

~~586 TH~~

**RETURN TO
REPORTS DESK
WITHIN
ONE WEEK**

FILE COPY

RESTRICTED
Report No. TO-690a

This report was prepared for use within the Bank and its affiliated organizations. They do not accept responsibility for its accuracy or completeness. The report may not be published nor may it be quoted as representing their views.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

TANZANIA
APPRAISAL OF THE
SECOND HIGHWAY PROJECT

January 15, 1969

Transportation Projects Department

CURRENCY EQUIVALENTS

Currency Unit:	=	Tanzanian Shilling
US\$1	=	T Sh 7.14286
T Sh 1	=	US\$0.14
T Sh 1 million	=	US\$140,000

FISCAL YEAR

July 1 - June 30

UNITS OF WEIGHTS AND MEASURES: BRITISH

1 mile	=	1.6 kilometers
1 foot	=	30.5 centimeters
1 acre	=	0.41 hectares
1 imperial gallon	=	1.20 US gallon
	=	4.54 liters
1 ton	=	
1.12 US sh ton	=	1.02 metric tons
1.00 US long ton	=	1.016 metric tons

ABBREVIATIONS - ACRONYMS

RAD	-	Roads and Aerodromes Division
ZTRS	-	Zambia-Tanzania Road Services Ltd.
UDI	-	Unilateral Declaration of Independence by Southern Rhodesia
USAID	-	United States Agency for International Development

RETURN TO REPORTS DESK
HOOMI PA 124 BY

JAN 4 1979

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Table of Contents

	<u>Page</u>
SUMMARY	i
1. INTRODUCTION	1
2. BACKGROUND	2
A. Economic Setting	2
B. Transport System	2
3. THE HIGHWAY SECTOR	6
A. Highway System	6
B. Road Transport	6
C. Highway Administration	7
D. Design Standards, Engineering and Construction	8
E. Maintenance	8
F. Highway Expenditures and Investment Planning	8
4. THE PROJECT	10
A. Description	10
B. Design Standards	11
C. Cost Estimates	11
D. Execution	13
E. Financing and Disbursement	13
5. ECONOMIC EVALUATION	15
A. Introduction	15
B. Traffic	16
C. Unit Savings in Vehicle Operating and Road Maintenance Costs	17
D. Probability Analysis of Economic Rate of Return	18
6. CONCLUSIONS AND RECOMMENDATIONS	20

This report was prepared by Messrs. E. Jaycox and L. Pouliquen, economists, and F. Soges, engineer.

Table of Contents

- Page 2 -

ANNEX

- A. Zambian Access to the Sea and the Current Transport Crisis
- B. Probability Analysis of the Economic Rate of Return

TABLES

- 1. Central Government Road Expenditures
- 2. Design Standards
- 3. Estimated Tanzanian Traffic on Project Road Sections
- 4. Estimated Vehicle Operating Costs (1967-1968)
- 5. Estimated Vehicle Operating Costs on Project Road Sections
- 6. Estimated Vehicle Operating Costs - Kitonga Gorge

MAPS

- Map 1 - East & Central African Transport Links - IBRD-1253R8
- Map 2 - Tanzania Highway System - IBRD-2266R4

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

SUMMARY

i. A large part of Tanzania's road network was built to rudimentary standards, but due to recent development of traffic it has become economical to upgrade progressively the primary roads and to improve and extend the other parts of the road system. The project forms part of this national program, and also of a larger international program to improve the entire Tan-Zam Highway linking Dar es Salaam, the capital of Tanzania on the Indian Ocean, with landlocked Zambia to the south-west. The proposed project consists of the reconstruction of the Morogoro-Iyayi section (310 miles) of the Tan-Zam Highway. The Zambian sections of the highway are all under reconstruction partly financed by Bank loans (469-ZA and 563-ZA); reconstruction of the section from the Zambia-Tanzania border to the project section has begun and is being financed by USAID.

ii. The cost estimate of the project is US\$38 million equivalent, with a foreign exchange component of about US\$25.8 million equivalent. The estimates are based on completed detailed engineering for the whole project section. The proposed amount of external financing is US\$30.0 million equivalent, which is about 80% of the total cost and would cover the foreign exchange requirement and a part of the local cost; the balance of the local cost would be covered by the Government. Financing of part of the local cost is recommended on overall economic grounds as explained in the report "Prospects for Economic Development in Tanzania" of August 31, 1967. The external financing would be provided by the Bank Group and Sweden. The Bank has agreed to act as executing agency for the Swedish credit.

iii. Execution of the project is the responsibility of the Roads and Aerodromes Division of the Ministry of Communications, Labour and Works. The detailed engineering has been carried out by consultants satisfactory to the Association, partly under USAID financing. Construction will be by contractors, under unit price contracts awarded on the basis of international competitive bidding, and will be supervised by consultants. The project is expected to be completed by the end of 1971.

iv. While the project forms part of a larger international program, it is economically justified on the basis of Tanzanian needs alone. It is expected to yield an economic rate of return of 15% from Tanzanian traffic only, and an overall rate of return of 20% from Tanzanian and Zambian traffic combined, which is satisfactory.

v. This would be the second highway project in Tanzania by the Bank Group. The first project is being financed under a US\$14 million credit (48-TA) made in 1964, and a US\$3.0 million supplementary credit (115-TA) made in 1968. Execution of this first project, after a difficult start, is now proceeding satisfactorily; it was about 75% complete as of November 1968 and is expected to be fully completed by the end of 1971.

vi. The project constitutes a suitable basis for financing by the Bank Group and Sweden in a total amount of US\$30.0 million equivalent. The proposed financing would comprise a US\$8 million equivalent IDA credit and a US\$15 million equivalent Swedish credit, together with a US\$7 million equivalent Bank loan on a 30 year term including a 10 year grace period.

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

1. INTRODUCTION

1.01 The Government of the United Republic of Tanzania asked the Association in January 1968 to help finance the reconstruction of the Morogoro-Iyayi section (310 miles) of the Dar es Salaam-Tunduma (Zambia border) primary road. The application resulted from earlier discussions (1966-67) involving the Governments of Tanzania and Zambia, USAID and the Association on the subject of developing a reliable road link from land-locked Zambia to the sea at Dar es Salaam. The cost estimate of the project is US\$38.0 million equivalent; financing by the Bank Group and Sweden in a total amount of about US\$30.0 million equivalent is recommended, which would cover the estimated foreign exchange requirement of US\$25.8 million equivalent and a part of the local costs. The completion of the project is expected by the end of 1971. The reconstruction of other portions of the Dar es Salaam-Zambia road link are being financed by USAID in Tanzania, and by a UK grant and Bank loans (469-ZA and 563-ZA) in Zambia.

