms of length of permanent way, rolling stock and number of cadres, it ranks lowest in terms of tons/wagon and tons/locomotive moved in 1979.

The decreased tonnages transported during the years 1975-1980 have contributed to the drain of Tanzania's foreign currency reserves through higher imports of petrol and spare parts for highway transport, increased deterioration of highway infrastructure due to higher volumes of traffic and shortages up country of bulk commodities, such as fertilizer and cement.

5.9.3 Actions Under Way to Improve TRC Operations

In order to improve TRC operations, external assistance has been provided since 1979. Various studies and programs recently completed or under way include:

- Morogoro Maintenance Shop for diesel locomotives financed by the Canadian International Development Agency (CIDA); first phase is completed and second phase is under way.

- Tanzania Railway Sector Study financed by CIDA aimed at the development of government policy in the railway sector and identification of short-, medium- and long-term priorities; completed in November 1980.

- Studies for the improvement of permanent way between Tabora and Kigoma, financed by EEC. This section of the central TRC line is the weakest portion of the TRC system; 1982 completion date is anticipated.

- Programs for replacement of rolling stock (to be completed in 1982) and relaying of approximately 180 miles of track on the Dar es Salaam-Tabora line (about to begin), both financed by CIDA.

- Study to determine the need for strengthening all bridges on the central line, financed by KFW; expected to be completed at the end of 1980.

5.9.4 Additional Actions Required in the Short Term

Although needed and helpful, the external assistance being provided is somewhat uncoordinated and mostly of a long-term nature. Assistance aimed at short-term improvements is urgently needed. Among the improvements needed are:

- Reorganization of the traffic department of TRC and filling the critically needed management positions.

- Improved wagon utilization.

- Improved performance monitoring (moving rolling stock to points of demand and insuring through maintenance that rolling stock will be returned to service in the shortest possible time).

- Improved financial health of TRC by increasing tariffs (based on effective cost of improved operations and value of cargo transported).

The World Bank has plans to provide financial and technical assistance, beginning in 1982, aimed at the improvement of rolling stock, telecommunications, permanent way and maintenance shops.

5.9.5 Medium- and Long-Term Improvement Objectives and Prospects

The Tanzania Railway Sector Study indicates that a 20-year program will be needed to upgrade TRC operations and to develop its capacity to meet the anticipated Tanzanian and international traffic demand. The required investment to meet the targeted objectives is estimated at 5.4 billion T.Sh., or $500 million.[1]

Among the principal actions recommended for the medium and long term are:

- Replacement of rails on the central line, Dar es Salaam to Kigoma, with 80 pound rail and improvement of ballast.

- Improvement of ports (primarily Kigoma and Mwanza).

- Divesting the TRC of hotel, trucking and bus services to concentrate exclusively on rail business.[2]

- Consideration of unification with TARZARA.[3]

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[1] Economic cost, using shadow prices of 1.5 for foreign currency component, 1.25 for skilled labor costs and 0.75 for unskilled labor costs.

[2] TRC provides bus and truck services in the southern region of Tanzania. In 1979 the TRC truck and bus fleet (46 trucks, 56 buses) carried 32,000 metric tons and 600,000 passengers.

[3] Standardization of track gauge for interchangeability of rolling stock operations was determined to be uneconomical.

Although the Tanzania Railway Sector Study recommends immediate action for the construction of a new Railway College and targets the completion of training of cadres by 1985, it is unlikely that the actions will achieve results in the short term. The construction of a new Railway College in Dar es Salaam will alone take three years, if funds can be immediately authorized. Development of programs for training upper level cadres and recruiting qualified expatriate experts will also take time, particularly if the conditions that have previously contributed to slow expatriate hiring are not improved. The proposed aim to use TRC facilities for "on-the-job" training, while sound, will impose additional burdens on available TRC office and shop facilities.

5.9.6 Transshipment Facilities at Isaka

To date, the program for construction of the Isaka rail facilities has not been successful. The Isaka village train station presently consists of a group of three villages with a combined population of approximately 1,800 people. The villages have no telephone or electric service. There is a water supply system but it functions badly due to the frequent breakdown of the pumps. The rail facilities consist of a small train station and tool shed. A new warehouse, presently under construction on the west side of the existing road, is not intended to be part of the future facilities but rather will provide cereal storage.

In April 1980, a two-man delegation from Rwanda visited the Isaka site; however, to date, the Rwandan Government has not indicated the extent of the facilities required nor have the terms been formulated for financing the construction or determining who will execute it. According to Mr. R.M. Minja, Director of Planning of the Tanzanian Ministry of Communications and Transport, Rwanda was contacted by the Tanzanian Government regarding facility requirements so that Tanzania can give the Rwandan Government the option of either obtaining the land (free of charge) and constructing the needed facilities on it or defining the requirements and letting the Tanzanian Government take the initiative in having the facilities constructed.

It is therefore difficult to estimate, for the purposes of the economic evaluation of the middle route, the cost of the Isaka rail facilities. In the absence of any more specific data the Consultant has assumed that $3.7 million would be required, based on the following:

1,000 meters of siding at $600/meters	=	$ 600,000
4 covered storage warehouses (3,000 square meters each) @ 200/square meter[1]	=	2,400,000
1 administration building (600 square meters of space) @ $500/square meter	=	300,000
Site work (earthwork, fencing, utilities, roads, etc.)	=	400,000
	Total	$3,700,000

The problems that remain, besides the size and extent of the facilities, are the availability of a labor force to work at Isaka, their transport and the administrative responsibilities. Managing the Isaka facility as part of a "free port" with simplified customs formalities should be given serious consideration in order to reduce to a minimum delays during transshipment.

The local and foreign currency costs of the railroad facilities at Isaka can be estimated as shown in Table 5.7.

Table 5.7
LOCAL AND FOREIGN CURRENCY COMPONENTS OF FINANCIAL COSTS WITH THE ISAKA RAILHEAD FACILITY
(million T.Sh.)

	Local Currency		Foreign Currency		Total Cost
	%	Cost	%	Cost	
RR Siding	40	1.92	60	2.88	
Warehouse	30	5.76	70	13.44	
Administration Building	30	0.72	70	1.68	
Site Work	40	1.92	60	1.28	
Total		10.32		19.28	29.60
% of Total		34.9		65.1	

[1] Equal to covered storage capacity of AMI shed at Berth No.1 in the port of Dar es Salaam.

The results of converting Table 5.7 to economic costs are shown in Table 5.8.

Table 5.8

LOCAL AND FOREIGN CURRENCY COMPONENTS OF ECONOMIC COSTS WITH THE ISAKA RAILHEAD FACILITY
(million T.Sh.)

	Local Currency		Foreign Currency		Total Cost
	%	Cost	%	Cost	
RR Siding	20	1.83	80	7.43	
Warehouses	14	5.49	86	34.28	
Administration Building	14	0.69	86	4.28	
Site Work	20	1.83	80	3.43	
Total		9.84		49.42	59.26 1/
% of Total		16.6		83.4	

1/ Includes taxes. For total less taxes see Table 6.1.

5.9.7 TRC Capacity to Carry Rwanda/Burundi Traffic

The proportion of the so called ZBR (Zaire, Burundi, Rwanda) traffic in percent of the total TRC traffic demand is small. The CIDA Railway Sector Study gives the following traffic demand projections by commodity (in million tons):

Commodity	1985	Year 1990	2000
Petroleum, Cement & Grains	0.95	1.13	1.55
Sugar and Coffee	0.17	0.21	0.27
Livestock	0.06	0.06	0.06
Fertilizers	0.06	0.07	0.09
All Other Cargo	0.86	0.96	1.44
ZBR Cargo	0.29	0.33	0.38
Uganda Cargo	0.11	0.24	0.31
Totals	2.50	3.00	4.10
ZBR Cargo (% of Total)	(11.6)	(11.0)	(9.3)

It can be seen that ZBR cargo represents about one-tenth of the total projected TRC demand. However, the Railway Sector Study projects that the TRC ability to meet the demand, although increasing over time, will be 83 percent of the total demand by the year 2000:

Year	Demand (million tons)	Capacity (million tons)	Percent of Demand
1978 (actual)	1.95	1.06	54.4
1985	2.50	1.90	76.0
1990	3.00	2.40	80.0
2000	4.10	3.40	82.9

On the basis of 100 percent and 75 percent of TRC transport capacity projected by the Railway Sector Study, ZBR traffic percentage of total traffic is:

Year	Total Tonnage Transported (A) RSS* Proj.	Total Tonnage Transported (B) 75% RSS* Proj.	ZBR Traffic	% of Total (A)	% of Total (B)
1985	1.900	1.425	0.290	15.3	20.4
1990	2.400	1.800	0.330	13.8	18.3
2000	3.400	2.550	0.380	11.2	14.9

*RSS = Railway Sector Study

From the above, it is clear that ZBR traffic will represent a significant portion (up to 20 percent) of the total TRC traffic in the short term and will become less significant in the medium and long term.

The capacity of TRC trains is at present limited by the length of the passing track along the central line, which dictates that the maximum train length cannot exceed 50 wagon units. A 50-wagon train can carry 600 tons of cargo. Assuming one train per day (seven days per week) this amounts to 219,000 tons per year per train. Using sufficient length of passing track to accommodate 60 wagon units, one daily train would transport 262,800 tons per year For comparison purposes, the Railway Sector Study projections of future TRC cargo transporting capacities were used to derive the following table:

Year	Cargo (106 Tons)	Number of Trains/Day: 50-Car Trains	Number of Trains/Day: 60-Car Trains
1985	1.9	8.68	7.23
1990	2.4	10 96	9.13
2000	4.1	18.72	15.60

If service is provided only six days per week, the number of trains each day would increase by 16.67 percent. It is easy to recognize that even four or five cargo trains per day in each direction, on the average, will require an effective railway operations staff. In 1974, EARC handled 1.6 million tons, or approximately an average of eight trains per day on a seven day/week basis. On a six day/week basis, EARC would have handled nine trains per day. If we assume that 10 trains per day is the maximum reasonable number of trains that can be handled, then the length of a train would need to be increased to approximately 95 wagons each to be able to meet the Sector Study projections. It is clear then that in the medium term it will be necessary to lengthen passing track sections as well as to equip TRC with a modern telecommunications system and an efficient management and operations staff. The above considerations, which do not take into account the needs for additional trains for passenger transport, illustrate the critical need of the TRC to upgrade its management and supervisory staff quickly. The following are Sector Study projections of passenger traffic demands and TRC's capacity to provide passenger transport:

Year	Demand	Capacity	% of Demand
	(millions of passengers)		
1978 (actual)	5.4	2.8	51.8
1985	6.0	4.2	70.0
1990	6.9	5 5	79.7
2000	11.0	9.8	89.1

Assuming one passenger car can carry 120 people, in 1985 the TRC would need to handle two additional trains per day on a seven day per week basis, or a total of 10 or 11 trains per day including cargo trains.[1] By the year 2000, assuming a doubling in the length of the cargo trains to 100 cars and using 50-car passenger trains, the TRC would need to handle from 13 to 14 cars per day, on the average, each day of the week.

Inherent in the use of longer trains is the requirement to use more locomotives. The pulling capacity of one locomotive depends also on the steepness of grade of the track. In general the locomotives used by the TRC can pull between 500 and 700 tons on normal grades (less than 1.5 percent). Thus, one 50 car train (600 tons) needs only one locomotive. At present, with 116 locomotives in its fleet, the TRC has the capacity to pull approximately 70,000 tons of cargo. For the anticipated capacity of 1.9 million tons/year in 1985, the TRC would need nine locomotives/day on the average on a seven day per week basis.

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[1] Assuming passenger trains are 50 cars long.

This amounts to less than 10 or 11 locomotives pulling 10 or 11 trains per day anticipated in 1985. Thus, the 116 locomotives presently available to TRC are more than sufficient for the foreseeable needs, even using a multiplier factor of four to account for shunting needs in various yards (estimated at 30 locomotives with 50 percent of the locomotives being repaired or maintained at any time.

The needs for cargo wagons, at 12 tons per wagon, translate to the following wagon fleets in various years (on a seven day/ week basis):

	Cargo Wagon Needs		
Year	Avg./day	50% Utiliz.	75% Utiliz.
1985	434	868	580
1990	548	1096	730
2000	776	1552	1035

In 1980, the utilization rate of 35 percent translates into a need (on a seven day per week basis) for 652 cargo wagons and 196 passenger wagons, on the basis of 1 million tons of cargo and 3 million passengers per year. With approximately 750 new wagons, recently delivered, together with 3,000 old ones, the present TRC wagon fleet capacity appears to be adequate.

In regard to tonnage of cargo arriving at Isaka via the Rusumo Falls-Isaka road, the projections of diverted traffic from both the southern as well as the northern routes are as follows:

	Import/Export Cargo Diverted via Isaka (000 tons)		
Year	Rwanda	Burundi	Total
1985	134.2	21.0	155.2
1990	187.0	25.9	212.9
1995	233.4	30.3	263.7
2000	291.8	36.1	327.9
2004	350.0	41.5	391.5

If this cargo is subtracted from the total ZBR traffic predicted in the CIDA Railway Sector Study, the following distribution of tonnage between the port of Kigoma and Isaka is as follows:[1]

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[1] Assuming that Rwanda traffic via the port of Mwanza is negligible.

Year	ZBR Cargo (000 tons) Via Kigoma	Via Isaka	Total
1985	135	155	290
1990	117	213	330
1995	91	264	355
2000	52	328	380
2004	8	392	400

These figures indicate the growing importance of the Isaka railhead in the long term and the gradual decrease in ZBR traffic passing through the ports of Bujumbura and Kigoma.

5.10 PORT OPERATIONS

5.10.1 Port of Dar es Salaam

The effectiveness of the rail portion (Isaka-Dar es Salaam) of the middle route depends also on the efficiency and ease of throughput in the port of Dar es Salaam. The port is served by both TRC and TAZARA. It handles the export/import cargoes of Tanzania, Zambia and Rwanda, and to a smaller extent Burundi and Eastern Zaire. The cargoes handled by the Dar es Salaam port in 1978 were as follows:

Traffic Through Dar es Salaam Port in 1978

Export/Import Cargoes		Tons	Totals (Tons)
Imports:	Zambia	406,000	
	Tanzania	867,000	
	RBZ*	105,000	
			1,378,000
Exports:	Zambia	607,000	
	Tanzania	236,000	
	RBZ*	85,000	
			928,000
Total Export/Import Traffic			2,306,000
Total RBZ Export/Import Traffic			190,000
(Percent of Total Export/Import Traffic)			(8.2)

* RBZ = Rwanda, Burundi, Eastern Zaire

Excluding Zambia traffic, which is transported by TAZARA, and assuming all RBZ traffic was transported by TRC, the percentage of RBZ cargo tonnage to total tonnage handled in the port of Dar es Salaam by TRC would have been 14.7 percent. The RBZ traffic represents a significant proportion of the TRC traffic in the Dar es Salaam port.

All of the RBZ traffic, excluding petrol and oil shipments and a small proportion of Burundi traffic, is handled by Agence Maritime Internationale (AMI), a Belgian shipping company.

The port is managed by the Tanzania Harbour Authority (THA). It has 11 quays (total length 2,016 meters), one oil jetty (36,000 ton capacity), 13 covered storage warehouses (106,331 square meters total surface) and open storage areas (150,331 square meter total surface). The port has sufficient cargo handling equipment except for that needed for containers.

AMI has a warehouse and an open storage area at Berth No. 1 with capacities of 6,000 tons and 10,000 tons of miscellaneous cargo, respectively. The loading and unloading of ships is the

responsibility of the THA. Berth No. 1 serves as the area for loading and unloading the RBZ destined cargo outs the TRC line. Handling of cargo from the quay onto the TRC train is the responsibility of AMI. AMI is equipped with eight small forklifts and one large size one (27 tons capacity) for handling containers. AMI has had difficulties recently with the local help and the result is inefficient productivity and a considerable amount of damaged cargo.

The port of Dar es Salaam reached the maximum throughput in 1977 when it handled 2.35 million tons of general cargo; 2.11 million tons of petrol, oil and lubricants; and 22,000 tons of miscellaneous cargo. THA indicates that the maximum capacity of the port is 6 million tons per year.

Since 1975 an increasing proportion of the total port traffic has been the Zambian traffic. [illegible] the total of approximately 2.4 million tons of general cargo in 1977, 1.36 million tons (or approximately 57 percent) were from or destined to Zambia. Around 1977, the port began to experience increasing congestion, for the following reasons:

a. Insufficient capacity of TAZARA and the Tanzam Highway to handle the Zambian cargo; consequently, it tended to remain in port and contribute to inefficienct port operations.

b. Decline in the productivity of cargo handling personnel due to a general decline in morale caused by wage stagnation and an insufficient availability of cargo handling equipment (particularly for handling containers), a situation that was further aggravated by the increased amount of cargo to be handled.

c. Inadequate number of port management personnel, in part due to the loss of skilled cadres following the breakup of the East African Harbours Authority (EAHA).

During 1979 and 1980 the congestion began to lessen due to lower levels in the Zambian cargo tonnages and an improved rate of moving arriving cargoes out of the port.[1] The result has been a marked reduction in ship waiting time, which in early 1979 was 25 days and in late 1980 was down to three or four days at the most. The port congestion itself had an effect on RBZ import traffic, which at the height of congestion tended to be rerouted via Mombasa.[2]

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[1] In 197[illegible] Zambia began diversion of its export/import traffic to South African ports.

[2] RBZ import traffic through Dar es Salaam port was 12,000 tons in early 1978 and 30,000 tons in early 1979.

Another problem that contributed to the Dar es Salaam port congestion was the sudden surge in container traffic, for which the port was ill equipped. The number of container units unloaded in the port between 1976 and 1979 was as follows:

Year	Number of Container Units
1976	212
1977	220
1978	984
1979	2,445
1980*	4,236*

* January to April only.

To improve port services and operations several projects are being prepared under the sponsorship of the World Bank. They are projected for execution between 1981 and 1984. Included are improvements to:

- Container berth and container handling equipment
- Widening and deepening of the entrance channel
- Bulk cargo handling facilities
- Warehouse for Zambian imports
- Maintenance facilities

Thus, one can conclude that the port of Dar es Salaam should not constitute a bottleneck for the ZBR export/import traffic in the future, provided that Zambian traffic does not again clog the port and provided that the port management cadres are strengthened.

5.10.2 Port of Kigoma

The port of Kigoma, constructed in 1921, constitutes a "bottleneck" for the Burundi and Zaire traffic transiting towards the port of Dar es Salaam. The port, which has not had any major improvements since 1921, has problems due to the inadequacy of port facilities and to the inefficiency of the TRC and ARNOLAC operations. Among the principal problems are: [1]

- Limited length of the only quay of the port, which allows docking of only four barges at a time.

- Terrain of the port, which is on several levels, hampering efficient handling of cargo.

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[1] ARNOLAC operates the barge transport on Lake Tanganyika between the ports of Kigoma and Bujumbura.

- Insufficient capacity of warehouses. Frequently, cargo is left in the railway freight cars for a period of time before being loaded on the barges. This in turn ties up the railway operations at the port.

- Antiquated and insufficient cargo handling equipment.

- Port operations hampered by poor communications with TRC. Frequently, freight cars do not arrive as scheduled or arrive without required documents, which means they are not authorized to be unloaded.

- Uncoordinated barge operations. Barges reserved for "dirty" cargo (cement, fertilizers, etc.) cannot be used for "clean" cargo (sugar, flour, salt, etc.). Thus, there are often too many barges of the wrong type in port and cargo pits in port occupy scarce storage space waiting for the right type of barge to arrive.

The port is managed by AMI Tanzania. Between 1977 and 1980 the port handled approximately 200,00 tons of cargo. Import tonnage was approximately equal to the export tonnage. Export commodities are primarily copper and zinc from Zaire and coffee from Burundi.

Several improvements of the port and its facilities are planned in the short term. Based on a study by HAECON, financed by Belgium, the port's needs by the end of 1982 include:

- Levelling of its terrain to facilitate cargo handling

- Acquisition of new cargo and container handling equipment

These changes would allow the port to increase its throughput to 280,500 tons. The HAECON study recommends additional improvements over the medium and long term. It projects port traffic, in year 2000, at 422,500 tons. It is unlikely, however, that the port will see an increase in its traffic in the future if the Rusumo-Isaka road is built and if the railway leading to the Angolan port of Lobito is opened to Zaire copper and zinc export traffic.

The EEC intends to finance the improvements of the Kigoma port, but the decision has been delayed several times.

5.10.3 Port of Bujumbura

The port of Bujumbura was formerly the regional port serving Burundi, Rwanda and the Kivu region of Zaire. Its capacity is still adequate for the traffic transiting through this port.

The port is managed by a private company known as Exploitation du Port de Bujumbura (EPB), which has a concession to use these port facilities owned by the Burundi Government.

It is not expected that the projected traffic will exceed the port's capacity in the near or medium term.

The port only needs periodic dredging and maintenance of its facilities and equipment. Similarly, the port of Kigoma needs a mobile 50-ton crane capable to handle containerized cargo.

The port of Bujumbura also suffers from the inefficient operation of ARNOLAC, whose barge fleet is old and not suited for container or palletized cargo handling. ARNOLAC's fleet consists of two self-propelled barges and 10 tow barges. Due to government-set tariffs that are insufficient to cover capital replacement costs, the owners of ARNOLAC have let the fleet deteriorate and will seemingly be able to continue barge service only so long as minimal maintenance and repairs suffice to keep the fleet operational.

The main need, at present, is for spare parts for the existing equipment, resurfacing of the port area and a crane because containers return to Dar es Salaam usually empty because of lack of export commodities suitable for containerization.

ECONOMIC EVALUATION 6

6. ECONOMIC EVALUATION

6.1 ECONOMIC EVALUATION BACKGROUND

6.1.1 Introduction

In December 1980 the Consultant submitted the Draft Economic and Technical Feasibility Study of the Bukombe-Isaka Road Link. Based on the review of the draft report, the Consultant was requested to make certain revisions. The net result of these revisions was to significantly improve the relative economic attractiveness of the construction of a paved road by incorporating the cost of rehabilitating and properly maintaining the existing road in order to obtain adequate vehicle operating performance on it. At the same time, the vehicle operating savings for a new road were increased by identifying the anticipated geometric operating improvements and distance savings for the proposed new road, by shortening the anticipated time period for attracting generated and diverted traffic, by introducing traffic-variable maintenance costs and by reducing some of the costs associated with the proposed construction of a new road, such as the Isaka rail station.

The details of the revisions and basis for the economic evaluation are described below.

6.1.2 Traffic Diversion and Growth Rates

a. Generated

In the present analysis, generated traffic is assumed to reach a maximum of 15 percent of normal commercial and passenger traffic for construction of a new 6.5 meter paved roadway. For the construction of a new 6.5 meter wide gravel road, anticipated generated traffic was reduced by the ratio of the VOC for operating over the new gravel road as compared to the paved road. In the economic analysis, 50 percent of the generated traffic VOC savings are applied as benefits to each proposed improved facility.

b. International

In the present analysis, 80 percent of the Rwanda gross surface export/import traffic is assumed to be diverted to a new 6.5 meter wide paved road and all 80 percent will be diverted in the first year the road is open (1985), increasing at the rate of 5 percent per year thereafter based on the analysis shown in Article 6.4.4. For the purpose of this analysis, diversion of Burundi gross surface export/import traffic to the proposed route is anticipated to be only 10 percent of the Burundi gross

surface export/import traffic, as described in Article 6.4.4. It will all be diverted to the new road in 1985 and rise at an annual rate of 4.5 percent for the 20-year period.

c. Traffic Growth Rates

In addition to the original forecast of 5 percent traffic growth rate described in the Consultant's report of December 1980, a 7 percent rate of growth for traffic is also presented for review in the analysis for the 23-year period 1981-2004.

6.1.3 Vehicle Operating Savings

The Consultant has adopted the user cost data developed by Brokonsult AB in its Dodoma Report.[1] The methodology employed by Brokonsult AB is outlined in detail in Article 4.4 of this report. The main cost parameters and consumption rates are also presented. In addition, the proposed new road is 5 kilometers shorter in length than the existing Bukombe to Isaka road. In the following economic evaluation, the VOCs for the existing gravel road have been developed for a total distance of 117.5 kilometers, and the VOCs for the proposed gravel and paved roads have been calculated on the basis of 112.5 kilometers. The 5 kilometer savings for the proposed gravel and paved roads are incorporated in the VOC savings as well as the generated and international traffic calculations.

6.1.4 Travel Time Savings

In the December 1980 draft report, the Consultant incorporated travel time savings for commercial vehicles. In this analysis, time savings for passengers have also been developed and are presented in Article 6.6. Given the significant debate in transportation planning circles regarding the validity of including travel savings to passengers as an economic benefit for a proposed road improvement, in the following pages the economic evaluation of alternative improvement levels has been calculated both "with" and "without" passenger time savings.

6.1.5 Increase in Vehicle Operating Costs due to Design Standards

The existing Bukombe-Isaka roadway is only 5.5 meters wide and the proposed roadways would be 6.5 meters wide with

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[1] Dodoma Transport and Logistics Study, the United Republic of Tanzania, Capital Development Authority, United Nations. Prepared by Brokonsult AB, Vol. III, Annex V, 1977.

1.5 meter shoulders. Therefore, factors have been developed to evaluate the increased operating costs due to vehicle passage on the narrower roadway. These costs are presented in Article 6.5 and incorporated in the economic evaluation in the following pages.

6.1.6 Isaka Rail Facility Costs

In the draft report of December 1980, the Consultant incorporated the full cost for the required Isaka rail facility improvement to handle freight and passenger traffic transfer from the proposed road to the Tanzanian Railroad, given that the facility must be improved to efficiently handle transit traffic flowing between Rwanda, Burundi and Dar es Salaam. In the revised analysis, the Consultant has assumed in the first instance that the total costs should be allocated one-half to the railroad, which will be the major recipient of the proposed benefits. Two-thirds of the remaining half would be allocated to the already constructed Rusomo and Lusahunga roads and one-third to the proposed new road. Thus, only one-sixth of the Isaka rail facility costs are incorporated in this analysis.

In the second analysis, the Consultant has assumed that all costs for the improved Isaka railroad station would be allocated to the railroad and no costs would be allocated to the proposed road improvements. The results of both analyses are shown below.

6.1.7 Maintenance

For the present economic evaluation, the Consultant has drawn on prior experience in highway maintenance programs in Sudan, Uganda and Kenya to introduce variable maintenance costs sensitive to alternative traffic volumes and surface width and conditions for different road surfaces. The details are given in Article 5.7.4 of this report for each potential improvement level.

6.1.8 Salvage Values

Salvage values (see Article 6.3.3) were incorporated in the twentieth year as residual values for each road improvement. No regravelling or resurfacing (periodic) maintenance cost has been applied in the last few years in order to ensure consistency in the analysis of residual values.

6.1.9 Definition of Existing Road

The existing road was originally a gravel road 5.5 meters wide. It has deteriorated as a result of inadequate maintenance to a

level that presently approximates a condition similar to an earth road. For the sake of consistency, however, the Consultant has assumed in this analysis that the existing road would be rehabilitated and upgraded to its original gravel standard and properly maintained during the 20-year planning period. In this way, the analysis avoids an overstatement of the VOC savings with a comparison of a poorly maintained existing road to a well maintained new road. This was accomplished by incorporating a 35.6 million T.Sh. investment (economic costs) in the cost of the existing road for its rehabilitation to improve it to a maintainable condition and then assuming annual and periodic maintenance costs as described in Article 5.7.4 to ensure that the existing road is maintained to a proper gravel standard. However, the question still remains of whether, even if properly maintained, the existing facility will provide a level of service comparable to a superior modern gravel road. Therefore, the economic internal rate of return calculations have been prepared on the basis of two assumptions: a) the existing road will be properly maintained and will provide VOCs comparable to a modern 5.5 meter wide gravel road, and b) the existing road will provide less than optimal service, comparable to only 90 percent of the savings a modern gravel road provides in VOCs as compared to a well maintained earth road.

6.2 EVALUATION CRITERIA USED FOR THE ECONOMIC ANALYSIS

The following economic criteria were used in the economic evaluation.

6.2.1 Benefit/Cost Ratio

The benefit/cost ratio (B/C) expresses the ratio of total discounted benefits to total discounted costs for a specified time period.

6.2.2 Net Present Value

The net present value (NPV) is a computation of the difference between the total streams of discounted benefits and costs over the life of the project. This procedure measures the net value of savings in monetary terms; from an overall economic viewpoint, the NPV may be more meaningful than the B/C ratio, which expresses only a ratio between savings and costs. The equation of NPV is as follows:

$$NPV = -INV + \frac{cf1}{(1+i)1} + \frac{cf2}{(1+i)2} \quad .... \quad \frac{cfn}{(1+i)n}$$

NPV = net present value
INV = cash outlay
$\frac{cf1}{(1+i)1}$ = cash flow generated the first year

$\frac{cf2}{(1+i)2}$ = cash flow generated the second year

i = the rate of return or desired yield

6.2.3 Economic Internal Rate of Return

The final economic indicator used in this study is the Economic Internal Rate of Return (EIRR). This indicator, in effect, expresses the return on investment; it is the discount rate that equates the streams of benefits and costs so that the Net Present Value = 0. The equation used to solve for the EIRR is that used to compute NPV; in this instance, NPV is set to zero and the equation is solved for "i," as follows:

$$0 = -INV + \frac{cf1}{(1+i)1} + \frac{cf2}{(1+i)2} + \ldots \frac{cf20}{(1+i)20}$$

6.3 FINANCIAL AND ECONOMIC COSTS

The following assumptions and data have been used in the economic evaluation.

6.3.1 Construction Period and Project Life

The construction period is January 1982 to June 1984, and by the end of 1984 it is assumed that the rail transshipment facilities at Isaka will also be completed. The project life is assumed to be for 20 years after the road opening; thus, the evaluation period ends in year 2004.

6.3.2 Opportunity Cost of Capital

The opportunity cost of capital is difficult to determine in the absence of free markets, especially since prevailing interest rates also reflect such factors as inflation and risk. However, it appears likely that the opportunity cost of capital in many developing countries is quite high, frequently as high as 12 percent or more.

Most consultants and financial agencies have used a range of 8 to 15 percent as the discount rate for feasibility studies in Tanzania. Rates of 10 percent and 12 percent per annum have been adopted in this study.

6.3.3 Construction Costs

For purposes of the economic analysis, project costs including construction of the Bukombe-Isaka road and the Isaka rail (transshipment) terminal were prepared. These costs have been estimated based on engineering design criteria and construction cost estimates obtained for similar recent highway and railroad projects in Tanzania. Detailed construction cost estimates are presented in Articles 5.5.5 and 5.5.7.

The local and foreign currency components of new paved and gravel roads financial and economic construction costs are shown in Tables 6.1 and 6.3.[1] The construction costs by year of expenditure are shown in Tables 6.2 and 6.4. Construction expenditures are anticipated to occur over a three-year period (beginning in 1982 and ending in 1984).

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[1] The economic costs reflect an adjustment to take into account the differential between the official and the free market foreign exchange rate (see Article 5.7.5 and notes 1 and 2 in Table 6.1).

Table 6.1

LOCAL AND FOREIGN CURRENCY COMPONENTS OF NEW PAVED ROAD CONSTRUCTION COSTS

(in 1980 million T. Sh.)

	Bukombe-Isaka Road			Isaka Rail Terminal		
	Local	Foreign	Total	Local	Foreign	Total
Project Cost (Financial)	116.33	73.43	189.76	10.32	19.28	29.60
Percent Total	61.30	38.70	100.00	34.90	65.10	100.00
Percent Taxes	8.50%	10.35%		8.50%	10.35%	
Taxes	9.89	7.60		0.88	2.00	
Total Less Taxes	106.42	65.82		9.44	17.28	
Total Adjusted for Economic Cost of Foreign Currency (Economic Cm)	113.95 1/	164.65 2/	278.60	10.11	43.20	53.31

Source: Consultant's estimates.

1/ Reflects an adjustment to take into account foreign currency exchange differential for intermediate goods (e.g., fuel and cement) that are purchased in local currency. It is estimated that 4.7 percent of the local currency construction cost component is the cost of the intermediate goods. An adjustment factor of 2.5 times foreign currency cost component was applied.

2/ Reflects an adjustment of 2.5 times Financial Foreign cost, after taxes, to account for the foreign currency exchange differential (official vs. free market rate), based on the Dodoma Transport and Logistic Study.

Table 6.2

CONSTRUCTION COST BY YEAR OF EXPENDITURE

(in 1980 million T. Sh.)

ear	Bukombe-Isaka Road 1/	Isaka Railroad Terminal 1/	Total
982	110.07		110.07
983	117.57	2.40 2/	119.37
984	50.96	6.50 2/	57.46
	278.60	8.90 2/	287.50

urce: Consultant's estimates.

From Table 6.1.

Only one-sixth of the Isaka railroad facility construction cost is assigned to the project cost on the basis of assigning one-half of the total cost to road links and one-half to the railroad link. The Bukombe-Isaka road section represents only one-third of the total road link.

Table 6.3

LOCAL AND FOREIGN CURRENCY COMPONENTS OF NEW GRAVEL ROAD CONSTRUCTION COSTS

(in 1980 million T. Sh.)

	Bukombe-Isaka Road		
	Local	Foreign	Total
Project Cost	99.43	50.78	150.21
Percent Taxes	8.50%	10.35%	
Taxes	8.45	5.26	
Total Less Taxes	90.98	45.52	
Total Adjusted for Foreign Currency	97.40	113.80	211.20

Table 6.4

CONSTRUCTION COST BY YEAR OF EXPENDITURE

(in 1980 million T. Sh.)

Year	Bukombe-Isaka Road	Isaka Railroad Terminal 1/	Total
1982	84.46	-	84.46
1983	95.04	2.40	97.44
1984	31.70	6.50	38.20
	211.20	8.90	220.10

1/ Only one-sixth of the Isaka railroad facility construction cost is assigned to the project cost on the basis of assigning one-half of the total cost to the road link and one-half to the railroad link. The Bukombe-Isaka road link section represents only one-third of the total road link.

6.3.4 Maintenance Costs

Maintenance cost estimates for gravel and bituminous surfaced roads are presented in Chapter 5, Article 5.7.4. These cost estimates are based on information obtained from the Ministry of Works in Tanzania and various recent reports.

Both gravel and bituminous surfaced roads require annual and periodic maintenance. In general, periodic maintenance for gravel roads is performed more frequently than for bituminous surfaced roads. The maintenance costs and frequencies are summarized in Table 6.5.

Table 6.5

MAINTENANCE COST ESTIMATES BY TYPE OF ROAD SURFACE BASED ON AADT OF 200 (in 1980 T.Sh./km)

	Surface Type	
	Gravel	Bituminous
A. Annual	15,600	16,700
B. Periodic		
Once every 3 years	84,300	
Once every 5 years		115,900

Source: Table 5.6 of this report

The maintenance costs (for 200 AADT level of traffic) shown in Table 6.5 were adjusted for other levels of AADT using formulas detailed in Article 5.7.4 and the respective costs for various road improvements were calculated in the computer model.

6.3.5 Residual Value

The total residual value of a road is composed of the aggregate residual values of certain portions of road construction whose useful life exceeds a 20-year planning period. In the case of the Bukombe-Isaka road the components of residual value can be assumed as shown in Table 6.6.

Table 6.6

COMPONENTS OF THE RESIDUAL VALUE OF THE ROAD AFTER 20 YEARS

Bill No.	Description	Residual Value (%)	Assumed Useful Life (Years)
3	Site Clearance	80	100
5	Earthworks	80	100
7	Base Course	0	20
8	Bituminous Surfacing	0	20
9	Bridges and Culverts	60	50

Thus in the case of paved road (Alternative No. 3), the residual value is calculated to be 44.04 million T.Sh. after deducting taxes and adjusting the local and foreign currency components for the true cost of foreign exchange.[1] [2] The corresponding computation is shown in Table 6.7 below:

Table 6.7

ECONOMIC VALUES OF COST COMPONENTS OF THE RESIDUAL VALUES

Bill No.	Total Value		Residual Value			
	L	F	%	L 1/	F 2/	Subtotals
3	7.03	0.78	80	5.509	1.398	6.91
5	23.84	5.96	80	18.681	10.686	29.37
9	2.98	4.47	60	1.751	6.011	7.76
Total						44.04

1/ (1.00-0.085)(0.953+0.047 x 2.5) = 0.97951 x L

2/ (1.00-0.1035) x 2.5 = 2.24125 x F

(For treatment of taxes see Article 5.5.7.b)

[1]Refer to Article 5.5.5 for a discussion of construction costs.

[2]A factor of 2.5 (based on the Dodoma Transport and Logistic Study, see Article 4.4) was applied to the foreign currency component after deducting taxes. It was estimated that 4.7 percent of the local currency components corresponds to imported goods purchased locally. This amount was also inflated by the 2.5 factor.

The residual value of a new gravel road is the same as that of the new paved road since both the base course and the double bituminous surface treatment paving were assumed to have no useful life after 20 years.

6.3.6 Base Year and Opening Year

A three-year construction period, 1982 through 1984, is assumed for the road, and by the end of 1984 the Isaka facilities are assumed to be completed. Opening year, therefore, is 1985. Movement of goods over the route is assumed to commence in January 1985. The economic analysis covers the period of 1981 to 2004.

6.4 FORECAST OF FUTURE TRAFFIC VOLUMES

Four categories of traffic were considered in this analysis: normal, generated, diverted and international.

6.4.1 Normal Traffic

Existing and future normal passenger and freight traffic is not dependent on the improvements under study. Normal traffic is that traffic required to meet the day-to-day transport needs of routine economic activity in the Tanzanian project area together with its natural growth.

As previously discussed, the existing Isaka-Rusomo road traverses a largely rural undeveloped region of Tanzania. Forecasts prepared in 1974 by Sir Alexander Gibb and Partners projected a 9 percent per year growth in total traffic, while forecasts prepared by the Government of Tanzania projected growth rates of 3 to 4 percent per year. For the purpose of this study, a mid-range average of annual growth rates of 5 and 7 percent is used in the analysis for Tanzanian traffic from 1981-2004 (defined in this report as normal traffic). The growth rates exclude both generated and diverted traffic, which if included would produce corresponding growth rates of 5.2 and 7.1 percent over the 23-year period 1981 to 2004. For the period 1974-1981 a growth rate of only 2 percent has been used. This reflects the relatively poor surface of the existing road and the recent socioeconomic conditions in the region.

During the planning period the traffic mix is also expected to remain evenly split between heavy and light vehicles. Over the long term, however, the composition of heavy vehicles may change, with heavier vehicles serving the region as a result of the proposed road improvement. At present, only about 1 percent of the traffic consists of truck-trailers. With the completion of the proposed road, it is assumed that between 1990 and 2004 the use of truck-trailers will increase and heavy vehicles will include 40 percent country buses, 50 percent 12-ton trucks and 10 percent 32-ton truck-trailers, reflecting the increased attractiveness of the road.

6.4.2 Generated Traffic

Generated traffic is new traffic that arises as a result of a specific road improvement. It is movements or trips that would not have been made (would not be "generated") without the road improvement in question. Improving the Bukombe-Isaka road will generate additional traffic. The magnitude and extent of this additional traffic is at present speculative. However, for purposes of this study, it will be assumed that generated

traffic, which is limited to Tanzanian traffic (international traffic has been projected independently) is anticipated to increase gradually after completion of the road construction in 1984 and rise to 15 percent of the projected normal traffic in 1985 for a new paved road and to correspondingly lower levels (based on VOC savings) for a new gravel road (see Table 6.10).

6.4.3 Tanzanian Diverted Domestic Traffic

Given the lack of parallel routes in reasonable proximity to the Bukombe-Isaka road, local traffic diversion will probably be negligible. For purposes of this study, no local diverted traffic is assumed.

6.4.4 International Traffic

Rwanda and Burundi foreign trade is likely to be attracted to an improved road/railroad route via Isaka to Dar es Salaam. The extent of the traffic diversion will depend on the transport cost, distance, number of transshipments and border crossings and time in transit. This comparison of the various routes is presented in Table 6.8. Of the five alternative routes, the least-cost route to Rwanda is Route IV: Dar es Salaam to Isaka via railway then Isaka to Kigali by road. Transport costs for this route are considerably more economical than each of the alternative routes. This route is also the shortest with the minimum number of border crossings. However, transport travel time for this route is considerably longer than the alternative routes through Mombasa. For this reason, it is anticipated that only 80 percent of the Rwanda gross surface export/import traffic will be diverted to a new 6.5 meter wide paved road.