1.02 An IDA appraisal mission visited Tanzania in April 1968, with a representative of the Swedish International Development Authority. The mission found that certain design problems regarding the choice of adequate pavement standards and the definition of the scope of the works had to be resolved, and sufficiently reliable cost estimates established before the appraisal could be completed. The design problems were resolved in July 1968, and cost estimates, based on completed detailed engineering for all sections, were received in October 1968.

1.03 This appraisal is based on detailed engineering of the project road sections by consultants, and on the findings of the IDA appraisal mission consisting of Messrs. E. V. K. Jaycox and L. Pouliquen, economists, and F. Soges, engineer. Mrs. J. Comer, programmer analyst, contributed substantially to the probability analyses.

1.04 This would be the second highway project and the third lending for highways by the Bank Group in Tanzania. The first credit of US\$14 million (Credit 48-TA) was granted to the Republic of Tanganyika (now United Republic of Tanzania) in 1964 for the construction of eight road sections totalling 739 miles. This original project was revised, and a supplementary credit of US\$3 million (Credit 115-TA) was granted on March 21, 1968 for the revised project, which includes the construction of six road sections totalling 533 miles, the detailed engineering of a 142-mile section of the project road (Morogoro-Mahenge) and of 208 miles of secondary and tertiary roads, and a staffing and training program for the Roads and Aerodromes Division of the Ministry of Communications, Labour and Works. Implementation of the first highway project was difficult at the start because of shortage of staff in the Roads and Aerodromes Division and increases in construction costs, but performance is now satisfactory. The project was about 75% complete as of November 1968 and is expected to be fully completed by the end of 1971 (see Report No. TO-600a).

2. BACKGROUND

A. Economic Setting

2.01 Tanzania lies a few degrees south of the equator in East Africa. It has a land area of 341,150 square miles, roughly about the size of France and Spain combined, a large part of which consists of a high, arid plateau in the center. Agricultural production is concentrated in the more fertile areas on the periphery where rainfall is also more abundant: the Lake Victoria region, the highlands around Kilimanjaro, the Southern Highlands, and the Northern Coastal district.

2.02 Tanzania's population is about 12 million according to the 1967 census and is growing at the rate of about 2.8% annually. The population is predominantly African, with less than 1% being Asians and Europeans. With a density of about 35 persons per square mile, the country is sparsely populated; however, population pressures exist in some of the more developed agricultural areas.

2.03 Gross domestic product per capita is very low at an estimated US\$65 in 1967. In the period 1962 to 1967, GDP at constant prices grew at the rate of about 5% per annum, and real per capita incomes rose at an average of only 2.2% per annum. Agriculture is the principal economic activity. Crop production, animal husbandry, forestry and fisheries together account for about 52% of domestic production. About half of total agricultural production is consumed for subsistence. The main cash crops are cotton, sisal and coffee. A small but rapidly growing industrial sector accounts for some 6% of the GDP. Mining of gold and diamonds is important for exports, but exploitation of other known mineral deposits is as yet insignificant, partly due to remoteness from markets.

B. Transport System

General

2.04 The basic transport system is extensive in relation to the volume of traffic it is called upon to handle because population and production centers are widely dispersed around the periphery of the country. It consists of three main seaports, about 1,500 miles of long haul railway lines through the center and to the north, about 10,000 miles of primary and secondary roads with low standards but of suitable geographical distribution, relatively few lower type roads feeding into the above roads, 20 airports handling scheduled flights, and coastal and lake shipping services. Seaport and railway services are provided by statutory corporations and form part of the East African Community system of common services to Tanzania, Kenya and Uganda.

2.05 The main flow of traffic and, consequently, the orientation of the country's trunk transport system, run roughly east-west to and from the seaports, mainly Dar es Salaam and Tanga. This pattern reflects the economy's

dependence on exports of primary products and the reverse flow of manufactured goods and fuel distributed throughout the country from the coast where they are either imported or produced. The transport system of Tanzania is also utilized by the neighboring landlocked states, Zambia, Rwanda and Burundi, and the eastern part of the Congo, which rely on it in varying degrees for access to the sea. Extraordinary burdens have been placed on the Tanzania transport system by Zambian requirements arising from Southern Rhodesia's unilateral declaration of independence (UDI) in November 1965 and the subsequent large-scale diversion of Zambian traffic from Southern Rhodesian to Tanzanian routes. The Zambian problem of access to the sea, the present transport emergency, and the plans for long-range solutions are discussed briefly below; for more detail see Annex A.

The Zambia-Tanzania Transport Problem (See Map 1)

2.06 Since Zambia gained independence in October 1964, a major long-term policy objective has been to reduce its almost complete dependence on Southern Rhodesia for access to the sea and for many of its vital supplies. Zambia wishes to develop alternative transport capacity to the sea for its mineral (principally copper) exports and a wide variety of imported goods. Its objective is to divert traffic from existing facilities in Southern Rhodesia and Mozambique in order to ensure overall long-run transport reliability and to place competitive pressure on existing facilities so as to keep the prices for its external transport services at reasonable levels. Zambia also wishes to develop new and closer trade relations with neighboring countries to the northeast forming the East African Community, and thus modify its inherited and somewhat arbitrary pattern of international traffic. Pursuant to this policy, Zambia has applied for membership in the Community and, together with Tanzania, is planning to develop new transport links to the sea via Tanzania.

2.07 UDI transformed Zambia's long-term aims into an immediate problem. A series of U.N. Security Council resolutions 1/ following UDI placed increasingly strict economic sanctions on Southern Rhodesia, beginning with an international embargo on the shipment of petroleum and other products to or through Southern Rhodesia; most recently (May 1968) a complete embargo on all normal trade was imposed. These measures necessitated the emergency transport of liquid fuels and other imports to Zambia and the backhaul of some copper exports over the most immediately available alternative route to the sea, the 1,200 mile road from Kapiri Mposhi, Zambia to Dar es Salaam, Tanzania - now commonly known as the Tan-Zam Highway.

2.08 The Tan-Zam Highway has been the principal route for the traffic diverted from Rhodesia, primarily because of the greater flexibility inherent in trucking operations as compared to the alternative rail routes. An important limiting factor on traffic movement has been the condition of the mostly

1/ Resolutions 216 (1965) of 12 November 1965; 217 (1965) of 20 November 1965; 221 (1966) of 9 April 1966; 232 (1966) of 16 December 1966; and 253 (1968) of 29 May 1968.

earth/gravel surfaced road, although the combined problems of traffic control, trucking organization, goods storage, commercial arrangements and border formalities have also formed operative constraints on traffic. The emergency operation of about 120 heavy trucks per day over the highway, in addition to normal traffic, required extraordinary maintenance expenditures of about US\$3 million equivalent in Zambia and about US\$2 million equivalent in Tanzania during 1966/67. Even so, the road has often been closed at one or more points for several days at a time due to broken structures or mired or wrecked vehicles. Over 100 drivers have been killed hauling emergency traffic over the road since early 1966.