While the Dar es Salaam-Isaka-Bujumbura route is estimated to be the more economical transport route to Burundi, the transport cost for this route is only marginally less than the estimated cost of the alternative Dar es Salaam-Kigoma-Bujumbura route. The transport cost differential between these two routes is probably within the margin of error; consequently, the Dar es Salaam-Isaka-Bujumbura route is not clearly the more economical route. Also, the transport timeframe, number of transshipments and distances are comparable. Taking into consideration the comparability of these two routes and the fact that the Dar es Salaam-Isaka-Bujumbura route requires an additional border crossing, traffic diversion is not likely to be significant and, in any case, would not greatly influence the economic analysis since actual user savings are slight. However, some Burundi traffic may divert from the northern route through Mombasa. At present, approximately 20 percent of

Table 6.8

OMPARISON OF ROUTINGS FROM RWANDA AND BURUNDI TO INDIAN OCEAN PORTS [1]

Routings	Transport Cost US $/ Ton A (TSW/ton)	Modes	Distance (Km)	Trans-Shipments	Border Crossings	Time Taken (Days) [4]
Rwanda to						
Mombasa via Malaba	395 (3160)	Rail	1085	2	2	15.6 to 17.5
		Road	808			
		Total	1893			
Mombasa via Kampala	385 (3080)	Rail	1338	2	2	15.6 to 17.5
		Road	586			
		Total	1924			
Mombasa	455 (3640)	Road	1737	1	2	23.6 to 48.5
Dar es Salaam via Isaka	152 [2] (1160)	Rail	982	2	1	41 to 81 [3]
		Road	496			
		Total	1478			
Dar es Salaam via Kigoma	330 (2640)	Rail	1253	3	2	47 to 95
		Barge	175			
		Road	285			
		Total	1713			
Burundi to						
Mombasa via Malaba	545 (4360)	Rail	1085	2	3	16.6 to 18.5
		Road	1093			
		Total	2178			
Mombasa via Kampala	530 (4240)	Rail	1338	2	3	16.6 to 18.5
		Road	871			
		Total	2209			
Mombasa	610 (4880)	Road	2022	1	3	24.6 to 49.5

Table 6.8

COMPARISON OF ROUTINGS FROM RWANDA AND BURUNDI TO INDIAN OCEAN PORTS

(continued)

Routings	Transport Cost US $/ Ton A (TSW/ton)	Modes	Distance (Km)	Trans-Shipments	Border Crossings	Time Taken (Days)
Burundi to (continued)						
Dar es Salaam via Isaka	175 1/ (1520)	Rail Road	982 598	2	1	42 to 82 2/
		Total	1580			
Dar es Salaam via Kigoma	195 (1560)	Rail Barge	1253 175	2	1	46 to 94
		Total	1428			

1/ Total transport cost (financial) in 1980 U.S. dollars includes port costs; transshipment costs; road, railroad, and barge costs; forwarders fees; border crossing fees; and shipping costs differential (assuming a common external node--Europe--for analytical purposes adds differential for longer shipping distance: $20/ton to Dar es Salaam; 1979 costs updated to 1980 costs use an assumed 15 percent inflation rate).

2/ Assumes road transport costs of $0.07/ton-kilometer and railroad costs of $38/ton.

3/ Prorates transport travel time for road and railroad links in relation to distance.

4/ Based on experience prior to 1980.

Source: A Report on the International Transportation Bottlenecks Affecting Rwanda and Burundi, International Bank for Reconstruction and Development, February 1980.

the Burundi gross surface import/export traffic is transported via Mombasa. Unless the transport travel time for the Dar es Salaam-Isaka-Bujumbura routing is reduced (mainly due to the railway delays; see Article 5.9), traffic is not likely to be diverted from the Mombasa alternatives. With increased management efficiency of TRC, the travel time on the rail link should gradually decrease. It is however anticipated that only a relatively small percentage of the Burundi gross surface import/export traffic will divert to the Dar es Salaam-Isaka-Bujumbura route. For purposes of this analysis, diversion of Burundi gross surface import/export traffic to this route is anticipated to be limited to approximately 10 percent of the Burundi gross surface import/export traffic. This diversion is assumed to occur the first year the road is opened.

The summary of projected international traffic diverted to a new 6.5 meter wide paved Bukombe-Isaka road link is shown in Table 6.9. Traffic forecasts for the Isaka-Bukombe road are summarized in Table 6.10.

For alternate improvement levels (e.g., gravel) the forecasts of international and generated traffic were lowered, reflecting lower vehicle operating savings.

Table 6.9

PROJECTED INTERNATIONAL TRAFFIC

(trucks per day)

YEAR	BURUNDI	RWANDA	TOTAL
1979	-	-	-
1985	4	31	35
1990	6	37	43
1995	8	51	59
2000	10	65	75
2004	14	70	84

Table 6.10

TRAFFIC FORECAST SUMMARY

(vehicles per day)

YEAR	NORMAL TRAFFIC 1/		GENERATED TRAFFIC				INTERNATIONAL TRAFFIC 2/	
	5%	7%	5%		7%			
	(G and P)		(G)	(P)	(G)	(P)	(G)	(P)
1985	120	135	12	18	13	20	23	35
1990	150	189	15	23	19	28	29	43
1995	200	266	20	30	27	40	40	59
2000	264	373	27	40	38	56	50	75
2004	318	489	32	48	49	73	54	84

(G) = gravel road (P) = paved road

1/ Based on 90 vehicles per day in 1979 between Kahama and Isaka.

2/ Assumes truck fleet comprised of 12-ton capacity trucks exclusively through 1989, then 12-ton truck and 32-ton truck tractor trailer in 5:1 ratio from 1990 to 2004.

6.5 "DELTA L" FOR LESS THAN ADEQUATE SURFACE WIDTH

When two vehicles approach in opposite directions on a narrow roadway, one or both must leave the travelway to travel at least partially on the shoulders. These maneuvers cause speed change cycles that increase vehicle operating costs. The severity of this problem varies with width of the roadway, traffic volume and vehicle operating speed.

The increased vehicle operating cost due to the narrow roadway widths is estimated as follows:

$$L = \frac{R \times V \times \Delta L + S}{S}$$

Where L is increased vehicle operating cost per vehicle/kilometer of travel, expressed in equivalent additional meters per 1,000 meters of travel

R is (7.2 meters - width of travel surface in meters) ./. 7.2 meters

V is vehicles per hour in both directions

Δ L is the "Delta L" for a speed change cycle, from vehicle operating speed to 8 kilometers per hour, the assumed passing speed

S is vehicle travel speed

The above equation for the specific roadway alternatives can be viewed as shown below:

Paved:

$$\Delta L = \frac{0.26 \times ADT + 10 \times 1{,}071 + 72}{72}$$

or

$$\Delta L = 1 + 0.39\ ADT$$

Gravel:

$$\Delta L = \frac{0.26 \times ADT + 10 \times 670 + 56}{56}$$

$$\Delta L = 1 + 0.31\ ADT$$

Existing Gravel:

$$\Delta L = \frac{0.62 \times ADT + 10 \times 500 + 48}{48}$$

or

$$\Delta L = 1 + 0.64\ ADT$$

6.6 TIME VALUE

The value of travel time of commercial and passenger vehicles has been examined in this study.

6.6.1 Operator Time Benefits - Commercial Vehicles

The value of travel time of commercial vehicles has been assumed to be equivalent to the economic wage rate of the vehicle driver and the assistant. Because this component is already included in the development of the vehicle operating costs, any further analysis would result in double counting.

6.6.2 Passenger Time Value

Whether the passengers' time should be allowed generally depends on whether the extra time will be used for work or voluntary leisure or whether it merely increases under-employment. In the project area and the zone of influence, which has largely an agrarian economy, it is difficult to value passenger time savings resulting from road improvements.

The method adopted in this study is the assessment of the travel time saved at the average wage rate, assuming all trips are either work related and all of the passenger time savings attributable to the road improvements would be put to productive use or that the perceived value of pleasure time saved would be equal to work time. However, all economic evaluations are shown with and without the value of passenger time savings to avoid possible distortion in the analysis.

The average wage rate, taken to be T.Sh. 385 per week on the basis of a 44-hour work week is equivalent to T.Sh. 8.75 per hour for taxi/passenger cars. Half of this is assigned for the bus passengers to represent the lower income levels of bus users.

The average occupancy of passenger cars/taxis was estimated at five passengers (excluding the driver) reflecting the relatively high occupancy rates of station-wagon type taxis or pickup trucks, while that of buses was estimated at 35 passengers.

The average speeds (kilometers/hour) considered are as follows:

	PAVED	GRAVEL
Car/taxi:	72	56
Bus:	56	48

The cost per hour of passenger time for automobiles, taxis and buses is thus calculated as follows:

Passenger car/taxi:	5 persons x 8.75 T.Sh. = 43.75 T.Sh./hr.
Buses:	35 persons x 4.38 T.Sh. = 153.30 T.Sh./hr.

The passenger time costs per kilometer on paved and gravel roads (and at the average speeds considered) are indicated below:

	SURFACE TYPE	
VEHICLE TYPE	PAVED	GRAVEL
	(T.Sh./km)	
Passenger Car/Taxi	0.61	0.78
Bus	2.74	3.19

The results of these passenger time savings are presented in Table 6.11.

Table 6.11

PASSENGER TIME SAVINGS [1/]

(000 T.Sh.)

YEAR	Upgraded Existing Road to New Gravel Road — Assumed Traffic Growth 5%	7%	Upgraded Existing Road to New Paved Road — Assumed Traffic Growth 5%	7%
1985	254	287	853	950
1986	267	302	896	1,028
1987	281	319	940	1,083
1988	288	354	966	1,128
1989	308	372	1,035	1,244
1990	222	281	767	979
1991	234	296	810	1,024
1992	253	304	883	1,080
1993	269	339	923	1,133
1994	282	360	973	1,192
1995	296	393	1,018	1,353
1996	310	421	1,069	1,477
1997	333	448	1,145	1,557
1998	359	483	1,232	1,648
1999	373	507	1,283	1,770
2000	399	557	1,371	1,871
2001	407	592	1,397	2,068
2002	433	628	1,485	2,216
2003	454	674	1,561	2,308
2004	477	722	1,638	2,523

1/ Includes normal and generated traffic only because diverted international traffic is essentially freight.
Traffic mix based on vehicle-type composition shown in Table 4.21 and ADTs shown in Tables 6.13 through 6.16.

6.7 SAVINGS IN TRANSPORT AND VEHICLE OPERATING COSTS

6.7.1 Savings in Transport Costs for Rwanda/Burundi

Among the economic benefits of the proposed Bukombe-Isaka road improvement are transport cost savings for Rwanda and Burundi. In a more comprehensive study the savings in transport costs for Rwanda and Burundi would be computed as the difference in the total economic transport costs, handling costs and time costs between the proposed route and the alternative northern and southern routes, from which traffic is likely to divert. The total economic transport cost savings would then be prorated to the Isaka-Rusumo road project and capital improvements for the Tanzanian railway. However, due to the limited scope of this study, transport cost savings for Rwanda and Burundi attributable to the proposed road link cannot be determined in detail. For purposes of this study, transport cost savings for Rwanda and Burundi attributable to the proposed road link have been computed as the economic savings in vehicle operating costs for the international traffic projected in Article 6.4.

The projected savings in transport costs (reduced vehicle operating costs for the international traffic) are presented in Table 6.12. The NPV of the projected transport cost savings are as follows:

Discount Rate	Upgrading Existing Road to Gravel (million T.Sh.)	Upgrading Existing Road to Paved (million T.Sh.)
10%	12,365	123,584
12%	9,976	99,720

6.7.2 Savings in Vehicle Operating Costs for Tanzanian Traffic

Vehicle operating cost (VOC) savings attributable to the proposed Bukombe-Isaka road project were computed for Tanzanian traffic (at 5 percent and 7 percent traffic growth rates). The projected annual savings in vehicle operating costs are presented in Tables 6.13, 6.14, 6.15 and 6.16, representing the Tanzanian normal traffic VOC saving between the existing road upgraded to good gravel standard and a new paved or gravel road. The savings in VOC for the generated traffic were computed separately because the economic benefits derived from VOC savings for generated traffic are less than for other domestic traffic (only one-half of the savings in VOC for generated traffic are considered for purposes of economic

Table 6.12

PROJECTED SAVINGS IN TRANSPORT COSTS
FOR RWANDA AND BURUNDI

Year	ADT[1/] Rwanda	ADT[1/] Burundi	ADT[1/] Total	Annual Transport Cost Savings[2/] (10^3 T. Sh.) Upgraded Exist. Road to New Paved Road	Annual Transport Cost Savings[2/] (10^3 T. Sh.) Upgraded Exist. Road to New Gravel Road
1985	31	4	35	13,217	1,317
1986	32	4	36	13,594	1,354
1987	34	4	38	14,350	1,430
1988	35	5	40	15,106	1,506
1989	36	5	41	15,483	1,543
1990	37	6	43	16,238	1,618
1991	39	6	45	16,993	1,693
1992	43	6	49	18,504	1,844
1993	47	7	54	20,392	2,032
1994	49	7	56	21,147	2,258
1995	51	8	59	23,844	2,379
1996	54	8	62	25,056	2,500
1997	58	8	64	25,865	2,581
1998	61	9	70	28,289	2,822
1999	63	9	72	29,098	2,903
2000	65	10	75	30,310	3,024
2001	67	10	77	31,118	3,105
2002	68	11	79	31,926	3,185
2003	69	13	82	33,139	3,306
2004	70	14	84	33,946	3,386

1/ Figures are rounded.

2/ From Table 4.21. Economic VOC for upgraded existing road to paved and for upgrading existing road to gravel standards (5 kilometers difference only). Assumed future traffic mix in 1995 of 12-ton and 32-ton trucks in a 5:1 ratio.

Table 6.13

UPGRADED EXISTING ROAD TO NEW GRAVEL ROAD
VEHICLE OPERATING COST SAVINGS FOR TANZANIAN TRAFFIC
(5 percent traffic growth rate)

Year	Average Daily Traffic (vehicles)	Light Vehicles Per Day 1/	Heavy Vehicles Per Day 2/	Annual Vehicle Operating Cost Savings (T. Sh.) Light Vehicles	Heavy Vehicles	Total 3/
1985	120	60	60	893	2,078	2,971
1986	126	63	63	923	2,180	3,103
1987	132	66	66	967	2,283	3,250
1988	138	69	69	1,002	2,391	3,393
1989	144	72	72	1,054	2,498	3,552
1990	150	75	75	1,089	2,798	3,887
1991	160	80	80	1,173	2,976	4,149
1992	170	85	85	1,233	3,209	4,442
1993	180	90	90	1,309	3,349	4,658
1994	190	95	95	1,369	3,580	4,949
1995	200	100	100	1,455	3,721	5,176
1996	212	106	106	1,542	3,952	5,494
1997	225	113	113	1,628	4,196	5,824
1998	238	119	119	1,730	4,428	6,158
1999	250	125	125	1,816	4,658	6,474
2000	264	132	132	1,919	4,738	6,657
2001	275	138	137	1,993	5,139	7,132
2002	288	144	144	2,095	5,349	7,444
2003	303	151	152	2,198	5,651	7,849
2004	318	159	159	2,331	5,921	8,252

1/ Based on a 50/50 split, light vehicles/heavy vehicles and a 70/30 split, light van/automobiles.

2/ Based on a 50/50 split, light vehicles/heavy vehicles. Ratio of bus/12-ton truck/32-ton truck trailer: 60/40/00 1985 to 1989 and 40/50/10 1990 to 2004.

3/ Upgraded existing road (gravel) to new gravel same VOC applies. Upgraded existing road (gravel) length 117.5 kilometers, new gravel 112.5 kilometers. Excludes VOC savings attributable to generated traffic. VOC from Table 4.21.

Table 6.14

UPGRADED EXISTING ROAD TO NEW GRAVEL
VEHICLE OPERATING COST SAVINGS FOR TANZANIAN TRAFFIC
(at 7 percent traffic growth rate)

ar	Average Daily Traffic (Vehicles)	Light Vehicles Per Day 1/	Heavy Vehicles Per Day 2/	Annual Veh. Op. Cost Savings (T. Sh.) Light Vehicles	Heavy Vehicles	Total 3/
85	135	68	67	975	2,353	3,328
86	144	72	72	1,045	2,494	3,539
87	154	77	77	1,120	2,667	3,787
88	165	83	82	1,206	2,840	4,046
89	176	88	88	1,282	3,045	4,327
90	189	95	94	1,380	3,490	4,870
91	203	101	102	1,482	3,758	5,240
92	216	108	108	1,573	4,022	5,595
93	231	116	115	1,671	4,324	5,995
94	246	123	123	1,789	4,573	6,362
95	266	133	133	1,950	4,907	6,857
96	284	142	142	2,064	5,279	7,343
97	303	151	152	2,198	5,651	7,849
98	325	163	162	2,371	6,023	8,394
9	347	173	174	2,516	6,466	8,982
0	373	186	187	2,705	6,945	9,650
1	399	200	199	2,914	7,404	10,318
2	426	213	213	3,098	7,916	11,014
3	455	228	227	3,303	8,488	11,791
4	489	244	245	3,550	9,124	12,674

1/ Based on 50/50 split, light vehicles/heavy vehicles and 70/30 split, light van/automobiles.

2/ Based on 50/50 split, light vehicles/heavy vehicles. Ratio of bus/12-ton truck/32-ton truck trailer: 60/40/00 1985 to 1989 and 40/50/10 1990 to 2004.

3/ Upgraded existing road (gravel) to new gravel same VOC applies. Upgraded existing road (gravel) length 117.5 kilometers, new gravel 112.5 kilometers. Excludes VOC savings attributable to generated traffic. VOC from Table 4.21.

Table 6.15

UPGRADED EXISTING ROAD TO PAVED ROAD
VEHICLE OPERATING COST SAVINGS FOR TANZANIAN TRAFFIC
(at 5 percent traffic growth rate)

Year	Average Daily Traffic (Vehicles)	Light Vehicles Per Day 1/	Heavy Vehicles Per Day 2/	Annual Veh. Op. Cost Savings (T. Sh.) Light Vehicles	Heavy Vehicles	Total 3/
1985	120	60	60	4,615	20,260	24,875
1986	126	63	63	4,848	21,260	26,108
1987	132	66	66	5,082	22,259	27,341
1988	138	69	69	5,315	23,325	28,640
1989	144	72	72	5,548	24,325	29,873
1990	150	75	75	5,782	27,580	33,362
1991	160	80	80	6,153	29,335	35,488
1992	170	85	85	6,456	31,626	38,082
1993	180	90	90	6,923	33,002	39,925
1994	190	95	95	7,226	35,292	42,518
1995	200	100	100	7,693	36,669	44,362
1996	212	106	106	8,159	38,959	47,118
1997	225	113	113	8,626	41,336	49,962
1998	238	119	119	9,161	43,626	52,787
1999	250	125	125	9,628	45,915	55,543
2000	264	132	132	10,164	48,358	58,522
2001	275	138	137	10,536	50,248	60,784
2002	288	144	144	11,071	52,714	63,785
2003	303	151	152	11,607	55,692	67,299
2004	318	159	159	12,238	58,360	70,598

1/ Based on 50/50 split, light vehicles/heavy vehicles and 70/30 split, light vans/automobiles.

2/ Based on 50/50 split, light vehicles/heavy vehicles. Ratio of bus/12-ton truck/32-ton truck trailer: 60/40/00 1985 to 1989 and 40/50/10 1990 to 2004.

3/ Upgraded existing road (gravel) to paved. Economic VOC from Table 4.21. Upgraded existing road (gravel) 117.5 kilometers, paved 112.5 kilometers. Excludes VOC savings attributable to generated traffic.

Table 6.16

UPGRADED EXISTING ROAD TO PAVED ROAD
VEHICLE OPERATING COST SAVINGS FOR TANZANIAN TRAFFIC
(at 7 percent traffic growth rate)

ear	Average Daily Traffic (Vehicles)	Light Vehicles Per Day 1/	Heavy Vehicles Per Day 2/	Annual Veh. Op. Cost Savings (T. Sh.) Light Vehicles	Heavy Vehicles	Total 3/
985	135	68	67	5,151	22,947	28,098
986	144	72	72	5,548	24,325	29,873
987	154	77	77	5,920	26,013	31,933
988	165	83	82	6,387	27,702	34,089
989	176	88	88	6,759	29,701	36,460
990	189	95	94	7,320	34,380	41,700
991	203	101	102	7,856	37,047	44,903
992	216	108	108	8,297	39,648	47,945
993	231	116	115	8,859	42,626	51,485
994	241	123	123	9,464	45,070	54,534
995	266	133	133	10,302	48,358	58,660
996	284	142	142	10,933	52,025	62,958
997	303	151	152	11,607	55,692	67,299
998	325	163	162	12,541	59,360	71,901
999	347	173	174	13,309	63,715	77,024
000	373	186	187	14,312	68,488	82,800
001	399	200	199	15,359	72,961	88,320
002	426	213	213	16,387	78,005	94,392
003	455	228	227	17,459	83,651	101,110
004	489	244	245	18,764	89,919	108,683

1/ Based on 50/50 split, light vehicles/heavy vehicles and 70/30 split, light vans/automobiles.