2.09 To handle these emergency transport requirements, a set of relatively short-term and expensive solutions were undertaken (including air-lifts). These have failed to reduce appreciably Zambia's dependence upon the Rhodesian transport system. With the continuation of the emergency, longer-term transport solutions are being sought that are relevant both to long-term policy goals and to meeting present needs more effectively.

2.10 The most advanced of these is the just completed oil pipeline from Dar es Salaam to the copper mining area (Copperbelt) in the northern part of Zambia. Reconstruction of the full length of the Tan-Zam Highway to modern two-lane bituminous paved standard is also in an advanced stage of planning and partly under execution. The Zambian sections are all under construction; the 122-mile section from Kapiri Mposhi to Serenje is part of the project under Bank Loan 469-ZA and the 235-mile Mpika-Tunduma (on the Tanzania-Zambia border) section is being financed under Bank Loan 563-ZA. In Tanzania, reconstruction of the 150-mile section from Tunduma to Iyayi is being financed with the assistance of USAID. The 310-mile section from Iyayi to Morogoro is the subject of this appraisal report. The remaining section from Morogoro to Dar es Salaam (123 miles) is already paved; its adequacy to serve probable future traffic is currently being assessed by consultants financed by USAID. In addition to the pipeline and improved road connection, the Zambian and Tanzanian Governments have announced their intention to construct a 980-mile rail link from the vicinity of Kapiri Mposhi on the Zambian Railway system to the Kidatu railhead of the East African Railway system in Tanzania. The idea of this link predates the emergency by many years, and has been the subject of a number of engineering and economic investigations. The detailed engineering of the link is now underway with the assistance of Mainland China which, according to press reports, has also given some assurances with respect to financing of eventual construction.

Traffic Prospects on the Tan-Zam Highway

2.11 The future volume and duration of Zambian export/import traffic over the Tan-Zam Highway is uncertain. Once the pipeline is fully operational and oil traffic over the road ceases, the Zambian Government's intention is to increase the trucking of copper exports and general goods imports over the road. While the trucking capacity now carrying oil could be converted with relative ease to copper and general cargo, the increased volumes of dry cargo create capacity problems at the port of Dar es Salaam. That is, new deep-water berths are required for any additional Zambian goods traffic beyond the approximately 190,000 tons of copper exports and 70,000 tons of general cargo

imports handled in 1967. Three berths are now under construction at the port, with financing from the Bank (Loan 428-EA), and will be in operation by the end of 1969. A further two berths are planned to be in operation by 1971 to handle the expected increase in Zambian traffic as well as the normal growth of Tanzanian traffic. The possibilities of containerization of cargoes at Dar es Salaam in general and of Zambian import cargoes particularly are being investigated. This could significantly increase the capacity of the entire Tan-Zam Highway transport system. If and when the Tan-Zam railway is built, it is probable that most, if not all, Zambian import/export traffic using the road would be diverted to the railway. Regardless of its economic characteristics, the railway would have to haul the bulk of available traffic to be financially viable. In these uncertain circumstances, the forecasts of traffic over the project road take into account the probabilities of future traffic levels and trends as they are affected by the main foreseeable constraints on the physical system and the timing of other major transport investments (see Section 5, Economic Evaluation, and Annex B).

3. THE HIGHWAY SECTOR

A. Highway System (see Map 2)

3.01 The road network comprises about 10,400 miles of primary and secondary roads, about 10,700 miles of tertiary or district roads, and an unknown mileage of unclassified minor roads and tracks for which there is no established public responsibility. Only about 900 miles are bituminous paved and 800 miles are engineered gravel; the remaining 19,400 miles are low-standard gravel or earth roads. The road system is most developed in the hinterlands of the three main seaports and along the shore of Lake Victoria.

3.02 Provision of a serviceable road system at reasonable cost has been a problem in Tanzania because the density of traffic is low and population centers are widespread. Historically, the Government has met the problem by constructing an extensive but very low-standard, low-cost network of all-weather roads which, with a few gaps, was capable of meeting road transport requirements with reasonable efficiency. However, with traffic development it has become economical to upgrade progressively the primary roads, including major realignment and reconstruction to fully engineered standards, and to improve and extend the secondary and tertiary road network feeding into the primary system. This next stage of development of Tanzania's road system to higher standards, which is already underway, will be much more expensive than providing the present all-weather facilities.

B. Road Transport

3.03 While the road system is fairly extensive, traffic volumes are relatively low except in the vicinity of the major coastal centers and in the Lake Victoria area. The main function of internal road transport lies in the delivery and collection of goods to and from rail lines and terminals. For the most part, these are short-haul services, but the southern highland agricultural areas, and the port of Mtwara, both of which are not served by rail, require long-haul road transport. The recent increases in industrial goods consumption have created demand for a greater range of transport services, particularly for inter-urban road transport even in areas served by rail. The sudden demand for a substantial volume of international through traffic of Zambian exports/imports on the Tan-Zam Highway has undoubtedly further increased the importance of roads in the transport system. On the basis of very fragmentary information, it is estimated that local primary road traffic is increasing at about 7-8% annually, or about 50% above the recent growth of the GDP.

3.04 The vehicle fleet is growing at an estimated annual average rate of 7.5%. In 1966 there were about 55,000 registered motor vehicles, or about one vehicle per 190 inhabitants compared with 180 in Uganda and 100 in Kenya. About 20% of the fleet consists of trucks, buses and tractor-trailers. Over 70% of the total fleet has been registered during the past five years, indicating that the fleet is not over age, and has probably been growing in capacity and efficiency more rapidly than in numbers.

3.05 While the road transport industry has been growing rapidly, it is still not highly developed. The industry consists primarily of owner-operator truckers and small rural bus companies; there are a few large firms offering long-distance services on main routes. The largest trucking firm, the newly formed Zambia-Tanzania Road Services Ltd. (ZTRS), owned by the Zambian and Tanzanian Governments (35% each) and Italian vehicle supply and financial interests (30%), is engaged exclusively in the movement of Zambian import/export traffic through Tanzania. By mid-1968, the ZTRS fleet numbered 442 truck-trailer units of thirty-ton capacity. In general, the carriage of goods and passengers for hire is restricted by route-licensing and area-licensing regulations designed primarily to protect the railway's differential tariff from road competition.

3.06 In connection with Bank Loan 428-EA for development of East Africa's railways and harbors, the Governments of Tanzania, Kenya and Uganda undertook to carry out a transport coordination study, which is being financed by the UNDP with the Bank as executing agency. The study is being carried out by consultants and is expected to be completed by February 1969. The object of the study is to provide each of the three Governments with a sound basis for formulating its transport regulation, pricing and investment policies. Detailed review of the effects of the administrative restrictions on the road transport industry forms a specific part of the study. The work of the consultants is being closely supervised by the Bank. While there were serious theoretical and methodological difficulties at the outset the study now appears to be progressing satisfactorily.

C. Highway Administration

3.07 The Roads and Aerodromes Division (RAD) of the Ministry of Communications, Labour and Works is responsible for the administration of the road system. The Division is directly responsible for the primary and secondary roads, and provides technical assistance to the District Councils which are in charge of the tertiary roads. The organization of the RAD is sound; however, performance is limited by the shortage of competent staff. The staff shortage reached its peak in 1965; since then, it has been slowly easing due to intensive recruitment of new staff. The staff situation of the RAD is discussed in detail in Report No. TO-600a of January 18, 1968, entitled "Tanzania, Appraisal of a Revised Highway Project." The Association found the Government's efforts to improve the capacity of the RAD commendable and agreed, under the supplementary credit for the first highway project (115-TA dated March 1968), to provide assistance in obtaining additional foreign experts and to finance a part of their costs. The recruitment of the experts, who will take executive positions and will train national counterparts, has been delayed because of the long time involved in obtaining clearance to proceed from all interested government offices. The recruitment advertisement was published on December 14, 1968, and it is expected that a first team of six experts will report to work within six months.

D. Design Standards, Engineering and Construction

3.08 A large part of the road network was constructed to rudimentary standards; only a few roads have been properly engineered. The design standards for new construction are selected on a case by case basis. The RAD is planning to adopt uniform guidelines for the design of roads, divided into four classes from low type gravel surfaced to asphalt paved roads. This more systematic approach to road design represents a substantial improvement over earlier trial and error methods of building roads, and will help to make more effective use of the large investments presently being made in the development of the highway sector. Consultants and contractors are used extensively for all major construction projects. Contracts are usually awarded on a competitive basis, and the bidding procedures followed have encouraged participation by international contractors. Local construction firms are small; the only firm qualifying for major works is semi-public, with 60% of its capital being owned by a Government agency, the National Development Corporation.

E. Maintenance

3.09 The 10,400 miles of primary and secondary roads are maintained by the RAD with central Government funds, and the 10,700 miles of tertiary roads by the District Councils with locally-collected funds supplemented by Government grants. The bituminous paved roads are reasonably well maintained, but the gravel and earth roads, particularly those which are under the District Councils, are often left in poor condition. Under Credit No. 115-TA, the Government gave assurance that it would adequately maintain the country's whole road system. The Government is now considering a five-year program to place all roads under the direct responsibility of the RAD, and to provide the necessary additional equipment and funds for road maintenance. The Bank regards this program as appropriate to improving the maintenance of the country's road system.

F. Highway Expenditures and Investment Planning

3.10 Total Central Government highway expenditure including administration, maintenance and construction has risen from about T Sh 60 million (US\$8.4 million) in 1962/63 to an estimated T Sh 176 million (US\$24.6) in 1967/68, including funds received from foreign sources (See Table 1). The increase has not been gradual; it dates from and is for the most part a reflection of the implementation of the first IDA highway project which effectively got underway in 1965/66. A large rise in maintenance expenditure due to the imposition of Zambian transit traffic on the Tan-Zam Highway in 1966/67 also contributed to the substantial rise in total highway expenditures. This rise in expenditures was appraised by the economic mission to East Africa in 1966 (see Report AF, 58a, Volume III, Annex D, dated August 31, 1967) and found to be economically appropriate, given the backlog of highway needs in Tanzania. Highway expenditures will continue to rise over the next three years to a level of about US\$32 million per year (including about US\$9.2 million for administration and maintenance), with the continuation of the IDA

trunk road program now underway, implementation of works on the Tan-Zam highway and the start of some new works now in the planning stage. This level of expenditure is considered feasible, since most major capital works are now, or are about to be, put in the hands of consultants and contractors.

3.11 The Five-Year Plan (1964/65-1968/69), published in 1964, seriously underestimated the cost of road works and overestimated the capacity of the RAD to carry out the planning and preparation of road investments. The Bank/IDA economic mission recommended immediate measures to strengthen the RAD's project planning elements, and to set up an economic planning unit for transportation investments. These measures are now being implemented, and work now underway on the next five-year plan is on a much more satisfactory basis. The next plan will place more emphasis upon agricultural feeder roads and secondary roads of local importance.

4. THE PROJECT

A. Description

4.01 The project consists of:

- (i) The realignment and reconstruction to two-lane asphalt paved standard of the existing earth/gravel sections of the Tan-Zam Highway from a point 38 miles west of Morogoro to Mahenge (a length of 102 miles) including the Ruaha River bridge at Mbuyuni, and from Iringa to Iyayi (a length of 125 miles);
- (ii) The reconstruction to two-lane asphalt paved standard of the existing paved but low standard sections of the Tan-Zam Highway from Morogoro to a point 38 miles to the West (a length of 38 miles) and from Mahenge to Iringa (a length of 45 miles);
- (iii) Consultants' services for the engineering supervision of the above works.

4.02 The Tan-Zam Highway is a primary artery connecting Dar es Salaam, the capital city on the Indian Ocean, with the high plateau in the center and the fertile highlands in the southwest of Tanzania. It also provides a link to the sea for landlocked Zambia further to the south (see Maps 1 and 2). From Morogoro to Mikumi the road crosses flat lowlands; it then enters into very rugged terrain, passes through the narrow, deep gorge of the Great Ruaha River and, ascending an abrupt escarpment at Kitonga, emerges on the high plateau near Iringa. From there the road runs to Makumbako and Iyayi in rolling terrain.

4.03 There are two bituminous paved stretches on the existing road, a 38-mile section from Morogoro to the west, and a 45 mile section from Mahenge to Iringa which includes a 5-mile stretch through the Kitonga escarpment. Although paved, these stretches are poorly aligned and, in places, are so narrow that traffic is restricted to a single lane. The pavement structure over these two sections is rapidly disintegrating under present traffic volumes. These sections will be upgraded and reconstructed to improved two lane asphalt paved standards. In general, the construction plans call for the existing road and pavement structure to be salvaged to the maximum extent possible.

4.04 Except for the short paved sections discussed above, the rest of the project road is at present no more than an improved track, poorly aligned, with obsolete structures, and weak earth or gravel surfacing. Since the Zambian import/export traffic was imposed in 1965, these earth/gravel sections have been kept under intensive maintenance, but nevertheless, the traffic has reached a level where maintenance cannot keep pace with use, and riding conditions on the already poor road are deteriorating rapidly. These earth/gravel sections will be realigned and fully reconstructed to two-lane asphalt paved standards.