2/ Based on 50/50 split, light vans/heavy vehicles. Ratio of bus/12-ton truck/32/ton truck trailer: 60/40/00 1985 to 1989 and 40/50/10 1990 to 2004.

3/ Upgraded existing road (gravel) to paved. Economic VOC from Table 4.21. Upgraded existing road (gravel) 117.5 kilometers, paved 112.5 kilometers. Excludes VOC savings attributable to generated traffic.

analysis since generated traffic is attributable to construction of the road project). Generated traffic VOC savings are presented in Tables 6.17 and 6.18. The Net Present Value (NPV) of the vehicle operating cost savings attributable to normal and generated traffic is as follows:

Discount Rate	Upgrading Existing Road to Gravel Standard Traffic Growth		Upgrading Existing Road to Bitumen Standard Traffic Growth	
	5%	7%	5%	7%
Normal Traffic (million T.Sh.)				
10%	28,280	36,514	241,126	311,494
12%	22,820	29,203	194,409	248,975
Generated Traffic (million T.Sh.)				
10%	2,121	2,737	18,085	23,285
12%	1,712	2,189	14,581	18,609

Table 6.17

UPGRADED EXISTING ROAD TO NEW GRAVEL ROAD
VEHICLE OPERATING COST SAVINGS ATTRIBUTABLE TO GENERATED TRAFFIC
(000 T. Sh.)

Year	Vehicles Per Day 1/		Annual Vehicle Operating Cost Savings 2/	
	5%	7%	5%	7%
1985	18	20	223	249
1986	19	21	233	265
1987	20	23	244	284
1988	21	24	254	303
1989	22	26	266	324
1990	23	28	291	365
1991	25	30	311	393
1992	26	32	333	419
1993	28	34	349	449
1994	29	37	371	477
1995	30	40	388	514
1996	32	42	412	551
1997	34	45	436	589
1998	36	48	462	630
1999	38	52	485	674
2000	40	56	499	724
2001	43	60	543	774
2002	45	64	558	826
2003	47	69	589	884
2004	48	73	618	951

1/ Based on normal traffic vehicle mix and 15 percent of normal traffic.

2/ Based on economic VOC from Table 4.21. Upgraded existing road (gravel) 117.5 kilometers versus new gravel road, 112.5 kilometers. Same VOC applies for upgraded existing road and new gravel. For economic analysis purposes, only 50 percent of the generated traffic vehicle operating cost savings are applied.

Table 6.18

UPGRADED EXISTING ROAD TO PAVED ROAD

VEHICLE OPERATING COST SAVINGS ATTRIBUTABLE TO GENERATED TRAFFIC

(000 T. Sh.)

	Vehicles Per Day 1/		Annual Veh. Oper. Cost Savings 2/	
Year	5%	7%	5%	7%
1985	18	20	1,866	2,107
1986	19	21	1,958	2,240
1987	20	23	2,051	2,395
1988	21	24	2,148	2,557
1989	22	26	2,240	2,735
1990	23	28	2,502	3,128
1991	25	30	2,662	3,168
1992	26	32	2,856	3,596
1993	28	34	2,994	3,861
1994	29	37	3,189	4,090
1995	30	40	3,327	4,399
1996	32	42	3,534	4,722
1997	34	45	3,747	5,047
1998	36	48	3,959	5,393
1999	38	52	4,166	5,776
2000	40	56	4,389	6,210
2001	43	60	4,559	6,624
2002	45	64	4,784	7,079
2003	47	69	5,047	7,583
2004	48	73	5,295	8,151

1/ Based on normal traffic vehicle mix and 15 percent of normal traffic.

2/ Based on economic VOC from Table 4.21. Upgraded existing road (gravel) 117.5 kilometers versus paved road 112.5 kilometers. For economic analysis purposes, only 50 percent of the generated traffic vehicle operating cost savings are applied.

6.8 FINDINGS

6.8.1 Introduction

In this analysis, two levels of improvement were considered: a comparison of the existing gravel road (117.5 kilometers) versus a new gravel road (112.5 kilometers) and a new paved DBST paved road (112.5 kilometers).

Each proposed improvement was evaluated on the basis of assumed traffic growth rates of 5 and 7 percent for the period 1981-2004. In addition, each of the improvement levels was analyzed including and excluding a portion of the cost of the proposed improvements to the Isaka railway facilities. Finally, the economic internal rate of return, benefit/cost ratio and net present value for each proposed improvement level is presented with and without passenger time savings.

In order to verify whether or not the economic viability of the proposed improvements is significantly affected by changes in construction costs and economic benefits, a sensitivity analysis was also performed. Given the wide number of variables requested by the client in the preparation of the revised economic evaluation and the relatively complex analysis required in introducing variable maintenance costs, differing levels of generated and diverted traffic (see Article 4.3.2) and developing Delta "L" vehicle operating cost variations for surface width (see Article 6.5), the Consultant prepared a computer model for use in the economic evaluation. The computer printouts are shown in Annex A of this report. This model is also available should any additional analyses be required for the proposed road.

In addition to meeting the criteria described above, the model does the following:

a. Adjusts international and generated traffic (columns 3 and 4) by the ratio of vehicle operating savings for an optimal two-lane, 6.5 meter paved road as compared to a well maintained earth road to the comparable vehicle operating savings for each candidate road, i.e., existing gravel 61 percent, new gravel 67 percent and new paved 100 percent.

b. Calculates AADT for each candidate improvement and adjusts the routine annual maintenance costs (columns 7 and 9) accordingly.

c. Calculates EIRR, benefit/cost ratio, net present value and sensitivity studies for each candidate improvement.

6.8.2 Replacing the Existing Gravel Road With a New Gravel Road at 5 and 7 Percent Annual Traffic Growth

The results of this analysis are presented in Table 6.19. Including one-sixth of the Isaka rail facility costs and excluding passenger time savings, the EIRR is 6.02 percent and 8.36 percent and 5 and 7 percent forecast rates of traffic growth, respectively. The benefit/cost ratio at 10 and 12 percent opportunity cost of capital is 0.61 and 0.52, respectively, at 5 percent forecast rate of traffic growth and 0.84 and 0.69, respectively, at the 7 percent rate. Including the Isaka railway facility costs and time cost savings, at 5 and 7 percent traffic growth rates, the EIRR is 6.15 percent and 8.52 percent, respectively, while the benefit/cost ratios are 0.53 and 0.71 at 12 percent, and 0.62 and 0.85 at 10 percent. Without time cost savings and without including the cost of the Isaka railway facility, the EIRR is 6.28 percent and 8.72 percent while the benefit/cost ratios are 0.63 and 0.54 at the 10 percent and 0.87 and 0.72 at 12 percent. Finally excluding the Isaka rail facility costs and including the time cost savings, the EIRR is 6.40 percent and 8.87 percent and the benefit/cost ratios are 0.64/0.55 and 0.88/0.73 at the 10 and 12 percent rates, respectively.

In terms of the NPV, a comparison of the existing gravel road and new gravel road is negative at the 10 percent and 12 percent opportunity costs of capital.

The results of the sensitivity analysis at 5 and 7 percent traffic growth are presented in Tables 6.20 and 6.21. Construction costs were decreased by 10 and 20 percent while benefits were held constant in the first test, yielding the following results: a) construction costs decreased by 10 percent give an EIRR of 5.43 percent and b) construction costs decreased by 20 percent to give an EIRR of 8.36 percent.

For the second test, construction costs were held constant while the economic benefits were increased by 10 and 20 percent. In this test the EIRR is still below 8 percent for both cases (7.23 percent and 7.89 percent).

The third sensitivity analysis investigated the effect of a decrease in construction costs coupled with an increase in the economic benefits. Two cases evaluated were: a) a 10 percent decrease in construction costs combined with 10 percent increase in benefits and b) a 20 percent increase in the economic benefits combined with a 20 percent decrease in construction costs.

Table 6.19

EXISTING ROAD TO NEW GRAVEL ROAD
EIRR AND B/C RATIOS AT THE 5 AND 7 PERCENT TRAFFIC GROWTH RATES

		Isaka Costs	Time Savings	EIRR	B/C 10%	B/C 12%
5% Traffic Growth						
	1.	w/o	w	6.40	0.64	0.55
	2.	w/o	w/o	6.28	0.63	0.54
	3.	w	w	6.15	0.62	0.53
	4.	w	w/o	6.02	0.61	0.52
7% Traffic Growth						
	1.	w/o	w	8.87	0.88	0.73
	2.	w/o	w/o	8.72	0.87	0.72
	3.	w	w	8.52	0.85	0.71
	4.	w	w/o	8.36	0.84	0.69

Table 6.20

SENSITIVITY ANALYSIS OF EXISTING ROAD TO NEW GRAVEL ROAD
AT 5 PERCENT TRAFFIC GROWTH

Sensitivity Type	Without Isaka Costs	With Isaka Costs	With Time Savings	B/C 10%	B/C 12%	EIRR
10% Decrease in costs	X		X	0.57	0.48	5.43
No change in benefits		X	X	0.55	0.46	5.15
20% Decrease in costs	X		X	0.85	0.72	8.36
No change in benefits		X	X	0.83	0.70	7.97
10% Increase in benefits	X		X	0.70	0.60	7.23
No change in costs		X	X	0.70	0.60	7.01
20% Increase in benefits	X		X	0.81	0.69	7.89
No change in costs		X	X	0.79	0.66	7.68
10% Decrease in costs	X		X	0.83	0.71	8.04
10% Increase in benefits		X	X	0.80	0.68	7.82
20% Decrease in costs	X		X	1.01	0.90	10.84
20% Increase in benefits		X	X	1.03	0.87	10.38

Table 6.21

SENSITIVITY ANALYSIS OF EXISTING ROAD TO NEW GRAVEL ROAD AT 7 PERCENT TRAFFIC GROWTH

Sensitivity Type	Without Isaka	With Isaka	With Time Savings	B/C 10%	B/C 12%	EIRR
10% Increase in costs	X		X	0.78	0.65	7.82
No change in benefits		X	X	0.75	0.62	7.64
20% Decrease in costs	X		X	1.16	0.96	11.63
No change in benefits		X	X	1.12	0.93	11.27
10% Increase in benefits	X		X	0.99	0.82	9.95
No change in costs		X	X	0.96	0.79	9.64
20% Increase in benefits	X		X	1.11	0.92	11.13
No change in costs		X	X	1.07	0.88	10.74
10% Decrease in costs	X		X	1.13	0.94	11.36
10% Increase in benefits		X	X	1.09	0.90	10.98
20% Decrease in costs	X		X	1.44	1.19	14.11
20% Increase in benefits		X	X	1.30	1.15	13.70

For case (a) the EIRR equaled 8.04 percent while for case (b) the EIRR equaled 10.84 percent.

Similar tests were performed for the case of 7 percent traffic growth, and the results are presented in Table 6.21. The EIRR exceeds 14 percent only if costs are decreased by 20 percent coupled with a 20 percent increase in benefits. The EIRR exceeds 11 percent in the case of a 20 percent decrease in costs with no change in benefits, a 20 percent increase in benefits with no change in costs, and a 10 percent decrease in costs coupled with a 10 percent increase in benefits.

The detailed computer model results of the analysis comparing existing gravel to a gravel road at 5 and 7 percent traffic growth are presented in Annex A. The EIRR, benefit/cost ratios and discount rates are also shown in the annex tables.

The reason for the relatively low EIRR obtained by comparing the existing gravel Bukombe-Isaka road with a new gravel road reflects the fact that in this analysis the Consultant assumed that the relatively poorly maintained and deteriorated existing 5.5 meter wide gravel road can be brought up to its original design standards through the provision of 35.6 million T.Sh. for rehabilitation in the year 1984. This procedure was adopted to avoid the inconsistency of comparing a poorly maintained existing gravel road with a properly maintained new facility, and it is based on the assumption that the existing road can, in fact, be rehabilitated to its original design standards. As a result of this procedure, the vehicle operating savings for normal, diverted and generated traffic obtained by the proposed new gravel road are relatively small because the major savings for vehicles operating on a new gravel road would essentially be limited to the improved passing facilitated by a 6.5 meter wide roadway with 1.5 meter wide shoulders versus the existing 5.5 meter wide roadway. Also considered is the 5 kilometer reduction in total distance. While this does produce a 9.48 percent increase in diverted traffic and generated traffic benefits and vehicle operating savings, it is not sufficient in comparison with the 210 percent increase in additional construction costs compared to improving the existing gravel road to result in an attractive EIRR. However, questions have been raised concerning the reasonableness of assuming the existing road can be brought up to sufficient standard to provide a level of service comparable to a modern 6.5 meter gravel road. Thus, a second analysis was undertaken based on the fact that despite the 35.6 million T.Sh. improvement level, the existing gravel road would only sustain a service level comparable to 90 percent of the vehicle operating savings obtained by a new gravel road in comparison to a well maintained earth road. Based on this analysis, the findings were as follows:

Well-Maintained Earth Road to New Gravel Road	Isaka Costs	Time Costs	EIRR
5% Traffic Growth	w/o	w	16.09
	w/o	w/o	15.95
	w	w	16.01
	w	w/o	15.86
7% Traffic Growth	w/o	w	16.28
	w/o	w/o	16.16
	w	w	16.22
	w	w/o	16.10

6.8.3 Existing Road to New Paved Road at 5 and 7 Percent Annual Traffic Growth

Table 6.22 shows the results of the analysis of replacing the existing road with a new paved road at the 5 and 7 percent annual traffic growth rates. Including the Isaka rail facility costs and excluding time cost savings, the EIRR is 15.80 and 17.45 (at 5 and 7 percent traffic growth). The benefit/cost ratio, at 10 and 12 percent is 1.59 and 1.33 and 1.80 and 1.51, respectively. Including the Isaka railway facility costs and time cost savings at the 5 and 7 percent traffic growth rates, the EIRR is 16.02 and 17.70, while the benefit/cost ratios are 1.62 and 1.84 at 10 percent, and 1.36 and 1.54 at 12 percent. Without time cost savings and without the Isaka railway facility costs, the EIRR is 16.18 and 17.81. The benefit/cost ratios are 1.64 and 1.37 at 10 percent and 1.85 and 1.55 at 12 percent opportunity cost of capital. Finally, excluding the Isaka railway facility costs and including time cost savings, the EIRR rises to 16.45 and 18.08 and the benefit/cost ratios are 1.66 and 1.39 at 10 percent opportunity cost of capital and 1.89 and 1.58 at 12 percent opportunity cost of capital.

The NPV of the economic benefits for each case is also shown in Table 6.18.

The results of the sensitivity analysis at 5 and 7 percent traffic growth are presented in Tables 6.23 and 6.24. In the first case, construction costs were decreased by 10 and 20 percent while benefits were held constant. In the second case, construction costs were held constant while economic benefits were increased by 10 and 20 percent, and finally, the effect of a decrease in construction costs coupled with an increase in the economic benefits was analyzed. In all cases, the EIRRs are shown in Tables 6.23 and 6.24.

Table 6.22

EXISTING ROAD TO NEW PAVED ROAD EIRR AND B/C RATIOS AT THE 5 AND 7 PERCENT TRAFFIC GROWTH RATES

		Isaka Costs	Time Costs	EIRR	B/C		NPV	
					10%	12%	10%	12%
5% Traffic Growth								
	1.	W/O	W	16.45	1.66	1.39	152,804	88,992
	2.	W/O	W/O	16.18	1.64	1.37	146,378	83,732
	3.	W	W	16.02	1.62	1.36	146,403	82,760
	4.	W	W/O	15.80	1.59	1.33	139,977	77,500
7% Traffic Growth								
	1.	W/O	W	18.08	1.89	1.58	204,658	129,954
	2.	W/O	W/O	17.81	1.85	1.55	196,535	123,365
	3.	W	W	17.70	1.84	1.54	198,257	123,722
	4.	W	W/O	17.45	1.80	1.51	190,134	117,133

Table 6.23

SENSITIVITY ANALYSIS
EXISTING ROAD TO NEW PAVED ROAD
AT 5 PERCENT TRAFFIC GROWTH

Sensitivity Type	Without Isaka	With Isaka	With Time Savings	B/C 10%	B/C 12%	EIRR
10% Decrease in costs	X		X	1.50	1.26	15.04
No change in benefits		X	X	1.46	1.23	14.66
20% Decrease in costs	X		X	2.11	1.77	20.11
No change in benefits		X	X	2.04	1.72	19.69
10% Increase in benefits	X		X	1.84	1.54	17.93
No change in costs		X	X	1.79	1.50	17.56
20% Increase in benefits	X		X	2.02	1.69	19.44
No change in costs		X	X	1.96	1.65	19.02
10% Decrease in costs	X		X	2.06	1.73	19.73
10% Increase in benefits		X	X	2.00	1.68	19.33
20% Decrease in costs	X		X	2.55	2.14	23.57
20% Increase in benefits		X	X	2.48	2.08	23.10

Table 6.24

SENSITIVITY ANALYSIS
EXISTING ROAD TO NEW PAVED ROAD
AT 7 PERCENT TRAFFIC GROWTH

Sensitivity Type	Without Isaka	With Isaka	With Time Savings	B/C 10%	B/C 12%	EIRR
10% Increase in costs	X		X	1.71	1.43	16.64
No change in benefits		X	X	1.66	1.39	16.23
20% Decrease in costs	X		X	2.39	1.99	21.91
No change in benefits		X	X	2.32	1.94	21.49
10% Increase in benefits	X		X	2.09	1.74	19.68
No change in costs		X	X	2.03	1.70	19.28
20% Increase in benefits	X		X	2.29	1.91	21.22
No change in costs		X	X	2.23	1.86	20.77
10% Decrease in costs	X		X	2.33	1.95	21.53
10% Increase in benefits		X	X	2.27	1.90	21.10
20% Decrease in costs	X		X	2.89	2.41	25.20
20% Increase in benefits		X	X	2.81	2.35	24.80

In summary, the economic evaluation of constructing a 112.5 kilometer, 6.5 meter wide paved road to replace the existing 117.5 kilometer Bukombe-Isaka highway produced a relatively attractive economic internal rate of return when compared to a comparable gravel road improvement. Based on the revisions described in detail in the preceding articles, it produced a relatively more favorable EIRR than the original findings of the Consultant's December 1980 analysis. The explanation of the relatively more attractive EIRR and benefit/cost ratios for a proposed paved road improvement as compared to a new gravel road reflects the fact that a proposed gravel road improvement would be approximately 72 percent of the economic cost of a comparable paved road. However, the vehicle operating cost savings for traffic using the existing gravel road transferring to a new gravel road were only 9.48 percent, while the typical vehicle operating savings for traffic transferring from the existing gravel road to a new paved road were 57.05 percent. Thus, the incremental vehicle operating savings of a paved road compared to a new gravel road significantly exceeded the additional construction costs, and this finding is typical of most new roads (without extraordinary construction requirements) with traffic volumes in the 200 to 500 AADT vehicle range.

If the assumption that the existing gravel road cannot be rehabilitated to the level of a modern gravel road is valid, then a more attractive EIRR in the range of 15.9 percent to 16.3 percent is obtained. Furthermore, a more detailed and comprehensive analysis of a new gravel road investment might have produced a more attractive EIRR if the Consultant were able to properly inventory the existing 117.5 kilometer road, establish homogeneous link sections, and for each of these sections, compare the feasibility of rehabilitating the existing gravel road link to an improved gravel condition versus realigning that section. Under such an analysis, only the most critical links producing the highest economic rates of return could have been realigned to a new gravel section, while the remaining links could have either been rehabilitated and maintained in their existing condition or widened to a 6.5 meter carriageway. However, given the Consultant's scope of work and time constraints, such an analysis lay outside the purview of this study. But, such a study may be merited if budget constraints should indicate the need to develop a time-staged solution to the proposed Bukombe-Isaka road improvement.