B. Design Standards

4.05 The appraisal mission found that certain design features originally proposed by the consultants were chosen somewhat arbitrarily and were not supported by an adequate analysis. In particular the mission re-examined, with the cooperation of the consultants and the Government, the possibility of lowering the pavement standards and of salvaging certain parts of the already paved sections of the road, with a view to achieving savings through optimization of the designs. As a result of this investigation substantial savings were achieved. The design standards which were finally agreed upon were selected with regard to the functions of the road as a primary artery in Tanzania, and as an alternative access route to the sea for Zambian exports and imports (see Table 2). They are sufficiently flexible to permit the road to be built economically under the various physical conditions encountered. Design speeds range from 70 to 40 mph, gradients from 4 to 7 percent, and roadway width from 34 to 28 feet, according to terrain. Exceptional design features, such as a 25 mph design speed, 12 percent gradients and roadway width reduced to only 23 feet, have been accepted to meet the extraordinary difficulties of the terrain on the Kitonga escarpment. The standards are considered appropriate to provide an efficient facility for the expected economic life of the road.

4.06 Depending on the volume and duration of the Zambian export/import traffic, the pavement over some sections will probably require strengthening in stages. The pavement design provides for an initial strength at the outset, which can be reinforced in later stages by asphalt overlays as required by traffic growth. This method of stage construction of the pavement has been appraised from an economic viewpoint and clearly yields the most favorable (i.e. the least cost) solution. The appropriate time for strengthening is estimated at about ten years after completion of this reconstruction, but would depend on the amount of traffic and would have to be determined on the basis of the observed behavior of the pavement. During negotiations, the Government gave assurance that the condition of the road will be kept under observation, and the pavement strengthened if and when required. Pavement performance is sensitive to excessive axle loadings, therefore the project provides for the installation of a weigh station to control vehicle weights. The Government also gave assurance that the weigh station will be properly manned, and that the present legal limitations of axle loads, which are satisfactory, will be properly enforced.

C. Cost Estimates

4.07 The cost estimate of the project and the estimated foreign exchange component thereof are as follows:

	-- Cost Estimate --		Foreign Exchange
	<u>T Sh</u>	<u>US\$ Equivalent</u>	<u>Component,</u>
			<u>US\$ Equivalent</u>
	----- (1,000) -----		
A. Construction contracts			
Morogoro-Mahenge, including Ruaha bridge	120,000	16,805	
Mahenge-Iyayi	105,000	14,705	
Subtotal, construction contracts	225,000	31,510	21,430
B. Engineering services for supervision of construction			
Morogoro-Mahenge	4,000	560	
Mahenge-Iyayi	5,000	700	
Subtotal, engineering services	9,000	1,260	760
C. Contingency allowances			
a) for quantity variations, about 6% of construction contracts	13,000	1,820	
b) for price variations, about 10% on all costs	25,000	3,500	
Subtotal, contingency allowances	38,000	5,320	3,610
Total	272,000	38,090	25,800
Rounded off	270,000	38,000	25,800

The estimates were prepared by consultants, on the basis of work quantities derived from detailed engineering, and unit prices obtained from cost analyses checked against the unit prices recently tendered for the Iyayi-Tunduma construction contract. The cost for engineering services was estimated on the basis of prices negotiated with the consultants. An average amount of about 6% has been allowed on construction costs for quantity contingencies, and a further allowance of 10% on all costs has been included to cover possible

price variations. The cost estimates, including the allowances for contingencies, are consistent with experience in Tanzania and are considered realistic.

4.08 It is expected that all construction work will be executed by international contractors. On this basis, the foreign exchange component of construction is estimated to be about 68 percent, and includes the depreciation of equipment, spare parts, fuels, imported materials and the foreign cost of expatriate personnel, overheads and profits. The local component includes mainly labor, local services, and about 5 to 8 percent of the total cost for duties and taxes on fuel, equipment and company profits. The foreign exchange component of the consultants' services is estimated at about 60 percent.

D. Execution

4.09 The RAD is responsible for the execution of the project. The detailed engineering of the Mahenge-Iyayi road section was financed by USAID and was carried out by US consultants De Leuw, Cather International; that of the Morogoro-Mahenge section was carried out by UK consultants, Sir Alexander Gibb and Partners, financed under Credit 115-TA. The same consultants are likely to supervise the construction of their respective sections.

4.10 Construction will be under unit price contracts awarded on the basis of international competitive bidding, in accordance with procedures satisfactory to the Association. Bids were opened on December 2 for the Mahenge-Iyayi section, and are due to be opened on January 20, 1969 for the Morogoro-Mahenge section. The above sections are subdivided into three and two contracts respectively. Bids on each road section will be accepted for one or any combination of contracts. This method of bidding will enable smaller contractors to compete with larger firms and thereby help ensure competitive pricing. Construction is expected to be completed by the end of 1971.

E. Financing and Disbursement

4.11 The project would be financed jointly by the Bank Group, Sweden and the Government of Tanzania. The proposed amount of external financing is US\$30 million equivalent, which is about 80% of the total cost and would be composed of an IDA credit of US\$8 million equivalent, a Swedish credit of US\$15 million equivalent and a Bank loan of US\$7 million equivalent. External financing thus would cover the estimated foreign exchange requirements and a part of the local costs. Foreign financing of part of the local currency requirements is recommended on overall economic grounds as explained in the report "Prospects for Economic Development in Tanzania" (Report No. AF-58b) of August 31, 1967. Accordingly, of the total project cost of about US\$38 million equivalent, external sources would finance the estimated foreign exchange cost amounting to about US\$25.8 million equivalent and US\$4.2 million equivalent of local cost; the balance of the local cost, amounting to about

US\$8 million equivalent, would have to be covered by the Government. The Government will be able to meet this from its budgetary resources. Upon Sweden's request, the Bank has agreed to act as the executing agency for the Swedish credit.

4.12 The Association and Sweden will finance jointly, on the basis of present cost estimates (i) a total of 80% of the payments made to contractors; and (ii) the actual foreign exchange payments to the consultants. The percentage participation of the Bank Group and Sweden would be adjusted downwards in the event of any increase in the estimated costs of the project. Any surplus funds remaining in the loan account would be cancelled. The estimated disbursements from the proposed Bank Group and Swedish financing would be as follows:

	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>Total</u>
IDA credit	4.0	4.0		8.0
Swedish credit	4.0	8.0	3.0	15.0
Bank loan			7.0	7.0
	<hr/>	<hr/>	<hr/>	<hr/>
	8.0	12.0	10.0	30.0

5. ECONOMIC EVALUATION

A. Introduction

5.01 The project is economically justified. On an overall basis, it is expected to earn an acceptable rate of return without considering Zambian transit traffic which is of uncertain volume and duration. The road from Morogoro to Iyayi serves a substantial Tanzanian traffic flow based on established economic activity with considerable growth potential. On the basis of savings from Tanzanian traffic alone, and the estimated generated economic activity in Tanzania as a result of improvement of the road, the investment would earn an overall rate of return of about 15%.

5.02 However, some elements of the design and perhaps some sections of the project would not be necessary or economically justified if there were not likely to be a substantial volume of Zambian transit traffic using the road. The road is being built stronger and to higher standards than would otherwise be required for Tanzanian traffic alone. Certain sections are being reconstructed which would stand up to the local traffic but which would deteriorate rapidly with the imposition of the heavy additional Zambian traffic if they were not improved.

5.03 While extra costs are involved in building the road to serve the probable needs of Zambia, there are also additional economic benefits. Assuming no change in Tanzania's pricing policy for the use of its roads by foreign truckers, most of these additional benefits would accrue to Zambia in the form of lower costs for moving Zambian imports and exports via this route. ^{1/} To the extent that Tanzanian truckers are engaged in this movement and their profits are increased, some of the benefits from road user savings in respect of this traffic may be retained in Tanzania. In addition, given heavy Zambian transit traffic over the road, it will cost Tanzania substantially less to maintain the proposed improved road than it would to maintain a road built to handle Tanzanian traffic alone.

5.04 The movement of Zambian transit traffic through Tanzania and the port of Dar es Salaam will generate substantial economic activity for Tanzania. The national income generated from serving this traffic is, however, not accounted for in this project analysis as an economic benefit from the road improvement. The reasons are: first, while these benefits are perfectly real for Tanzania, from an overall economic viewpoint, the traffic and the associated economic activity is transferred from Southern Rhodesia and Mozambique without any new economic output necessarily being generated. Second, the level, and likely duration, of Zambian transit traffic are not determined primarily by the condition of this road, but by other overriding

^{1/} The question of whether this traffic, in itself, is an economically justified diversion is discussed at length in the appraisal report "Zambia - Appraisal of the Second Highway Project" (TO-676).

factors that involve the general state of transport reliability for Zambia, including capacity constraints on other parts of the total regional system that are less flexible than the existing road (i.e. port, storage, administration). Therefore, the level of the Zambian traffic on the road and the associated generated activity is considered likely to be nearly the same whether the road is improved or not. Thus, these large benefits cannot be attributed fully or directly to the proposed road investment.

5.05 For the purposes of the appraisal, the project was analyzed "with or without" Zambian transit traffic. The road was also analyzed in eight sections, according to traffic, terrain, and/or cost criteria so that individual sections could be appraised separately. Due to the uncertainties with respect to a major part of the traffic and to other critical variables, a probability analysis of the range of possible economic effects of the investment was conducted with the help of a computer program specifically developed in the Bank for this purpose. In addition, the pavement design in terms of the components of the pavement structure and optimum initial strength, given the probable ranges of future traffic, was analyzed exhaustively to give guidance as to the least cost solution (see para 4.06).

B. Traffic

5.06 In general, Tanzanian traffic on the Tan-Zam Highway falls off the further the distance from Dar es Salaam, except in the vicinities of major towns such as Morogoro and Iringa. The proportion of local truck and bus movements is very high at 60% and 75%, with the higher proportions being on the less trafficked sections. Local truck traffic is estimated to be currently growing at the rate of 8% to 10% p.a. on this road with automobile traffic growing somewhat more slowly at about 6% p.a. On the project road, local traffic varies from an estimated 83 vehicles per day on the Iyayi-Makumbako section to over 300 vehicle per day within twenty miles or so of Morogoro (Table 3).

5.07 In a feasibility study of the Tan-Zam Highway financed by USAID in 1966, the Stanford Research Institute made detailed economic resource maps and estimates of the elasticity of demand for transport in the area of influence of the road within Tanzania. It found the elasticity of demand to be relatively high. Unit savings in vehicle operating costs due to improvement will be large. The distances between the major origin and destinations on this road are also large. Thus, a large absolute fall in the cost of most vehicle trips should stimulate significant economic activity in the high potential agricultural areas south and west of Iringa. High transport costs caused by poor roads and long distances have been a significant barrier to the development of this fertile, temperate highland.

5.08 Transit traffic to and from Zambia in the period after completion of the road improvements, i.e. post-1971, is more difficult to forecast. Present transit traffic volumes and political conditions do not provide a clear guide for forecasting the needs of the future. The oil traffic which now forms the bulk of Zambian import traffic will be diverted to the new pipeline before the end of 1968. Copper export traffic over the road may

be affected by the unbalanced loads that will result from diversion of the oil traffic. The build-up of general goods import traffic and a balancing load of copper will depend both on the speed at which extra capacity now being provided at the port of Dar es Salaam comes into use and the future need to maintain transit traffic in this direction. Zambian import/export traffic levels will be affected by many factors, including the competitiveness and capacity of existing alternatives, the efficiency of the operation of the entire system to Dar es Salaam including trucking operations and commercial arrangements, and the actual growth of Tanzania's own port requirements as compared with the planned port expansion. These and related factors have been assessed, insofar as possible, and translated into judgments as to the probable levels of annual traffic over the road during the period after 1971. The results of this analysis give a best estimate for 1971 of about 750,000 tons composed of about 320,000 tons of general imports and about 430,000 tons of copper exports per year, or the equivalent of a total of about 75 30-ton truck-trailers per day in both directions.

5.09 The period for which Zambian traffic is likely to utilize the improved road is also uncertain, especially in view of the proposed parallel development of a rail link. This rail link would certainly supersede the highway in the role of ensuring a reliable access to the sea for Zambia, and would divert most of this transit traffic from the road. If the Governments of Zambia and Tanzania pursue their present intention to build the railway, the earliest time when it could become operational is mid 1974, i.e. after 18 months of engineering and about 5 years of construction. There is, however, the possibility that the railway may not be built prior to the 1980's, should the Governments of Zambia and Tanzania decide to postpone construction or find that the proposed improvement to the Tan-Zam Highway would serve as an adequate alternative for the foreseeable future. The range of future transit traffic possibilities is discussed in more detail in "Zambia - Appraisal of the Second Highway Project" (TO-676).

C. Unit Savings in Vehicle Operating and Road Maintenance Costs

5.10 Table 4 sets out estimated vehicle operating costs in flat-to-rolling and in rolling-to-hilly terrain over (a) a typical bitumen/asphalt surfaced road; (b) a good gravel road; and (c) a lower class gravel/earth road. To reflect the existing condition of the actual project road sections, the estimated cost of operating vehicles over the typical road have been adjusted on the basis of actual transit times, visual inspection, and interviews with major transporters (Table 5). Table 5 also shows the estimated savings per vehicle mile for various vehicle types on the different project road sections, and the distance savings between various points which, in some cases, are substantial (20%) and would contribute greatly to reducing total vehicle operating costs. Details of the analysis of the special operating characteristics in the 5-mile Kitonga Gorge escarpment, where present average transit speeds (up and down) range from 7.5 mph for truck trailers to 15 mph for automobile, are set out in Table 6.