ANNEX A

EXISTING TO PAVED AT 5 AND 7 PERCENT TRAFFIC GROWTH

EXISTING TO PAVED WITH 5 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITH 100% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-119.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-57.460	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	22.092	1.866	13.217	0.853	0.000	0.000	1.740	0.000	-1.839	37.920	173
1986	0.000	23.033	1.958	13.594	0.896	0.000	0.000	1.756	0.000	-1.851	39.387	181
1987	0.000	23.964	2.051	14.350	0.940	0.000	8.551	1.770	0.000	-1.865	49.761	190
1988	0.000	24.942	2.148	15.106	0.966	0.000	0.000	1.788	0.000	-1.878	43.071	199
1989	0.000	25.853	2.240	15.483	1.035	0.000	0.000	1.802	0.000	-1.891	44.522	207
1990	0.000	28.868	2.502	16.238	0.767	0.000	9.638	1.818	-13.247	-1.905	44.680	216
1991	0.000	30.370	2.662	16.993	0.810	0.000	0.000	1.844	0.000	-1.926	50.753	230
1992	0.000	32.306	2.856	18.504	0.883	0.000	0.000	1.870	0.000	-1.949	54.469	245
1993	0.000	33.426	2.994	20.392	0.923	0.000	11.495	1.900	0.000	-1.975	69.154	262
1994	0.000	35.300	3.189	21.147	0.973	0.000	0.000	1.922	0.000	-1.995	60.535	275
1995	0.000	36.590	3.327	23.844	1.018	0.000	0.000	1.947	-14.190	-2.017	50.519	289
1996	0.000	38.377	3.534	25.056	1.069	0.000	13.262	1.977	0.000	-2.043	81.232	306
1997	0.000	40.143	3.747	25.865	1.145	0.000	0.000	2.011	0.000	-2.069	70.842	323
1998	0.000	41.782	3.959	28.289	1.232	0.000	0.000	2.047	0.000	-2.101	75.208	344
1999	0.000	43.404	4.166	29.098	1.283	0.000	15.481	2.075	0.000	-2.126	93.381	360
2000	0.000	45.025	4.399	30.310	1.371	0.000	0.000	2.111	-15.354	-2.155	65.697	379
2001	0.000	46.069	4.559	31.118	1.397	0.000	0.000	2.138	0.000	-2.180	83.102	395
2002	0.000	47.669	4.784	31.926	1.485	0.000	17.656	2.170	0.000	-2.206	103.484	412
2003	0.000	49.494	5.047	33.139	1.561	0.000	0.000	2.206	0.000	-2.237	89.211	432
2004	48.210	51.142	5.295	33.946	1.638	0.000	0.000	2.240	0.000	-2.264	91.996	450
2 %	-246.796	538.539	49.981	340.346	16.742	33.556	57.064	29.878	-32.378	-30.948	1002.781	4.063
8 %	-242.174	250.174	22.760	155.405	7.964	28.268	26.337	14.746	-15.016	-15.339	475.300	1.963
10 %	-236.999	199.996	18.085	123.584	6.426	26.754	20.922	12.016	-11.865	-12.515	383.402	1.618
12 %	-231.258	162.169	14.581	99.720	5.261	25.347	16.829	9.922	-9.463	-10.346	314.018	1.358
14 %	-225.282	133.237	11.917	81.563	4.365	24.036	13.694	8.293	-7.613	-8.657	260.835	1.158
16 %	-219.270	110.801	9.862	67.554	3.665	22.814	11.265	7.009	-6.175	-7.323	219.471	1.001
18 %	-213.341	93.170	8.256	56.599	3.112	21.673	9.359	5.982	-5.046	-6.256	186.849	0.876
20 %	-207.562	79.142	6.985	47.923	2.668	20.608	7.847	5.152	-4.153	-5.393	160.779	0.775
22 %	-201.971	67.846	5.966	40.968	2.308	19.611	6.635	4.474	-3.440	-4.685	139.683	0.692
24 %	-196.585	58.651	5.141	35.329	2.013	18.677	5.654	3.913	-2.867	-4.101	122.410	0.623

INTERNAL RATE OF RETURN = 16.02 %

(Continued)

EXISTING TO PAVED WITH 5 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-119.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-57.460	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	22.082	1.866	13.217	0.000	0.000	0.000	1.740	0.000	-1.839	37.067	173
1986	0.000	23.033	1.958	13.594	0.000	0.000	0.000	1.756	0.000	-1.851	38.491	181
1987	0.000	23.954	2.051	14.350	0.000	0.000	8.551	1.770	0.000	-1.865	48.821	190
1988	0.000	24.942	2.148	15.106	0.000	0.000	0.000	1.788	0.000	-1.878	47.105	199
1989	0.000	25.853	2.240	15.483	0.000	0.000	0.000	1.802	0.000	-1.891	43.487	207
1990	0.000	28.858	2.502	16.238	0.000	0.000	9.638	1.818	-13.247	-1.905	43.913	216
1991	0.000	30.370	2.662	16.993	0.000	0.000	0.000	1.844	0.000	-1.926	49.943	230
1992	0.000	32.306	2.856	18.504	0.000	0.000	0.000	1.870	0.000	-1.949	53.586	245
1993	0.000	33.426	2.994	20.392	0.000	0.000	11.495	1.900	0.000	-1.975	68.231	262
1994	0.000	35.300	3.189	21.147	0.000	0.000	0.000	1.922	0.000	-1.995	59.562	275
1995	0.000	36.590	3.327	23.844	0.000	0.000	0.000	1.947	-14.190	-2.017	49.501	289
1996	0.000	38.377	3.534	25.056	0.000	0.000	13.262	1.977	0.000	-2.043	80.163	306
1997	0.000	40.143	3.747	25.865	0.000	0.000	0.000	2.011	0.000	-2.069	69.697	323
1998	0.000	41.782	3.959	26.289	0.000	0.000	0.000	2.047	0.000	-2.101	73.976	344
1999	0.000	43.404	4.166	29.098	0.000	0.000	15.481	2.075	0.000	-2.126	92.098	360
2000	0.000	45.025	4.389	30.310	0.000	0.000	0.000	2.111	-15.354	-2.155	64.326	379
2001	0.000	46.069	4.559	31.118	0.000	0.000	0.000	2.138	0.000	-2.180	81.705	395
2002	0.000	47.669	4.784	31.926	0.000	0.000	17.656	2.170	0.000	-2.206	101.999	412
2003	0.000	49.494	5.047	33.139	0.000	0.000	0.000	2.206	0.000	-2.237	87.650	432
2004	48.210	51.142	5.295	33.946	0.000	0.000	0.000	2.240	0.000	-2.264	90.358	450
2 %	-246.796	538.539	49.981	340.346	0.000	33.556	57.064	29.878	-32.376	-30.948	986.038	3.995
8 %	-242.174	250.174	22.760	155.405	0.000	28.268	26.337	14.746	-15.016	-15.339	467.336	1.930
10 %	-236.999	199.996	18.085	120.584	0.000	26.754	20.922	12.016	-11.865	-12.515	376.976	1.591
12 %	-231.258	162.169	14.581	99.720	0.000	25.347	16.829	9.922	-9.463	-10.346	308.758	1.335
14 %	-225.282	133.237	11.917	81.563	0.000	24.036	13.694	8.293	-7.613	-8.657	256.470	1.138
16 %	-219.270	110.801	9.862	67.554	0.000	22.814	11.265	7.009	-6.175	-7.323	215.805	0.984
18 %	-213.341	93.170	8.256	56.599	0.000	21.673	9.359	5.982	-5.046	-6.256	183.737	0.861
20 %	-207.562	79.142	6.985	47.923	0.000	20.608	7.847	5.152	-4.153	-5.393	158.110	0.762
22 %	-201.971	67.846	5.966	40.968	0.000	19.611	6.635	4.474	-3.440	-4.685	137.374	0.680
24 %	-196.585	58.651	5.141	35.329	0.000	18.677	5.654	3.913	-2.867	-4.101	120.398	0.612

INTERNAL RATE OF RETURN = 15.80 %

(Continued)

EXISTING TO PAVED WITH 5 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITH 100% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-117.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-50.960	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	22.082	1.856	13.217	0.853	0.000	0.000	1.740	0.000	-1.839	37.920	173
1986	0.000	23.033	1.958	13.594	0.896	0.000	0.000	1.756	0.000	-1.851	39.387	181
1987	0.000	23.964	2.051	14.350	0.940	0.000	8.551	1.770	0.000	-1.865	49.781	190
1988	0.000	24.942	2.148	15.106	0.966	0.000	0.000	1.788	0.000	-1.878	43.071	199
1989	0.000	25.853	2.240	15.483	1.035	0.000	0.000	1.802	0.000	-1.891	44.532	207
1990	0.000	28.868	2.502	16.238	0.767	0.000	9.638	1.818	-13.247	-1.905	44.650	216
1991	0.000	30.370	2.662	16.993	0.810	0.000	0.000	1.844	0.000	-1.926	50.753	230
1992	0.000	32.306	2.856	18.504	0.633	0.000	0.000	1.870	0.000	-1.949	54.469	245
1993	0.000	33.426	2.994	20.392	0.923	0.000	11.495	1.900	0.000	-1.975	69.154	262
1994	0.000	35.300	3.189	21.147	0.973	0.000	0.000	1.922	0.000	-1.995	60.535	275
1995	0.000	36.590	3.327	23.844	1.018	0.000	0.000	1.947	-14.190	-2.017	50.519	289
1996	0.000	38.377	3.534	25.056	1.069	0.000	13.262	1.977	0.000	-2.043	81.252	306
1997	0.000	40.143	3.747	25.865	1.145	0.000	0.000	2.011	0.000	-2.069	70.842	323
1998	0.000	41.782	3.959	28.289	1.232	0.000	0.000	2.047	0.000	-2.101	75.208	344
1999	0.000	43.404	4.166	29.098	1.283	0.000	15.481	2.075	0.000	-2.126	93.381	360
2000	0.000	45.025	4.389	30.310	1.371	0.000	0.000	2.111	-15.354	-2.155	65.697	379
2001	0.000	46.069	4.559	31.118	1.397	0.000	0.000	2.138	0.000	-2.180	63.102	395
2002	0.000	47.669	4.784	31.926	1.485	0.000	17.656	2.170	0.000	-2.206	103.484	412
2003	0.000	49.494	5.047	33.139	1.561	0.000	0.000	2.206	0.000	-2.237	89.211	432
2004	44.040	51.142	5.295	33.946	1.638	0.000	0.000	2.240	0.000	-2.264	91.996	450
2 %	-241.009	538.539	49.981	340.346	16.742	33.556	57.064	29.878	-32.378	-30.948	1002.781	4.161
8 %	-235.667	250.174	22.760	155.405	7.964	28.268	26.337	14.746	-15.016	-15.339	475.300	2.017
10 %	-230.598	199.996	18.085	123.584	6.426	26.754	20.922	12.016	-11.865	-12.515	383.402	1.663
12 %	-225.026	162.169	14.581	99.720	5.261	25.347	16.829	9.922	-9.463	-10.346	314.018	1.395
14 %	-219.253	133.237	11.917	81.563	4.365	24.036	13.694	8.293	-7.613	-8.657	260.835	1.190
16 %	-213.460	110.801	9.862	67.554	3.665	22.814	11.265	7.009	-6.175	-7.323	219.471	1.028
18 %	-207.754	93.170	8.256	56.599	3.112	21.673	9.359	5.982	-5.046	-6.256	186.847	0.899
20 %	-202.197	79.142	6.985	47.923	2.668	20.608	7.847	5.152	-4.153	-5.393	160.779	0.795
22 %	-196.822	67.846	5.966	40.968	2.308	19.611	6.635	4.474	-3.440	-4.665	139.683	0.710
24 %	-191.645	58.651	5.141	35.329	2.013	18.677	5.654	3.913	-2.867	-4.101	122.410	0.639

INTERNAL RATE OF RETURN = 16.45 %

(Continued)

EXISTING TO PAVED WITH 5 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-117.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-50.960	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	22.082	1.866	13.217	0.000	0.000	0.000	1.740	0.000	-1.839	37.067	173
1986	0.000	23.033	1.958	13.594	0.000	0.000	0.000	1.756	0.000	-1.851	38.491	181
1987	0.000	23.964	2.051	14.350	0.000	0.000	8.551	1.770	0.000	-1.865	46.821	190
1988	0.000	24.942	2.148	15.106	0.000	0.000	0.000	1.788	0.000	-1.878	42.105	199
1989	0.000	25.853	2.240	15.483	0.000	0.000	0.000	1.802	0.000	-1.891	43.427	207
1990	0.000	28.868	2.502	16.238	0.000	0.000	9.638	1.818	-13.247	-1.905	43.913	216
1991	0.000	30.370	2.662	16.993	0.000	0.000	0.000	1.844	0.000	-1.926	49.943	230
1992	0.000	32.306	2.856	18.504	0.000	0.000	0.000	1.870	0.000	-1.949	53.556	245
1993	0.000	33.426	2.994	20.392	0.000	0.000	11.495	1.900	0.000	-1.975	68.231	262
1994	0.000	35.300	3.189	21.147	0.000	0.000	0.000	1.922	0.000	-1.995	59.562	275
1995	0.000	36.590	3.327	23.844	0.000	0.000	0.000	1.947	-14.190	-2.017	49.501	289
1996	0.000	38.377	3.534	25.056	0.000	0.000	13.262	1.977	0.000	-2.043	80.163	306
1997	0.000	40.143	3.747	25.865	0.000	0.000	0.000	2.011	0.000	-2.069	69.697	323
1998	0.000	41.782	3.959	28.289	0.000	0.000	0.000	2.047	0.000	-2.101	73.976	344
1999	0.000	43.404	4.166	29.098	0.000	0.000	15.481	2.075	0.000	-2.126	92.098	360
2000	0.000	45.025	4.389	30.310	0.000	0.000	0.000	2.111	-15.354	-2.155	64.326	379
2001	0.000	46.069	4.559	31.118	0.000	0.000	0.000	2.138	0.000	-2.180	81.705	395
2002	0.000	47.669	4.784	31.926	0.000	0.000	17.656	2.170	0.000	-2.206	101.999	412
2003	0.000	49.494	5.047	33.139	0.000	0.000	0.000	2.206	0.000	-2.237	87.650	432
2004	44.040	51.142	5.295	33.946	0.000	0.000	0.000	2.240	0.000	-2.264	90.358	450
2 %	-241.009	538.539	49.981	340.346	0.000	33.556	57.064	29.878	-32.378	-30.948	986.038	4.091
8 %	-235.667	250.174	22.760	155.405	0.000	28.268	26.337	14.746	-15.016	-15.339	467.336	1.983
10 %	-230.598	199.996	18.085	123.584	0.000	26.754	20.922	12.016	-11.865	-12.515	376.976	1.635
12 %	-225.026	162.169	14.581	99.720	0.000	25.347	16.829	9.922	-9.463	-10.346	308.758	1.372
14 %	-219.253	133.237	11.917	81.563	0.000	24.036	13.694	8.293	-7.613	-8.657	256.470	1.170
16 %	-213.460	110.801	9.862	67.554	0.000	22.814	11.265	7.009	-6.175	-7.323	215.805	1.011
18 %	-207.754	93.170	8.256	56.599	0.000	21.673	9.359	5.982	-5.046	-6.256	183.737	0.884
20 %	-202.197	79.142	6.985	47.923	0.000	20.608	7.847	5.152	-4.153	-5.393	158.110	0.782
22 %	-196.822	67.846	5.966	40.968	0.000	19.611	6.635	4.474	-3.440	-4.685	137.374	0.698
24 %	-191.645	58.651	5.141	35.329	0.000	18.677	5.654	3.913	-2.867	-4.101	120.398	0.628

INTERNAL RATE OF RETURN = 16.18 %

(Continued)

EXIST TO PAVED WITH 7 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITH 100% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-117.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-50.960	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	24.603	2.107	13.217	0.950	0.000	0.000	1.772	0.000	-1.865	40.735	190
1986	0.000	25.928	2.240	13.594	1.028	0.000	0.000	1.794	0.000	-1.882	42.702	201
1987	0.000	27.405	2.395	14.350	1.083	0.000	9.638	1.818	0.000	-1.903	54.785	215
1988	0.000	28.932	2.557	15.106	1.128	0.000	0.000	1.846	0.000	-1.925	47.644	229
1989	0.000	30.591	2.735	15.483	1.244	0.000	0.000	1.870	0.000	-1.946	49.977	243
1990	0.000	34.779	3.128	16.238	0.979	0.000	11.586	1.904	-13.816	-1.972	52.825	260
1991	0.000	36.933	3.368	16.993	1.024	0.000	0.000	1.935	0.000	-2.000	58.253	278
1992	0.000	38.898	3.596	18.504	1.080	0.000	0.000	1.969	0.000	-2.029	62.018	297
1993	0.000	41.120	3.861	20.392	1.131	0.000	13.987	2.009	0.000	-2.063	80.457	319
1994	0.000	42.768	4.090	21.147	1.192	0.000	0.000	2.045	0.000	-2.094	69.149	339
1995	0.000	45.208	4.399	23.844	1.353	0.000	0.000	2.093	-15.173	-2.134	59.590	365
1996	0.000	47.681	4.722	25.056	1.477	0.000	16.840	2.134	0.000	-2.169	95.742	388
1997	0.000	49.918	5.047	25.865	1.557	0.000	0.000	2.180	0.000	-2.206	82.362	412
1998	0.000	51.935	5.393	28.289	1.648	0.000	0.000	2.236	0.000	-2.253	87.247	443
1999	0.000	54.223	5.776	29.098	1.770	0.000	20.328	2.288	0.000	-2.297	111.186	471
2000	0.000	56.486	6.210	30.310	1.871	0.000	0.000	2.347	-16.969	-2.347	77.908	504
2001	0.000	58.303	6.624	31.118	2.068	0.000	0.000	2.407	0.000	-2.395	98.123	536
2002	0.000	60.243	7.079	31.926	2.216	0.000	24.495	2.471	0.000	-2.447	125.983	569
2003	0.000	62.084	7.583	33.139	2.308	0.000	0.000	2.538	0.000	-2.504	105.149	606
2004	44.040	63.875	8.151	33.946	2.523	0.000	0.000	2.614	0.000	-2.566	108.543	646
2 %	-241.009	657.542	67.021	340.346	22.059	33.556	72.188	32.129	-34.707	-32.759	1157.374	4.802
8 %	-235.667	302.114	29.668	155.405	10.166	28.268	32.686	15.662	-16.009	-16.076	541.885	2.299
10 %	-230.598	240.617	23.362	123.584	8.123	26.754	25.808	12.716	-12.629	-13.079	435.256	1.888
12 %	-225.026	194.388	18.673	99.720	6.590	25.347	20.638	10.466	-10.057	-10.784	354.980	1.578
14 %	-219.253	159.134	15.136	81.563	5.421	24.036	16.702	8.722	-8.079	-9.002	293.631	1.339
16 %	-213.460	131.876	12.429	67.554	4.517	22.814	13.667	7.351	-6.544	-7.599	246.064	1.153
18 %	-207.754	110.521	10.330	56.599	3.808	21.673	11.299	6.259	-5.341	-6.479	208.659	1.004
20 %	-202.197	93.581	8.681	47.923	3.244	20.608	9.431	5.379	-4.390	-5.575	178.881	0.885
22 %	-196.822	79.984	7.369	40.968	2.790	19.611	7.941	4.661	-3.633	-4.837	154.854	0.787
24 %	-191.645	68.947	6.314	35.329	2.420	18.677	6.740	4.070	-3.025	-4.227	135.245	0.706

INTERNAL RATE OF RETURN = 18.08 %

(Continued)

EXIST TO PAVED WITH 7 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-117.570	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-50.960	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	24.[illegible]	2.107	13.217	0.000	0.000	0.000	1.772	0.000	-1.865	39.835	190
1986	0.000	25.928	2.240	13.594	0.000	0.000	0.000	1.794	0.000	-1.882	41.874	201
1987	0.000	27.405	2.395	14.350	0.000	0.000	9.638	1.818	0.000	-1.903	53.703	215
1988	0.000	28.952	2.557	15.106	0.000	0.000	0.000	1.846	0.000	-1.925	46.516	229
1989	0.000	30.591	2.735	15.483	0.000	0.000	0.000	1.870	0.000	-1.946	48.733	243
1990	0.000	34.779	3.128	16.238	0.000	0.000	11.586	1.904	-13.816	-1.972	51.846	260
1991	0.000	36.933	3.368	16.993	0.000	0.000	0.000	1.935	0.000	-2.000	57.324	278
1992	0.000	38.898	3.596	18.504	0.000	0.000	0.000	1.969	0.000	-2.029	60.938	297
1993	0.000	41.120	3.861	20.392	0.000	0.000	13.987	2.009	0.000	-2.063	79.506	319
1994	0.000	42.768	4.090	21.147	0.000	0.000	0.000	2.045	0.000	-2.094	67.957	339
1995	0.000	45.208	4.399	23.844	0.000	0.000	0.000	2.093	-15.173	-2.134	58.237	365
1996	0.000	47.681	4.722	25.056	0.000	0.000	16.840	2.134	0.000	-2.169	94.265	388
1997	0.000	49.918	5.047	25.865	0.000	0.000	0.000	2.180	0.000	-2.206	80.805	412
1998	0.000	51.935	5.393	28.289	0.000	0.000	0.000	2.236	0.000	-2.253	85.600	440
1999	0.000	54.223	5.776	29.098	0.000	0.000	20.328	2.288	0.000	-2.297	109.417	471
2000	0.000	56.486	6.210	30.310	0.000	0.000	0.000	2.347	-16.969	-2.347	76.037	504
2001	0.000	58.303	6.624	31.118	0.000	0.000	0.000	2.407	0.000	-2.396	96.055	536
2002	0.000	60.243	7.079	31.926	0.000	0.000	24.495	2.471	0.000	-2.447	123.767	569
2003	0.000	62.084	7.583	33.139	0.000	0.000	0.000	2.538	0.000	-2.504	102.841	606
2004	44.040	63.875	8.151	33.946	0.000	0.000	0.000	2.614	0.000	-2.566	106.020	646
2 %	-241.009	657.542	67.021	340.346	0.000	33.556	72.188	32.129	-34.707	-32.759	1135.315	4.711
8 %	-235.667	302.114	29.668	155.405	0.000	28.268	32.686	15.662	-16.009	-16.076	531.718	2.256
10 %	-230.598	240.617	23.362	123.584	0.000	26.754	25.808	12.716	-12.629	-13.079	427.133	1.852
12 %	-225.026	194.388	18.673	99.720	0.000	25.347	20.638	10.466	-10.057	-10.784	348.391	1.548
14 %	-219.253	159.134	15.136	81.563	0.000	24.036	16.702	8.722	-8.079	-9.002	288.210	1.315
16 %	-213.460	131.876	12.429	67.554	0.000	22.814	13.667	7.351	-6.544	-7.599	241.548	1.132
18 %	-207.754	110.521	10.330	56.599	0.000	21.673	11.299	6.259	-5.341	-6.479	204.852	0.986
20 %	-202.197	93.581	8.681	47.923	0.000	20.608	9.431	5.379	-4.390	-5.575	175.637	0.869
22 %	-196.822	79.984	7.369	40.968	0.000	19.611	7.941	4.661	-3.633	-4.837	152.064	0.773
24 %	-191.645	68.947	6.314	35.329	0.000	18.677	6.740	4.070	-3.025	-4.227	132.824	0.693

INTERNAL RATE OF RETURN = 17.81 %

(Continued)

EXIST TO PAVED WITH 7 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITH 100% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-119.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-57.460	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	24.603	2.107	13.217	0.950	0.000	0.000	1.772	0.000	-1.865	40.785	190
1986	0.000	25.928	2.240	13.594	1.028	0.000	0.000	1.794	0.000	-1.882	42.702	201
1987	0.000	27.405	2.395	14.350	1.083	0.000	9.638	1.818	0.000	-1.903	54.786	215
1988	0.000	28.932	2.557	15.106	1.128	0.000	0.000	1.846	0.000	-1.925	47.644	229
1989	0.000	30.591	2.735	15.483	1.244	0.000	0.000	1.870	0.000	-1.946	49.977	243
1990	0.000	34.779	3.128	16.238	0.979	0.000	11.586	1.904	-13.816	-1.972	52.625	260
1991	0.000	36.933	3.368	16.993	1.024	0.000	0.000	1.935	0.000	-2.000	58.253	278
1992	0.000	38.898	3.596	18.504	1.080	0.000	0.000	1.969	0.000	-2.029	62.018	297
1993	0.000	41.120	3.861	20.392	1.131	0.000	13.987	2.009	0.000	-2.063	80.437	319
1994	0.000	42.768	4.090	21.147	1.192	0.000	0.000	2.045	0.000	-2.094	69.149	339
1995	0.000	45.208	4.399	23.844	1.353	0.000	0.000	2.093	-15.173	-2.134	59.590	365
1996	0.000	47.681	4.722	25.056	1.477	0.000	16.840	2.134	0.000	-2.169	95.742	388
1997	0.000	49.918	5.047	25.865	1.557	0.000	0.000	2.180	0.000	-2.206	82.362	412
1998	0.000	51.935	5.393	28.289	1.648	0.000	0.000	2.236	0.000	-2.253	87.247	443
1999	0.000	54.223	5.776	29.098	1.770	0.000	20.328	2.288	0.000	-2.297	111.186	471
2000	0.000	56.486	6.210	30.310	1.871	0.000	0.000	2.347	-16.969	-2.347	77.908	504
2001	0.000	58.303	6.624	31.118	2.068	0.000	0.000	2.407	0.000	-2.396	98.123	536
2002	0.000	60.243	7.079	31.926	2.216	0.000	24.495	2.471	0.000	-2.447	125.983	569
2003	0.000	62.084	7.583	33.139	2.308	0.000	0.000	2.538	0.000	-2.504	105.149	606
2004	48.210	63.875	8.151	33.946	2.523	0.000	0.000	2.614	0.000	-2.566	108.543	646
2 %	-246.796	657.542	67.021	340.346	22.059	33.556	72.188	32.129	-34.707	-32.759	1157.374	4.690
8 %	-242.174	302.114	29.668	155.405	10.166	28.268	32.686	15.662	-16.009	-16.076	541.885	2.238
10 %	-236.999	240.617	23.362	123.584	8.123	26.754	25.808	12.716	-12.629	-13.079	435.256	1.837
12 %	-231.258	194.388	18.673	99.720	6.590	25.347	20.638	10.466	-10.057	-10.784	354.980	1.535
14 %	-225.282	159.134	15.136	81.563	5.421	24.036	16.702	8.722	-8.079	-9.002	293.631	1.303
16 %	-219.270	131.876	12.429	67.554	4.517	22.814	13.667	7.351	-6.544	-7.599	246.064	1.122
18 %	-213.341	110.521	10.330	56.599	3.808	21.673	11.299	6.259	-5.341	-6.479	208.669	0.978
20 %	-207.562	93.581	8.681	47.923	3.244	20.608	9.431	5.379	-4.390	-5.575	178.881	0.862
22 %	-201.971	79.984	7.369	40.968	2.790	19.611	7.941	4.661	-3.633	-4.837	154.854	0.767
24 %	-196.585	68.947	6.314	35.329	2.420	18.677	6.740	4.070	-3.025	-4.227	135.245	0.688

INTERNAL RATE OF RETURN = 17.70 %

(Continued)

EXIST TO PAVED WITH 7 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	PAVED	PAVED	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-110.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-119.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-57.460	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	24.603	2.107	13.217	0.000	0.000	0.000	1.772	0.000	-1.865	39.835	190
1986	0.000	25.928	2.240	13.594	0.000	0.000	0.000	1.794	0.000	-1.882	41.674	201
1987	0.000	27.405	2.395	14.350	0.000	0.000	9.638	1.818	0.000	-1.903	53.703	215
1988	0.000	28.932	2.557	15.106	0.000	0.000	0.000	1.846	0.000	-1.925	45.516	229
1989	0.000	30.591	2.735	15.483	0.000	0.000	0.000	1.870	0.000	-1.945	48.733	243
1990	0.000	34.779	3.128	16.238	0.000	0.000	11.586	1.904	-13.816	-1.972	51.846	260
1991	0.000	36.933	3.368	16.993	0.000	0.000	0.000	1.935	0.000	-2.000	57.229	278
1992	0.000	38.898	3.596	18.504	0.000	0.000	0.000	1.969	0.000	-2.029	60.938	297
1993	0.000	41.120	3.861	20.392	0.000	0.000	13.987	2.009	0.000	-2.063	79.306	319
1994	0.000	42.768	4.090	21.147	0.000	0.000	0.000	2.045	0.000	-2.094	67.957	339
1995	0.000	45.208	4.399	23.844	0.000	0.000	0.000	2.093	-15.173	-2.134	58.237	365
1996	0.000	47.681	4.722	25.056	0.000	0.000	16.840	2.134	0.000	-2.169	94.265	388
1997	0.000	49.918	5.047	25.865	0.000	0.000	0.000	2.160	0.000	-2.206	80.805	412
1998	0.000	51.935	5.393	28.289	0.000	0.000	0.000	2.236	0.000	-2.253	85.600	442
1999	0.000	54.223	5.776	29.098	0.000	0.000	20.328	2.288	0.000	-2.297	109.417	471
2000	0.000	56.485	6.210	30.310	0.000	0.000	0.000	2.347	-16.969	-2.347	76.037	504
2001	0.000	58.303	6.624	31.118	0.000	0.000	0.000	2.407	0.000	-2.376	96.055	536
2002	0.000	60.243	7.079	31.926	0.000	0.000	24.495	2.471	0.000	-2.447	123.767	569
2003	0.000	62.084	7.583	33.139	0.000	0.000	0.000	2.538	0.000	-2.504	102.841	606
2004	48.210	63.875	8.151	33.946	0.000	0.000	0.000	2.614	0.000	-2.566	106.020	646
2 %	-246.796	657.542	67.021	340.346	0.000	33.556	72.188	32.129	-34.707	-32.759	1135.315	4.600
8 %	-242.174	302.114	29.668	155.405	0.000	28.268	32.686	15.662	-16.009	-16.076	531.718	2.196
10 %	-236.999	240.617	23.362	123.584	0.000	26.754	25.808	12.716	-12.629	-13.079	427.133	1.802
12 %	-231.258	194.388	18.673	99.720	0.000	25.347	20.638	10.466	-10.057	-10.784	348.391	1.507
14 %	-225.282	159.134	15.136	81.563	0.000	24.036	16.702	8.722	-8.079	-9.002	288.210	1.279
16 %	-219.270	131.876	12.429	67.554	0.000	22.814	13.667	7.351	-6.544	-7.599	241.548	1.102
18 %	-213.341	110.521	10.330	56.599	0.000	21.673	11.299	6.259	-5.341	-6.479	204.852	0.960
20 %	-207.562	93.581	8.681	47.923	0.000	20.608	9.431	5.379	-4.390	-5.575	175.637	0.846
22 %	-201.971	79.984	7.369	40.968	0.000	19.611	7.941	4.661	-3.633	-4.837	152.064	0.753
24 %	-196.585	68.947	6.314	35.329	0.000	18.677	6.740	4.070	-3.025	-4.227	132.626	0.675

INTERNAL RATE OF RETURN = 17.45 %

EXISTING GRAVEL TO GRAVEL AT 5 AND 7 PERCENT TRAFFIC GROWTH

EXIST TO GRAVEL WITH 5 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITH 67% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.4[illegible]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-97.440	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-38.200	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	6.193	0.149	0.882	0.254	0.000	0.000	1.740	0.000	-1.680	7.539	155
1986	0.000	6.633	0.156	0.907	0.267	0.000	0.000	1.756	0.000	-1.692	8.027	162
1987	0.000	7.129	0.163	0.958	0.281	0.000	8.551	1.770	-9.637	-1.707	7.509	170
1988	0.000	7.691	0.170	1.009	0.288	0.000	0.000	1.788	0.000	-1.723	9.224	179
1989	0.000	8.207	0.178	1.034	0.308	0.000	0.000	1.802	0.000	-1.735	9.794	186
1990	0.000	9.104	0.195	1.084	0.222	0.000	9.638	1.818	-10.896	-1.749	9.416	194
1991	0.000	10.058	0.208	1.134	0.234	0.000	0.000	1.844	0.000	-1.771	11.708	206
1992	0.000	11.155	0.223	1.235	0.253	0.000	0.000	1.870	0.000	-1.796	12.941	220
1993	0.000	12.236	0.234	1.361	0.269	0.000	11.495	1.900	-13.048	-1.822	12.625	235
1994	0.000	13.246	0.249	1.513	0.282	0.000	0.000	1.922	0.000	-1.844	15.367	247
1995	0.000	14.353	0.260	1.594	0.296	0.000	0.000	1.947	0.000	-1.867	16.584	260
1996	0.000	15.789	0.276	1.675	0.310	0.000	13.262	1.977	-15.147	-1.893	16.248	275
1997	0.000	17.332	0.292	1.729	0.333	0.000	0.000	2.011	0.000	-1.920	19.777	290
1998	0.000	19.118	0.310	1.891	0.359	0.000	0.000	2.047	0.000	-1.954	21.770	309
1999	0.000	20.709	0.325	1.945	0.373	0.000	15.481	2.075	-17.656	-1.979	21.263	323
2000	0.000	22.453	0.334	2.026	0.399	0.000	0.000	2.111	0.000	-2.011	25.312	341
2001	0.000	24.432	0.364	2.080	0.407	0.000	0.000	2.138	0.000	-2.036	27.385	355
2002	0.000	26.300	0.374	2.134	0.433	0.000	17.656	2.170	-20.133	-2.063	26.871	370
2003	0.000	28.655	0.395	2.215	0.454	0.000	0.000	2.206	0.000	-2.095	31.830	388
2004	48.210	30.930	0.414	2.269	0.477	0.000	0.000	2.240	0.000	-2.123	34.207	404
2 %	-181.884	227.231	3.917	22.817	4.895	33.556	57.064	29.878	-64.870	-28.618	285.871	1.572
8 %	-183.856	97.687	1.787	10.418	2.335	28.268	26.337	14.746	-29.901	-14.147	137.531	0.748
10 %	-180.627	76.202	1.421	8.284	1.886	26.754	20.922	12.016	-23.743	-11.533	112.209	0.621
12 %	-176.722	60.360	1.147	6.684	1.545	25.347	16.829	9.922	-19.089	-9.528	93.216	0.527
14 %	-172.481	48.509	0.938	5.466	1.283	24.036	13.694	8.293	-15.527	-7.967	78.725	0.456
16 %	-168.110	39.518	0.777	4.526	1.079	22.814	11.265	7.009	-12.767	-6.736	67.484	0.401
18 %	-163.735	32.602	0.651	3.792	0.917	21.673	9.359	5.982	-10.603	-5.751	58.622	0.358
20 %	-159.429	27.213	0.551	3.210	0.787	20.608	7.847	5.152	-8.887	-4.955	51.525	0.323
22 %	-155.235	22.959	0.471	2.743	0.681	19.611	6.635	4.474	-7.512	-4.303	45.759	0.295
24 %	-151.178	19.562	0.406	2.365	0.594	18.677	5.654	3.913	-6.399	-3.765	41.007	0.271

INTERNAL RATE OF RETURN = 6.15 %

(Continued)

EXIST TO GRAVEL WITH 5 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-97.440	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-38.200	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	6.193	0.149	0.882	0.000	0.000	0.000	1.740	0.000	-1.680	7.285	155
1986	0.000	6.633	0.156	0.907	0.000	0.000	0.000	1.756	0.000	-1.692	7.760	162
1987	0.000	7.129	0.163	0.958	0.000	0.000	8.551	1.770	-9.637	-1.707	7.228	170
1988	0.000	7.691	0.170	1.009	0.000	0.000	0.000	1.788	0.000	-1.723	8.936	179
1989	0.000	8.207	0.178	1.034	0.000	0.000	0.000	1.802	0.000	-1.735	9.486	186
1990	0.000	9.104	0.195	1.084	0.000	0.000	9.638	1.818	-10.896	-1.749	9.194	194
1991	0.000	10.058	0.208	1.134	0.000	0.000	0.000	1.844	0.000	-1.771	11.474	206
1992	0.000	11.155	0.223	1.235	0.000	0.000	0.000	1.870	0.000	-1.796	12.[illegible]	220
1993	0.000	12.236	0.234	1.361	0.000	0.000	11.495	1.900	-13.048	-1.822	12.356	235
1994	0.000	13.246	0.249	1.513	0.000	0.000	0.000	1.922	0.000	-1.844	15.085	247
1995	0.000	14.353	0.260	1.594	0.000	0.000	0.000	1.947	0.000	-1.867	16.289	260
1996	0.000	15.789	0.276	1.675	0.000	0.000	13.262	1.977	-15.147	-1.893	15.938	275
1997	0.000	17.332	0.292	1.729	0.000	0.000	0.000	2.011	0.000	-1.920	19.444	290
1998	0.000	19.118	0.310	1.891	0.000	0.000	0.000	2.047	0.000	-1.954	21.411	309
1999	0.000	20.709	0.325	1.945	0.000	0.000	15.481	2.075	-17.636	-1.979	20.890	323
2000	0.000	22.453	0.334	2.026	0.000	0.000	0.000	2.111	0.000	-2.011	24.913	341
2001	0.000	24.432	0.364	2.080	0.000	0.000	0.000	2.138	0.000	-2.036	26.978	355
2002	0.000	26.300	0.374	2.134	0.000	0.000	17.656	2.170	-20.133	-2.063	26.438	370
2003	0.000	28.655	0.395	2.215	0.000	0.000	0.000	2.206	0.000	-2.095	31.376	388
2004	48.210	30.930	0.414	2.269	0.000	0.000	0.000	2.240	0.000	-2.123	33.730	404
2 %	-181.084	227.231	3.917	22.817	0.000	33.556	57.064	29.878	-64.870	-28.618	280.976	1.545
8 %	-183.856	97.687	1.787	10.418	0.000	28.268	26.337	14.746	-29.901	-14.147	135.196	0.735
10 %	-180.627	76.202	1.421	8.284	0.000	26.754	20.922	12.016	-23.743	-11.533	110.323	0.611
12 %	-176.722	60.360	1.147	6.684	0.000	25.347	16.829	9.922	-19.089	-9.528	91.671	0.519
14 %	-172.481	48.509	0.938	5.466	0.000	24.036	13.694	8.293	-15.527	-7.967	77.442	0.449
16 %	-168.110	39.518	0.777	4.526	0.000	22.814	11.265	7.009	-12.767	-6.736	66.406	0.395
18 %	-163.735	32.602	0.651	3.792	0.000	21.673	9.359	5.982	-10.603	-5.751	57.705	0.352
20 %	-159.429	27.213	0.551	3.210	0.000	20.608	7.847	5.152	-8.887	-4.955	50.739	0.318
22 %	-155.235	22.959	0.471	2.743	0.000	19.611	6.635	4.474	-7.512	-4.303	45.078	0.290
24 %	-151.178	19.562	0.406	2.365	0.000	18.677	5.654	3.913	-6.399	-3.765	40.413	0.267

INTERNAL RATE OF RETURN = 6.02 %

(Continued)

EXIST TO GRAVEL WITH 5 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITH 67% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-95.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-31.700	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	6.193	0.149	0.682	0.254	0.000	0.000	1.740	0.000	-1.680	7.539	155
1986	0.000	6.633	0.156	0.907	0.267	0.000	0.000	1.756	0.000	-1.692	8.327	162
1987	0.000	7.129	0.163	0.958	0.281	0.000	8.551	1.770	-9.637	-1.707	7.509	170
1988	0.000	7.691	0.170	1.009	0.288	0.000	0.000	1.788	0.000	-1.723	9.224	179
1989	0.000	8.207	0.178	1.034	0.308	0.000	0.000	1.802	0.000	-1.739	9.794	186
1990	0.000	9.104	0.195	1.034	0.222	0.000	9.638	1.818	-10.876	-1.749	9.416	194
1991	0.000	10.058	0.208	1.134	0.234	0.000	0.000	1.844	0.000	-1.771	11.708	206
1992	0.000	11.155	0.223	1.235	0.253	0.000	0.000	1.870	0.000	-1.796	12.941	220
1993	0.000	12.236	0.234	1.361	0.269	0.000	11.495	1.900	-13.046	-1.832	12.625	235
1994	0.000	13.246	0.249	1.513	0.282	0.000	0.000	1.922	0.000	-1.844	15.367	247
1995	0.000	14.353	0.260	1.594	0.296	0.000	0.000	1.947	0.000	-1.867	16.584	260
1996	0.000	15.789	0.276	1.675	0.310	0.000	13.262	1.977	-15.147	-1.893	16.243	275
1997	0.000	17.332	0.292	1.729	0.333	0.000	0.000	2.011	0.000	-1.930	19.777	290
1998	0.000	19.118	0.310	1.891	0.359	0.000	0.000	2.047	0.000	-1.954	21.770	309
1999	0.000	20.709	0.325	1.945	0.373	0.000	15.481	2.075	-17.666	-1.979	21.263	323
2000	0.000	22.453	0.334	2.026	0.399	0.000	0.000	2.111	0.000	-2.011	25.312	341
2001	0.000	24.432	0.364	2.080	0.407	0.000	0.000	2.138	0.000	-2.036	27.385	355
2002	0.000	26.300	0.374	2.134	0.433	0.000	17.656	2.170	-20.133	-2.063	26.871	370
2003	0.000	28.355	0.395	2.215	0.454	0.000	0.000	2.206	0.000	-2.095	31.830	388
2004	44.040	30.930	0.414	2.269	0.477	0.000	0.000	2.240	0.000	-2.123	34.207	404
2 %	-176.097	227.231	3.917	22.817	4.895	33.556	57.064	29.878	-64.870	-28.618	285.871	1.623
8 %	-177.349	97.687	1.787	10.418	2.335	28.268	26.337	14.746	-29.901	-14.147	137.531	0.775
10 %	-174.226	76.202	1.421	8.284	1.886	26.754	20.922	12.016	-23.743	-11.533	112.209	0.644
12 %	-170.490	60.360	1.147	6.684	1.545	25.347	16.829	9.922	-19.089	-9.528	93.216	0.547
14 %	-166.452	48.509	0.938	5.466	1.283	24.036	13.694	8.293	-15.527	-7.967	78.725	0.473
16 %	-162.300	39.518	0.777	4.526	1.079	22.814	11.265	7.009	-12.767	-6.736	67.484	0.416
18 %	-158.148	32.602	0.651	3.792	0.917	21.673	9.359	5.982	-10.603	-5.751	58.622	0.371
20 %	-154.064	27.213	0.551	3.210	0.787	20.608	7.847	5.152	-8.887	-4.955	51.525	0.334
22 %	-150.086	22.959	0.471	2.743	0.681	19.611	6.635	4.474	-7.512	-4.003	45.759	0.305
24 %	-146.237	19.562	0.406	2.365	0.594	18.677	5.654	3.913	-6.399	-3.765	41.007	0.280