5.11 The savings in road maintenance costs, which vary according to the surface type and condition of the various sections of the existing road,

depend to a great extent upon traffic volume and composition. The probable future daily traffic on the road has been translated from the various types of vehicles into equivalent traffic units and the annual costs of maintaining the road with and without improvement have been derived for each section from formulae which are estimated to reflect the fixed and variable elements of maintenance costs. Certain portions of the existing road which will be by-passed by the proposed new alignment, will continue to serve as secondary roads of local importance and will have to be maintained in addition to the new road.

D. Probability Analysis of Economic Rate of Return

5.12 Use of any single estimate for each of the variables in the rate of return calculation would yield a single value for the rate of return. This would not, however, reflect the project's range of possible or probable results given the uncertainties of traffic and of the reliability of data. These uncertainties have been explicitly taken into account in the carrying out of a probability analysis of the project's rate of return. Annex B sets out the best estimates, the ranges, and the associated probabilities reflecting the uncertainties with respect to major variables, together with a brief explanation of how the analysis was conducted.

5.13 On the basis of this analysis, the expected rates of return for the various sections on a "global" basis (i.e. including expected benefits to Zambia) are set out below in column A. Column B sets out the corresponding rate of return calculated on a basis excluding Zambian transit traffic, and has been included in order to show how insensitive the Tanzanian investment decision is to the uncertainty as to future Zambian traffic level and duration.

EXPECTED ECONOMIC RATE OF RETURN (%)

Section	<u>A</u>	<u>B</u>
	Local traffic plus full savings due to probable Zambian traffic	Local traffic only
1. Iyayi-Makumbako	22.7	13.9
2. Makumbako-Sao Hill	23.6	16.3
3. Sao Hill-Iringa	18.9	14.1
4. Iringa-Mahenge (less Kitonga Gorge)	13.8	11.2
5. Kitonga Gorge	11.8	9.7
6. Mahenge-Mikumi	20.1	14.4
7. Mikumi-Pavement end	23.0	18.2
8. Pavement end-Morogoro	22.6	19.1
Iyayi-Morogoro (overall)	20.1	15.0

The minimum expected rate of return to Tanzania is thus about 15%. In addition, Tanzania would probably receive a share of the savings likely to accrue in respect of the Zambian transit traffic. The probability analysis indicates that while there is a high degree of uncertainty with respect to some of the major variables, there is a relatively small risk that the project will not yield a satisfactory return. The analysis showed that there is only a 5% probability that the project will earn less than a 10% return for Tanzania, i.e. a 95% probability that the rate of return will be over 10% (see cumulative probability curve presented in Annex B).

6. CONCLUSIONS AND RECOMMENDATIONS

6.01 The project is soundly conceived, will contribute substantially to the economic development of Tanzania, and provide a suitable facility for alternative access to the sea for landlocked Zambia. The plans for execution and supervision of construction are appropriate.

6.02 During negotiations satisfactory assurances were obtained from the Government that:

- (i) the condition of the road will be kept under observation and the pavement strengthened if and when required (see para 4.06);
- (ii) the weigh station will be properly manned, and the legal limitations of vehicle axle loads will be properly enforced (see para 4.06).

6.03 During negotiations, the financial arrangements regarding the provision of funds by Sweden and the Government for their respective parts in the project costs were also satisfactorily confirmed.

6.04 The project provides a suitable basis for financing by the Bank Group and Sweden in a total amount of about US\$30.0 million equivalent. The proposed financing would comprise an IDA credit of US\$8 million equivalent, a Swedish Credit of US\$15 million equivalent, together with a Bank loan of US\$7 million equivalent for a 30 year term including a 10 year grace period.

January 15, 1969

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Zambian Access to the Sea and the Current Transport Situation

Access to the Sea

1. As a landlocked country depending heavily on exports and imports, Zambia must concern itself with ensuring a reliable access to the sea as well as with building an adequate internal network to facilitate economic development. Zambia's primary link to the sea has historically been via the Rhodesia Railways from the Copperbelt through Southern Rhodesia to the Mozambique ports of Beira and Lourenco Marques, both about 1,500 rail miles from the Copperbelt (see Map 1). In the past virtually all of Zambia's imports and exports moved over this line. Until late 1967, the Rhodesia Railways was owned in equal share by the Governments of Zambia and Southern Rhodesia and was operated by a statutory corporation as a common service to the two countries. As a result of the unilateral declaration of independence (UDI) by Southern Rhodesia in 1965, the Zambian Railways and Rhodesia Railways have been formed into separate operating entities. Discussions as to the division of assets and liabilities have not yet been completed. Existing rail routes which could provide alternatives to the Rhodesia Railway are (see Map 1): (1) the Bas-Congo-Katanga (BCK)-Benguela Railways through Katanga Province and Angola to the Atlantic port of Lobito; (2) the Katanga-Matadi rail/water route via Port Francqui; and (3) the Katanga-Lake Tanganyika-East African Railways line to Dar es Salaam. In addition to the alternative rail links, Zambia is connected through its primary road network to the neighboring highway/rail systems in Tanzania and Malawi, which provide outlets to the sea.

2. Historically, the movement of Zambia's copper production (currently about 700,000 tons per year) has been governed by several international agreements^{1/}, which have had the effect of ensuring that at least 80 percent of Zambia's copper output would move via the Rhodesia Railways and port of Beira. A 1960 agreement between the Federal Government and the Copperbelt mines limited export via Lobito to 36,000 tons per annum. As a result of these arrangements, the alternative rail routes have not developed sufficient capacity to handle more than a small amount of Zambian traffic.

^{1/} The Tripartite Agreement between Rhodesia Railways, Chemin de Fer du Bas Congo au Katanga, and Caminho de Ferro de Benguela (1956); the Beira Convention between the U.K. (on behalf of Zambia, Malawi, Rhodesia and the U.K.) and Portugal (1950); the Agreement between Southern Rhodesia and Northern Rhodesia relating to Rhodesia Railways (1963).

3. The orientation of Zambia's trade, economy, and transport facilities toward Southern Rhodesia is an outcome of African history and Zambia's federal past. Since independence it has become the established long-range policy of the Government of Zambia to reduce the country's dependence upon Rhodesia for access to the sea and for the supply of a wide variety of manufactured and raw material requisites. Zambia wishes to develop new and closer trade relations with neighboring nations to the north and east, and to change the inherited and somewhat arbitrary pattern of international traffic.