INTERNAL RATE OF RETURN = 6.40 %

(Continued)

EXIST TO GRAVEL WITH 5 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODIC	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-95.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-31.700	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	6.193	0.149	0.862	0.000	0.000	0.000	1.740	0.000	-1.680	7.225	155
1986	0.000	6.633	0.156	0.907	0.000	0.000	0.000	1.756	0.000	-1.692	7.760	162
1987	0.000	7.129	0.163	0.958	0.000	0.000	8.551	1.770	-9.637	-1.707	7.228	170
1988	0.000	7.691	0.170	1.009	0.000	0.000	0.000	1.788	0.000	-1.723	8.915	179
1989	0.000	8.207	0.178	1.064	0.000	0.000	0.000	1.802	0.000	-1.735	9.436	185
1990	0.000	9.104	0.195	1.084	0.000	0.000	9.638	1.818	-10.896	-1.749	9.194	194
1991	0.000	10.058	0.208	1.134	0.000	0.000	0.000	1.844	0.000	-1.771	11.474	206
1992	0.000	11.155	0.223	1.235	0.000	0.000	0.000	1.870	0.000	-1.796	12.688	220
1993	0.000	12.236	0.234	1.361	0.000	0.000	11.495	1.900	-13.048	-1.822	12.356	235
1994	0.000	13.246	0.249	1.513	0.000	0.000	0.000	1.922	0.000	-1.844	15.085	247
1995	0.000	14.353	0.260	1.594	0.000	0.000	0.000	1.947	0.000	-1.867	16.288	260
1996	0.000	15.789	0.276	1.675	0.000	0.000	13.262	1.977	-15.147	-1.893	15.938	275
1997	0.000	17.332	0.292	1.729	0.000	0.000	0.000	2.011	0.000	-1.920	19.444	290
1998	0.000	19.118	0.310	1.891	0.000	0.000	0.000	2.047	0.000	-1.954	21.411	309
1999	0.000	20.709	0.325	1.945	0.000	0.000	15.481	2.075	-17.666	-1.979	20.890	323
2000	0.000	22.453	0.334	2.026	0.000	0.000	0.000	2.111	0.000	-2.011	24.513	341
2001	0.000	24.432	0.364	2.080	0.000	0.000	0.000	2.138	0.000	-2.036	26.972	355
2002	0.000	26.300	0.374	2.134	0.000	0.000	17.656	2.170	-20.133	-2.063	26.438	370
2003	0.000	28.655	0.395	2.215	0.000	0.000	0.000	2.206	0.000	-2.095	31.376	388
2004	44.040	30.930	0.414	2.269	0.000	0.000	0.000	2.240	0.000	-2.123	33.730	404
2 %	-176.097	227.231	3.917	22.817	0.000	33.556	57.064	29.878	-64.870	-28.618	280.976	1.596
8 %	-177.349	97.687	1.787	10.418	0.000	28.268	26.337	14.746	-29.901	-14.147	135.196	0.762
10 %	-174.226	76.202	1.421	8.284	0.000	26.754	20.922	12.016	-23.743	-11.533	110.323	0.633
12 %	-170.490	60.360	1.147	6.684	0.000	25.347	16.829	9.922	-19.089	-9.528	91.671	0.538
14 %	-166.452	48.509	0.938	5.466	0.000	24.036	13.694	8.293	-15.527	-7.967	77.442	0.465
16 %	-162.300	39.518	0.777	4.526	0.000	22.814	11.265	7.009	-12.767	-6.736	66.406	0.409
18 %	-158.148	32.602	0.651	3.792	0.000	21.673	9.359	5.982	-10.602	-5.751	57.705	0.365
20 %	-154.064	27.213	0.551	3.210	0.000	20.608	7.847	5.152	-8.887	-4.956	50.739	0.329
22 %	-150.086	22.959	0.471	2.743	0.000	19.611	6.635	4.474	-7.512	-4.303	45.078	0.300
24 %	-146.237	19.562	0.406	2.365	0.000	18.677	5.654	3.913	-6.399	-3.765	40.413	0.276

INTERNAL RATE OF RETURN = 6.28 %

(Continued)

EXIST TO GRAVEL WITH 7 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITH 67% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-95.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-31.700	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	7.290	0.167	0.682	0.287	0.000	0.000	1.772	0.000	-1.707	8.692	170
1986	0.000	8.012	0.178	0.907	0.302	0.000	0.000	1.794	0.000	-1.724	9.468	180
1987	0.000	8.946	0.190	0.958	0.319	0.000	9.638	1.818	-10.844	-1.748	9.278	193
1988	0.000	9.925	0.203	1.009	0.354	0.000	0.000	1.846	0.000	-1.771	11.566	206
1989	0.000	10.968	0.217	1.034	0.372	0.000	0.000	1.870	0.000	-1.792	12.669	218
1990	0.000	12.710	0.245	1.084	0.281	0.000	11.586	1.904	-12.943	-1.819	13.048	233
1991	0.000	14.316	0.263	1.134	0.296	0.000	0.000	1.935	0.000	-1.849	16.096	250
1992	0.000	15.931	0.281	1.235	0.304	0.000	0.000	1.969	0.000	-1.879	17.841	267
1993	0.000	17.861	0.301	1.361	0.339	0.000	13.987	2.009	-15.777	-1.915	18.166	287
1994	0.000	19.655	0.320	1.513	0.360	0.000	0.000	2.045	0.000	-1.947	21.946	305
1995	0.000	22.284	0.344	1.594	0.393	0.000	0.000	2.093	0.000	-1.988	24.720	328
1996	0.000	24.865	0.369	1.675	0.421	0.000	16.840	2.134	-19.031	-2.035	25.249	349
1997	0.000	27.662	0.395	1.729	0.448	0.000	0.000	2.180	0.000	-2.063	30.351	370
1998	0.000	31.226	0.422	1.891	0.483	0.000	0.000	2.236	0.000	-2.112	34.146	398
1999	0.000	34.964	0.452	1.945	0.507	0.000	20.328	2.288	-22.914	-2.157	35.412	423
2000	0.000	39.568	0.485	2.026	0.557	0.000	0.000	2.347	0.000	-2.210	42.773	453
2001	0.000	44.414	0.519	2.080	0.592	0.000	0.000	2.407	0.000	-2.262	47.750	432
2002	0.000	49.730	0.553	2.134	0.628	0.000	24.495	2.471	-27.585	-2.315	50.112	512
2003	0.000	55.854	0.592	2.215	0.674	0.000	0.000	2.538	0.000	-2.374	59.500	545
2004	44.040	63.101	0.637	2.269	0.722	0.000	0.000	2.614	0.000	-2.438	66.905	581
2 %	-176.097	372.706	5.251	22.817	6.441	33.556	72.188	32.129	-81.283	-30.508	433.298	2.461
8 %	-177.349	152.593	2.328	10.418	2.983	28.268	32.686	15.662	-36.787	-14.917	193.234	1.090
10 %	-174.225	117.098	1.834	8.284	2.387	26.754	25.808	12.716	-29.042	-12.122	153.718	0.882
12 %	-170.490	91.275	1.467	6.684	1.939	25.347	20.638	10.466	-23.221	-9.985	124.609	0.731
14 %	-166.452	72.218	1.189	5.466	1.597	24.036	16.702	8.722	-18.789	-8.327	102.814	0.618
16 %	-162.300	57.957	0.977	4.526	1.333	22.814	13.667	7.351	-15.372	-7.023	86.229	0.531
18 %	-158.148	47.138	0.813	3.792	1.125	21.673	11.299	6.259	-12.707	-5.984	73.407	0.464
20 %	-154.064	38.820	0.683	3.210	0.959	20.608	9.431	5.379	-10.605	-5.145	63.340	0.411
22 %	-150.086	32.344	0.580	2.743	0.826	19.611	7.941	4.661	-8.929	-4.461	55.317	0.369
24 %	-146.237	27.238	0.497	2.365	0.717	18.677	6.740	4.070	-7.578	-3.897	48.830	0.334

INTERNAL RATE OF RETURN = 8.87 %

(Continued)

EXIST TO GRAVEL WITH 7 % ANNUAL TRAFFIC GROWTH WITHOUT ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-95.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-31.700	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	7.290	0.167	0.882	0.000	0.000	0.000	1.772	0.000	-1.707	8.405	170
1986	0.000	8.012	0.178	0.907	0.000	0.000	0.000	1.794	0.000	-1.724	9.166	180
1987	0.000	8.946	0.190	0.956	0.000	0.000	9.638	1.818	-10.844	-1.748	8.959	193
1988	0.000	9.925	0.203	1.009	0.000	0.000	0.000	1.846	0.000	-1.771	11.212	206
1989	0.000	10.968	0.217	1.034	0.000	0.000	0.000	1.870	0.000	-1.792	12.297	218
1990	0.000	12.710	0.245	1.084	0.000	0.000	11.586	1.904	-12.943	-1.819	12.767	233
1991	0.000	14.316	0.263	1.134	0.000	0.000	0.000	1.935	0.000	-1.849	15.800	250
1992	0.000	15.931	0.281	1.235	0.000	0.000	0.000	1.969	0.000	-1.879	17.537	267
1993	0.000	17.861	0.301	1.361	[illegible]	0.000	13.987	2.009	-15.777	-1.915	17.827	287
1994	0.000	19.655	0.320	1.513	[illegible]	0.000	0.000	2.045	0.000	-1.947	21.586	305
1995	0.000	22.284	0.344	1.594	0.000	0.000	0.000	2.093	0.000	-1.988	24.327	328
1996	0.000	24.865	0.369	1.675	0.000	0.000	16.840	2.134	-19.031	-2.025	24.828	349
1997	0.000	27.662	0.395	1.729	0.000	0.000	0.000	2.180	0.000	-2.063	29.903	370
1998	0.000	31.226	0.422	1.891	0.000	0.000	0.000	2.236	0.000	-2.112	33.663	393
1999	0.000	34.964	0.452	1.945	0.000	0.000	20.328	2.288	-22.914	-2.157	34.905	423
2000	0.000	39.568	0.485	2.026	0.000	0.000	0.000	2.347	0.000	-2.210	42.216	453
2001	0.000	44.414	0.519	2.080	0.000	0.000	0.000	2.407	0.000	-2.262	47.158	482
2002	0.000	49.730	0.553	2.134	0.000	0.000	24.495	2.471	-27.585	-2.315	49.484	512
2003	0.000	55.854	0.592	2.215	0.000	0.000	0.000	2.538	0.000	-2.374	58.826	545
2004	44.040	63.101	0.637	2.269	0.000	0.000	0.000	2.614	0.000	-2.438	66.183	581
2 %	-176.097	372.706	5.251	22.817	0.000	33.556	72.188	32.129	-81.283	-30.508	426.857	2.424
8 %	-177.349	152.593	2.328	10.418	0.000	28.268	32.686	15.662	-36.787	-14.917	190.252	1.073
10 %	-174.226	117.098	1.834	8.284	0.000	26.754	25.808	12.716	-29.042	-12.122	151.331	0.869
12 %	-170.490	91.275	1.467	6.684	0.000	25.347	20.638	10.466	-23.221	-9.985	122.670	0.720
14 %	-166.452	72.218	1.189	5.466	0.000	24.036	16.702	8.722	-18.789	-8.327	101.217	0.608
16 %	-162.300	57.957	0.977	4.526	0.000	22.814	13.667	7.351	-15.372	-7.023	84.896	0.523
18 %	-158.148	47.138	0.813	3.792	0.000	21.673	11.299	6.259	-12.707	-5.984	72.282	0.457
20 %	-154.064	38.820	0.683	3.210	0.000	20.608	9.431	5.379	-10.605	-5.145	62.381	0.405
22 %	-150.086	32.344	0.580	2.743	0.000	19.611	7.941	4.661	-8.929	-4.461	54.491	0.363
24 %	-146.237	27.238	0.497	2.365	0.000	18.677	6.740	4.070	-7.576	-3.897	48.113	0.329

INTERNAL RATE OF RETURN = 8.72 %

(Continued)

EXIST TO GRAVEL WITH 7 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITH 67% GENERATED AND DIVERTED TRAFFIC

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COST	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0 000	0. 000	0. 000	0 000	0. 000	0 000	0. 000	0 000	0 000	0 000	0 000	0
1982	-84 460	0. 000	0. 000	0. 000	0. 000	0. 000	0. 000	0 000	0. 000	0 000	0. 000	0
1983	-97 440	0. 000	0 000	0 000	0 000	0. 000	0 000	0 000	0 000	0 000	0 000	0
1984	-38 200	0. 000	0 000	0. 000	0. 000	35. 610	0. 000	0 000	0. 000	0 000	35 610	0
1985	0 000	7. 290	0. 167	0. 882	0. 287	0. 000	0. 000	1. 772	0. 000	-1. 707	8 692	170
1986	0 000	8 012	0 178	0. 907	0 302	0. 000	0. 000	1 794	0 000	-1 724	9 468	180
1987	0. 000	8 946	0 190	0. 958	0. 319	0. 000	9. 638	1 818	-10 844	-1 748	9 878	193
1988	0 000	9. 925	0 203	1. 009	0. 354	0. 000	0. 000	1. 846	0. 000	-1. 771	11 566	206
1989	0 000	10. 968	0. 217	1. 034	0 372	0. 000	0. 000	1. 870	0 000	-1 792	12 669	218
1990	0 000	12. 710	0. 245	1. 084	0. 281	0. 000	11. 586	1 904	-12 943	-1 819	13 048	233
1991	0 000	14. 316	0. 263	1. 134	0. 296	0. 000	0. 000	1. 935	0. 000	-1 849	16. 096	250
1992	0. 000	15. 931	0 281	1 235	0. 304	0. 000	0. 000	1. 969	0 000	-1 879	17 841	267
1993	0. 000	17. 861	0 301	1. 361	0 339	0. 000	13. 937	2 009	-15 777	-1 915	18 166	287
1994	0. 000	19. 655	0. 320	1. 513	0. 360	0. 000	0. 000	2. 045	0. 000	-1 947	21. 946	305
1995	0. 000	22. 284	0. 344	1. 594	0. 393	0. 000	0. 000	2 093	0. 000	-1 988	24. 720	328
1996	0. 000	24. 865	0. 369	1 675	0. 421	0. 000	16. 840	2. 134	-19 031	-2 025	25 249	349
1997	0 000	27. 662	0. 395	1. 729	0. 448	0. 000	0. 000	2. 180	0. 000	-2. 063	30 351	370
1998	0. 000	31. 226	422	1. 891	0. 483	0. 000	0. 000	2 236	0. 000	-2 112	34. 146	398
1999	0 000	34. 964	0. 452	1. 945	0 507	0. 000	20. 328	2. 288	-22 914	-2 157	35 412	423
2000	0 000	39. 568	0. 485	2. 026	0. 557	0. 000	0. 000	2. 347	0. 000	-2 210	42 773	453
2001	0. 000	44. 414	0. 519	2. 080	0. 592	0. 000	0. 000	2 407	0 000	-2 262	47. 750	482
2002	0. 000	49. 730	0. 553	2. 134	0. 628	0. 000	24. 495	2. 471	-27. 585	-2 315	50 112	512
2003	0 000	55. 854	0. 592	2. 215	0. 674	0. 000	0. 000	2. 538	0. 000	-2. 374	59. 500	545
2004	48. 210	63. 101	0. 637	2. 269	0. 722	0. 000	0. 000	2. 614	0. 000	-2 438	66 905	581
2 %	-181. 884	372. 706	5. 251	22. 817	6. 441	33. 556	72. 188	32. 129	-81. 283	-30. 508	433. 298	2. 382
8 %	-183. 856	152. 593	2. 328	10. 418	2. 983	28. 268	32. 686	15. 662	-36. 787	-14. 917	193. 234	1 051
10 %	-180 627	117. 098	1. 834	8. 284	2. 387	26. 754	25. 806	12 716	-29. 042	-12 122	153 718	0 851
12 %	-176. 722	91. 275	1. 467	6. 684	1. 939	25. 347	20. 638	10. 466	-23. 221	-9. 985	124. 609	0 705
14 %	172. 481	72. 218	1. 189	5. 466	1. 597	24. 036	16. 702	8 722	-19 789	-8 327	102 814	0 596
16 %	-168. 110	57. 957	0. 977	4. 526	1. 333	22. 814	13. 667	7 351	-15 372	-7 023	86 229	0 513
18 %	-163. 735	47. 138	0. 813	3. 792	1. 125	21. 673	11. 299	6. 259	-12. 707	-5 984	73 407	0 448
20 %	-159. 429	38. 820	0. 683	3. 210	0. 959	20. 608	9. 431	5 379	-10 605	-5 145	63 340	0 397
22 %	-155. 235	32. 344	0. 580	2. 743	0. 826	19. 611	7. 941	4. 661	-8. 929	-4 461	55 317	0 356
24 %	-151. 178	27. 238	0. 497	2. 365	0. 717	18. 677	6. 740	4. 070	-7. 578	-3. 897	48 630	0 323

INTERNAL RATE OF RETURN = 8. 52 %

(Continued)

EXIST TO GRAVEL WITH 7 % ANNUAL TRAFFIC GROWTH WITH ISAKA

WITHOUT TIME SAVINGS

YEAR	PROJECT	NORMAL	GENERATE	INTERNAT	TIME	UPGRADIN	EXIST	EXIST	GRAVEL	GRAVEL	NET BENE	ADT/BC RA
YEAR	COS	TRAFFIC	TRAFFIC	TRAFFIC	SAVINGS	EXIST	PERIODI	ROUTINE	PERIODIC	ROUTINE	NET BENE	ADT/BC RA
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	-84.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	-97.440	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	-38.200	0.000	0.000	0.000	0.000	35.610	0.000	0.000	0.000	0.000	35.610	0
1985	0.000	7.290	0.167	0.882	0.000	0.000	0.000	1.772	0.000	-1.707	8.405	170
1986	0.000	8.012	0.178	0.907	0.000	0.000	0.000	1.794	0.000	-1.724	9.166	180
1987	0.000	8.946	0.190	0.958	0.000	0.000	9.638	1.818	-10.844	-1.748	8.959	193
1988	0.000	9.925	0.203	1.009	0.000	0.000	0.000	1.846	0.000	-1.771	11.212	206
1989	0.000	10.968	0.217	1.034	0.000	0.000	0.000	1.870	0.000	-1.792	12.297	218
1990	0.000	12.710	0.245	1.084	0.000	0.000	11.586	1.904	-12.943	-1.819	12.767	233
1991	0.000	14.316	0.263	1.134	0.000	0.000	0.000	1.935	0.000	-1.849	15.800	250
1992	0.000	15.931	0.281	1.235	0.000	0.000	0.000	1.969	0.000	-1.879	17.537	267
1993	0.000	17.861	0.301	1.361	0.000	0.000	13.987	2.009	-15.777	-1.915	17.827	287
1994	0.000	19.655	0.320	1.513	0.000	0.000	0.000	2.045	0.000	-1.947	21.536	305
1995	0.000	22.284	0.344	1.594	0.000	0.000	0.000	2.093	0.000	-1.988	24.327	328
1996	0.000	24.865	0.369	1.675	0.000	0.000	16.840	2.134	-19.031	-2.025	24.828	349
1997	0.000	27.662	0.395	1.729	0.000	0.000	0.000	2.180	0.000	-2.063	29.903	370
1998	0.000	31.226	0.422	1.891	0.000	0.000	0.000	2.236	0.000	-2.112	33.663	398
1999	0.000	34.964	0.452	1.945	0.000	0.000	20.328	2.288	-22.914	-2.157	34.905	423
2000	0.000	39.558	0.485	2.026	0.000	0.000	0.000	2.347	0.000	-2.210	42.216	453
2001	0.000	44.414	0.519	2.080	0.000	0.000	0.000	2.407	0.000	-2.262	47.158	482
2002	0.000	49.730	0.553	2.134	0.000	0.000	24.495	2.471	-27.585	-2.315	49.484	512
2003	0.000	55.854	0.592	2.215	0.000	0.000	0.000	2.538	0.000	-2.374	58.826	545
2004	48.210	63.101	0.637	2.269	0.000	0.000	0.000	2.614	0.000	-2.438	66.183	581
2 %	-181.884	372.706	5.251	22.817	0.000	33.556	72.188	32.129	-81.283	-30.508	426.857	2.347
8 %	-183.856	152.593	2.328	10.418	0.000	28.268	32.686	15.662	-36.787	-14.917	190.252	1.035
10 %	-180.627	117.098	1.834	8.284	0.000	26.754	25.808	12.716	-29.042	-12.122	151.331	0.838
12 %	-176.722	91.275	1.467	6.684	0.000	25.347	20.638	10.466	-23.221	-9.985	122.670	0.694
14 %	-172.481	72.218	1.189	5.466	0.000	24.036	16.702	8.722	-18.789	-8.327	101.217	0.587
16 %	-168.110	57.957	0.977	4.526	0.000	22.814	13.667	7.351	-15.372	-7.023	84.896	0.505
18 %	-163.735	47.138	0.813	3.792	0.000	21.673	11.299	6.259	-12.707	-5.984	72.282	0.441
20 %	-159.429	38.820	0.683	3.210	0.000	20.608	9.431	5.379	-10.605	-5.145	62.381	0.391
22 %	-155.235	32.344	0.580	2.743	0.000	19.611	7.941	4.661	-8.929	-4.461	54.491	0.351
24 %	-151.178	27.238	0.497	2.365	0.000	18.677	6.740	4.070	-7.578	-3.897	48.113	0.318

INTERNAL RATE OF RETURN = 8.36 %

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C *****TP54 ************************************************************
C      THIS PROGRAM PREPARES ECONOMIC CALCULATION (IRR) WORKSHEET
C      INPUT FILE "I_TP54" CONTAINS:
C          1ST CARD--TITLE OF JOB   CC 1-80
C          2ND CARD--NUMBER OF COLUMN HEADINGS CC 1-2
C          3RD CARD--ONE CARD FOR EACH COLUMN HEADING, CONTAINING
C                    A "1" FOR INVESTMENT OR
C                    A "2" FOR BENEFIT IN CC 1
C                    NAME OF COLUMN HEADING IN CC 2-80
C          4TH CARD--ZERO YEAR  CC 1-4
C          5TH CARD--NUMBER OF YEARS IN ANALYSIS PERIOD  CC 1-2
C          6TH CARD--NUMBER OF ALTERNATIVE INTEREST RATES  CC 1-2
C          7TH CARD--ALTERNATIVE INTEREST RATES
C                CC 1-3, 4-6, 7-9, ETC
C          8TH CARD--ONE CARD FOR EACH YEAR DURING ANALYSIS PERIOD
C                      YEAR NUMBER IN CC 1-2
C                      ANNUAL COST FOR COLUMN 1 IN CC 3-9
C         IN ALL TABLES
C             I IS INTEREST RATE
C             J IS YEAR
C             K IS COLUMN
      INTEGER*2 RD, WR, TY
      DIMENSION TITL(40), HEAD(12, 20), TITL2(40), TITL3(40)
      DIMENSION IA31(12), IA7(10)
      DIMENSION IB1(30), IB1A(30), AIB2(30, 12), AIB3(30, 12)
      DIMENSION TABA(30), TABB(30)
      DIMENSION TACA(13), TACB(10, 13)
      DIMENSION Z(12), TADA(10)
      DIMENSION IXADT(30), IYADT(30)
      CALL ATTDEV (INTS(5), INTS(8), INTS(1), INTS(45))
      CALL ATTDEV (INTS(6), INTS(8), INTS(2), INTS(66))
      CALL CONTRL (INTS(1), 'I_TP54', INTS(5))
      CALL CONTRL (INTS(2), 'O_TP54', INTS(6))
      RD=5
      WR=6
      TY=1
C     SURFACE TYPE FROM AND TO 1 FOR EARTH, 2 FOR GRAVEL AND 3 FOR PAVED
      READ(RD, 1021) IST1, IST2, TRADJ, BEADJ
 1021 FORMAT(2I2, 2F6.2)
C     1ST CARD *****TITLE OF JOB ***** TITL(L)
      READ(RD, 1001)(TITL(J), J=1, 40), (TITL2(J), J=1, 40)
 1001 FORMAT(40A2/40A2)
      WRITE(TY, 2001)(TITL(J), J=1, 40)
 2001 FORMAT(20X, 40A2)
C
C     2ND CARD *****NUMBER OF COLUMN HEADINGS ***** IA2
      READ(RD, 1003) IA2
 1003 FORMAT(I2)
      DO 81 K=1, IA2
   81 Z(K)=1.0
      WRITE(TY, 1004) IA2
 1004 FORMAT(' NUMBER OF COLUMN HEADINGS IS ', I3)
C
C     3RD CARD *****NAME OF COLUMN HEADINGS ***** HEAD(K, J)
      DO 101 K=1, IA2
      READ(RD, 1005)IA31(K), (HEAD(K, K1), K1=1, 20)
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( 57)  1005 FORMAT(I1,20A2)
( 58)   101 WRITE(TY,1006)IA31(K),(HEAD(K,KI),KI=1,20)
( 59)  1006 FORMAT(I2,20A2)
( 60) C
( 61) C     4TH CARD ***** BASE YEAR FOR ECONOMIC CALCULATIONS ***** IA4
( 62)       READ(RD,1007)IA4
( 63)  1007 FORMAT(I4)
( 64)       WRITE(TY,1008) IA4
( 65)  1008 FORMAT(' BASE YEAR FOR ECONOMIC CALCULATIONS IS ',I5)
( 66) C
( 67) C     5TH CARD ***** NUMBER OF YEARS IN ANALYSIS PERIOD ***** IA5
( 68)       READ(RD,1009) IA5
( 69)  1009 FORMAT(I2)
( 70)       WRITE(TY,1010) IA5
( 71)  1010 FORMAT(I3,' YEARS IN ANALYSIS PERIOD ')
( 72) C
( 73) C     6TH CARD ***** NUMBER OF ALTERNATIVE INTEREST RATES ***** IA6
( 74)       READ(RD,1011) IA6
( 75)  1011 FORMAT(I2)
( 76)       WRITE(TY,1012) IA6
( 77)  1012 FORMAT(' NUMBER OF ALTERNATIVE INTEREST RATES IS ',I3)
( 78) C
( 79) C     7TH CARD ***** ALTERNATIVE INTEREST RATES ***** IA7(I)
( 80)       READ(RD,1013)(IA7(I),I=1,IA6)
( 81)  1013 FORMAT(10I3)
( 82)       WRITE(TY,1014)(IA7(I),I=1,IA6)
( 83)  1014 FORMAT('ALTERNATIVE INTEREST RATES ARE ',10I4)
( 84) C
( 85) C     8TH CARD ***** ANNUAL COSTS(AIB2(J,K) BY YEAR(IB1(J) *****
( 86)       DO 103 J=1,IA5
( 87)       READ(RD,1015)IB1(J),(AIB2(J,K),K=1,IA2),IXADT(J),IYADT(J)
( 88)  1015 FORMAT(I2,10F6.3,2I4)
( 89)       AIB2(J,3)=AIB2(J,3)*BEADJ
( 90)       AIB2(J,4)=AIB2(J,4)*BEADJ
( 91)       IB1A(J)=IB1(J)+IA4
( 92) C
( 93) C
( 94) C
( 95) C     CALCULATION OF DELTA L FOR TRAFFIC ENCOUNTERS ON
( 96)       IXADT(J)=IXADT(J)*TRADJ
( 97)       ADT=IXADT(J)
( 98) C     NARROW ROADWAYS
( 99) C
(100)       IF(IXADT(J).LT.1) GO TO 104
(101)       IF(IST2.GT.2) GO TO 205
(102) C     FROM GRAVEL (AND TO GRAVEL)
(103)       D1F=1.0+0.64*ADT
(104)       D2F=1.0+D1F/1000.0
(105)       D3F=ADT*365.0*112.5*14.18*D2F/1000000.0
(106)       D1T=1.0+0.31*ADT
(107)       D2T=1.0+D1T/1000.0
(108)       D3T=ADT*365.0*112.5*14.18*D2T/1000000.0
(109)       GO TO 207
(110)   205 D2F=1.00
(111)       D3F=ADT*365.0*112.5*9.42*D2F/1000000.0
(112)       D1T=1.0+0.39*ADT
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(      113)        D2T=1.0+D1T/1000.0
(      114)        D3T=ADT*365.0*112.5*9.42*D2T/1000000.0
(      115)    207 CONTINUE
(      116)        DELTA=D3F-D3T
(      117) C
(      118)        WRITE(TY,9112)AIB2(J,2),AIB2(J,3),AIB2(J,4),AIB2(J,5)
(      119)   9112 FORMAT(4F10.3)
(      120)        IF(IST2.GT.2) GO TO 777
(      121)        DTOT=AIB2(J,2)+AIB2(J,3)+AIB2(J,4)+AIB2(J,5)
(      122)        AIB2(J,2)=AIB2(J,2)+1.00*DELTA*AIB2(J,2)/DTOT
(      123)        AIB2(J,3)=AIB2(J,3)+0.00*DELTA*AIB2(J,3)/DTOT
(      124)        AIB2(J,4)=AIB2(J,4)+0.00*DELTA*AIB2(J,4)/DTOT
(      125)        AIB2(J,5)=AIB2(J,5)+0.00*DELTA*AIB2(J,5)/DTOT
(      126)        GO TO 778
(      127)    777 DTOT=AIB2(J,2)+AIB2(J,3)+AIB2(J,4)+AIB2(J,5)
(      128)        AIB2(J,2)=AIB2(J,2)+1.00*DELTA*AIB2(J,2)/DTOT
(      129)        AIB2(J,3)=AIB2(J,3)+0.00*DELTA*AIB2(J,3)/DTOT
(      130)        AIB2(J,4)=AIB2(J,4)+0.00*DELTA*AIB2(J,4)/DTOT
(      131)        AIB2(J,5)=AIB2(J,5)+0.00*DELTA*AIB2(J,5)/DTOT
(      132)    778 WRITE(TY,9001) D1T,D2T,D3T,D1F,D2F,D3F
(      133) C
(      134)        WRITE(TY,9111)AIB2(J,2),AIB2(J,3),AIB2(J,4),AIB2(J,5)
(      135)   9111 FORMAT(4F10.3)
(      136)   9001 FORMAT(' DT = ',6F8.4)
(      137) C
(      138) C      CALCULATE MAINTENANCE COST FOR OLD SURFACE TYPE
(      139)    104 IF(IXADT(J).LT.1) GO TO 297
(      140)        IF(IST1.GT.1) GO TO 201
(      141) C      FROM EARTH SURFACE
(      142) C         PERIODIC MAINTENANCE
(      143)        IF(AIB2(J,7).LT.0.001) GO TO 211
(      144)        AIB2(J,7)=0.4953+0.039624*IYADT(J)
(      145) C         ROUTINE MAINTENANCE
(      146)    211 IF(AIB2(J,8).LT.0.001) GO TO 203
(      147)        AIB2(J,8)=0.6447+0.002102*IYADT(J)
(      148)        GO TO 203
(      149) C      FROM EXISTING ROAD
(      150) C         PERIODIC MAINTENANCE
(      151)    201 IF(AIB2(J,7).LT.0.001) GO TO 215
(      152)        AIB2(J,7)=0.8508+0.045296*IYADT(J)
(      153) C         ROUTINE MAINTENANCE
(      154)    215 IF (AIB2(J,8).LT.0.001) GO TO 203
(      155)        AIB2(J,8)=1.4320+0.001990*IYADT(J)
(      156) C
(      157) C      TO SURFACE TYPE
(      158)    203 IF(IST2.GT.2) GO TO 795
(      159) C      TO GRAVEL SURFACE
(      160) C         PERIODIC MAINTENANCE
(      161)        IF(AIB2(J,9).GT.-0.001) GO TO 217
(      162)        AIB2(J,9)=-(0.7155+0.052479*IXADT(J))
(      163) C         ROUTINE MAINTENANCE
(      164)    217 IF(AIB2(J,10).GT.-0.001) GO TO 297
(      165)        AIB2(J,10)=-(1.4040+0.001780*IXADT(J))
(      166)        GO TO 297
(      167) C      TO PAVED SURFACE
(      168) C         PERIODIC MAINTENANCE
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(      169)   795 IF(AIB2(J,9) GT. -0.001) GO TO 221
(      170) C     AIB2(J,9)=-(17.7890+0.006803*IXADT(J))
(      171)       AIB2(J,9)=-(10.4550+0.012925*IXADT(J))
(      172) C        ROUTINE MAINTENANCE
(      173)   221 IF(AIB2(J,10).GT. -0.001) GO TO 297
(      174) C     AIB2(J,10)=-(2.1086+0.001327*IXADT(J))
(      175)       AIB2(J,10)=-(1.5726+0.001537*IXADT(J))
(      176)   297 CONTINUE
(      177)   103 WRITE(TY,1016)IB1(J),(AIB2(J,K),K=1,IA2),IXADT(J)
(      178)  1016 FORMAT(I4,10F10.3,I7)
(      179) C
(      180)       WRITE(TY,1017)
(      181)  1017 FORMAT('ALL INPUT CARDS FOR 1ST ITERATION HAVE BEEN READ ')
(      182) C
(      183) C     ***** ADJUSTMENTS FOR SENSITIVITY ANALYSIS *****
(      184)       WRITE(TY,1019)(Z(K),K=1,IA2)
(      185)  1019 FORMAT(12F10.3)
(      186)   917 CONTINUE
(      187)       DO 51 K=1,IA2
(      188)       DO 51 J=1,IA5
(      189)    51 AIB3(J,K)=AIB2(J,K)*Z(K)
(      190)       KKK=IA2+1
(      191)       DO 52 K=1,KKK
(      192)    52 TACA(K)=0.0
(      193)       DO 53 I=1,IA6
(      194)       DO 53 K=1,KKK
(      195)    53 TACB(I,K)=0.
(      196) C
(      197)       DO 151 J=1,IA5
(      198)       TABA(J)=0.
(      199)   151 TABB(J)=0.
(      200) C     TABA(J) IS PROJECT INVESTMENT COST FOR YEAR(J)
(      201) C     TABB(J) IS NET ANNUAL BENEFITS FOR YEAR(J)
(      202)       DO 296 J=1,IA5
(      203)       DO 296 K=1,IA2
(      204)       IF(IA31(K).EQ.2) GO TO 294
(      205)       TABA(J)=TABA(J)+AIB3(J,K)
(      206)       GO TO 296
(      207)   294 TABB(J)=TABB(J)+AIB3(J,K)
(      208)   296 CONTINUE
(      209)       DO 301 J=1,IA5
(      210)   301 WRITE(TY,8001) IB1A(J),(AIB3(J,K),K=1,IA2),TABB(J)
(      211)  8001 FORMAT(I8,12F10.3)
(      212) C     TACA(K) IS TOTAL COSTS FOR ALL YEARS FOR COLUMN(K)
(      213)       DO 401 K=1,IA2
(      214)       DO 401 J=1,IA5
(      215)   401 TACA(K)=TACA(K)+AIB3(J,K)
(      216)       DO 402 J=1,IA5
(      217)   402 TACA(KKK)=TACA(KKK)+TABB(J)
(      218)       WRITE(TY,2002)(TACA(K),K=1,KKK)
(      219)  2002 FORMAT(' TOTAL   ',12F10.3)
(      220) C     TACB(I,K) IS NET PRESENT WORTH OF COLUMN K AT INTEREST RATE I
(      221) C     I IS EACH INTEREST RATE
(      222) C     K IS EACH COLUMN
(      223) C     J IS EACH YEAR
(      224)       DO 413 I=1,IA6
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(      225)        RI=IA7(I)/100.
(      226)        DO 411 K=1,IA2
(      227)        DO 411 J=1,IA5
(      228)    411 TACB(I,K)=TACB(I,K)+(AIB3(J,K)*(1.0/((1.0+RI)**IB1(J))))
(      229)        DO 412 J=1,IA5
(      230)    412 TACB(I,KKK)=TACB(I,KKK)+(TABB(J)*(1.0/((1.0+RI)**IB1(J))))
(      231)        TADA(I)=TACB(I,KKK)/(0.0-TACB(I,1))
(      232)    413 WRITE(TY,2011)IA7(I),(TACB(I,K),K=1,KKK),TADA(I)
(      233)   2011 FORMAT(I3,'  %  ',13F10.3)
(      234) C      CALCULATE IRR
(      235)        DO 501 I=1,IA6
(      236)    501 IF(TADA(I).LT.1.0) GO TO 502
(      237)    502 SAY=IA7(I)
(      238)        SAX=TACB(I,KKK)+TACB(I,1)
(      239)        I=I-1
(      240)        SBY=IA7(I)
(      241)        SBX=TACB(I,KKK)+TACB(I,1)
(      242)        CIRR=SBY-SBX*(SAY-SBY)/(SAX-SBX)
(      243)        WRITE(TY,6001)CIRR
(      244)   6001 FORMAT('INTERNAL RATE OF RETURN = ',F8.2,' % ')
(      245) C      PRINT OUTPUT ON O_TP51
(      246)        WRITE(WR,5001)(TITL(L),L=1,40)
(      247)   5001 FORMAT('1',40A2)
(      248)        WRITE(WR,5003)(TITL2(L),L=1,40)
(      249)   5003 FORMAT('0',40A2)
(      250)        WRITE(WR,5011)((HEAD(K,1),HEAD(K,2),HEAD(K,3),HEAD(K,4)),K=1,IA2)
(      251)   5011 FORMAT('0','   YEAR    ',10(2X,4A2),' NET BENE   ADT/BC RAT ')
(      252)        WRITE(WR,5011)((HEAD(K,5),HEAD(K,6),HEAD(K,7),HEAD(K,8)),K=1,IA2)
(      253)        DO 521 J=1,IA5
(      254)    521 WRITE(WR,5021)IB1A(J),(AIB3(J,K),K=1,IA2),TABB(J),IXADT(J)
(      255)   5021 FORMAT(' ',I8,11F10.3,I10)
(      256)        DO 531 I=1,IA6
(      257)    531 WRITE(WR,5031)IA7(I),(TACB(I,K),K=1,KKK),TADA(I)
(      258)   5031 FORMAT('0',I3,'  %  ' 13F10.3)
(      259)        WRITE(WR,5041) CIRR
(      260)   5041 FORMAT('0','INTERNAL RATE OF RETURN = ',F8.2,' % ')
(      261) C      ****READ SENSITIVITY ANALYSIS ADJUSTMENTS *****
(      262)        READ(RD,3131,END=999)(Z(I),I=1,IA2)
(      263)   3131 FORMAT(12F5.2)
(      264)        WRITE(TY,3131)(Z(I),I=1,IA2)
(      265)        READ(RD,1099)(TITL2(J),J=1,40)
(      266)   1099 FORMAT(40A2)
(      267)        WRITE(TY,1099)(TITL2(J),J=1,40)
(      268)        GO TO 917
(      269)    999 CONTINUE
(      270)        CALL CONTRL(INTS(4),INTS(0),INTS(5))
(      271)        CALL CONTRL(INTS(4),INTS(0),INTS(6))
(      272)        CALL EXIT
(      273)        END
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