The Current Transport Situation

4. UDI aggravated the already troubled atmosphere of Central Africa, and transformed Zambia's long-range aim to diversify its trading and transport pattern into an immediate problem. Following UDI, a series of UN Security Council resolutions^{2/}, placed progressively strict economic sanctions on Rhodesia beginning with an international embargo on the movement of petroleum and other products to or through Rhodesia, and imposing most recently (May 1968) a complete embargo. These sanctions necessitated the emergency transport of liquid fuels to Zambia and the backhaul of some copper exports over the most immediately available alternative link to the sea, the 1,200 mile road from the rail line at Kapiri Mposhi to Dar es Salaam, which is now commonly known as the Tan-Zam highway. During 1966 nearly 1,000 privately-owned trucks in Zambia and Tanzania were put into service for this purpose under contract to the Central African Road Services (CARS), acting as agent of the Zambian Government. In mid-1966, the Zambia-Tanzania Road Services Ltd. (ZTRS) was formed and began operating 30 ton capacity truck-trailer units to carry petroleum and general cargo imports and copper exports; by mid-1968 the ZTRS fleet had reached 442 units. In early 1967 a number of large foreign firms, operating a total of about 300 large tanker-trailers, entered the oil lift service over the Tan-Zam Highway. Oil lift operations over the Great East Road via the Malawi and Mozambique rail systems from Beira were also instituted on a smaller scale.

5. In addition to the emergency transport over the Tan-Zam Highway, a military-type airlift of oil products and copper was instituted early in 1966 by the US, U.K. and Canadian Air Forces via the Congo and East Africa. This has since been discontinued and replaced by the operations of Zambia Air Cargoes Ltd., a newly formed company operating four large cargo planes, which carry copper to Dar es Salaam and return with fuels.

6. Attempts have also been made to increase Zambian traffic on the alternative rail routes to Lobito, to Matadi, and via Lake Tanganyika and the East African Railways to Dar es Salaam. The only significant results

^{2/} Resolutions 216 (1965) of 12 November 1965; 217 (1965) of 20 November 1965; 221 (1966) of 9 April 1966; 232 (1966) of 16 December 1966; and 253 (1968) of 29 May 1968.

so far have been achieved on the BCK/Benguela line via the Congo and Angola to Lobito, for which additional rolling stock and personnel have been provided by Zambia to handle Zambian traffic on the BCK portion through the Congo (see Annex A para. 9).

7. The Tan-Zam highway has been the principal route for the traffic diverted from Rhodesia, due primarily to the greater flexibility inherent to trucking operations as compared to the rail routes. An important constraint on traffic movement has been the condition of the road, although the combined problems encountered in the areas of traffic control, trucking organization, goods storage, commercial arrangements and border formalities have probably formed the operative constraint on traffic. The emergency operation of about 120 heavy trucks per day over the Tan-Zam Highway, in addition to normal traffic, required extraordinary maintenance expenditures of about US\$3.0 million equivalent in Zambia and about US\$2.0 million equivalent in Tanzania during 1966/67, but even so the road has often been closed at one or more points for several days at a time due to broken structures or mired or wrecked vehicles. The damage to vehicles in the course of a journey requires extensive vehicle maintenance (averaging 5 days for ZTRS after each one-way trip). Under these conditions the ZTRS averages only 1.1 round trips per vehicle unit per month. While the condition of the road undoubtedly affects the capacity of the existing trucking fleet, the traffic on the road could be pushed up by continued expansion of the fleet until capacity constraints on less flexible parts of the system, i.e., the ports and storage facilities, become operative.

8. Since mid-1966 drastic fuel rationing has been imposed periodically in Zambia, often for many months at a time. Refined copper production in 1966 was down 15 percent due to fuel shortages that interrupted smelting operations. Costly stockpiles of copper concentrates had to be held as inventory. Fuel (coal and heavy fuel oil) costs for the copper industry averaged K 6.0 (US\$8.40 equivalent) per ton in 1965 prior to UDI; in 1967 the average cost had risen to K 18.0 (US\$25.20) per ton including a surcharge placed on coal from Rhodesia. Copper transport costs to the sea averaged K 30.0 (US\$42.00) per ton in 1965, the 1967 average by all routes was K 52.0 (US\$72.80). In October 1967 the Rhodesia Railways further increased average copper transport costs by raising charges on Zambian copper by 50 percent. At the same time average charges on other Zambian traffic were increased by over 25 percent. No systematic accounting of the economic costs to Zambia of the present situation has been made; however, the recent increases in rates for Zambian cargoes via the Rhodesia Railway, demonstrate the degree to which the Zambian economy is dependent upon a single access route, and the lack of competitive pressure from alternative routes which could help to ensure low cost external transport for Zambia.

9. While the diversion of transport of oil, copper and general imports has so far proved to be very expensive, it has failed to reduce appreciably Zambia's dependence upon Rhodesia for access to the sea and for the purchase of a wide range of vital supplies. In 1967, the average division of the monthly tonnage of import/export traffic between the various routes was approximately as follows:

Average Monthly Import/Export Tonnages

<u>Imports</u>				
<u>Via Rhodesia</u>	<u>Via Dar es Salaam</u>	<u>Via Lobito</u>	<u>Via Malawi</u>	<u>Total</u>
<u>Coal & general</u>	<u>Oil products & general</u>	<u>Coal & general</u>	<u>Oil products & general</u>	
145,000*	20,000	14,000	5,000	184,000
<u>Exports</u>				
<u>Copper & general</u>	<u>Copper</u>	<u>Copper & general</u>	<u>Copper & general</u>	<u>Total</u>
<u>60,000</u>	<u>17,500</u>	<u>11,500</u>	<u>4,500</u>	<u>93,500</u>
TOTAL <u>205,000*</u>	<u>37,500</u>	<u>25,500</u>	<u>9,500</u>	<u>277,000*</u>

* Including 90,000 tons of coal from Wankie, Rhodesia, which is to be replaced by local supply in 1969.

Long-Range Solutions

10. The most advanced of current projects to develop permanent alternative transport capacity to the sea is an oil pipeline from Dar es Salaam to the Copperbelt. The pipeline is estimated to cost about US\$48 million equivalent and will be capable of handling the entire refined fuel requirements of Zambia - about 200,000 tons in 1967. The Zambian and Tanzanian Governments have formed a joint company to own and operate the pipeline. Construction began in 1967, and the pipeline is scheduled to be in operation by November 1968. At this time, the oil traffic, which accounts for about half the total present traffic on the Tan-Zam Highway, will be diverted to the pipeline, except for the relatively small amounts of oil types unsuited to pipeline transmission.

11. Reconstruction of two-lane bituminous paved standard of the full length of the gravel/earth sections of the Tan-Zam Highway from Kapiri Mposhi at the Line of Rail in Zambia to Morogoro in Tanzania (965 miles) is now in advanced stage of planning, and partly under execution. The Zambian sections are all under construction; the first 122 mile section from Kapiri Mposhi to Serenje is part of the project under Bank Loan 469-ZA, and the 235 mile Mpika-Tunduma section is the subject of the project under Bank Loan 563-ZA. In Tanzania, reconstruction of the 150 miles section from the border at Tunduma to Iyayi is being financed with the assistance of USAID; the remaining 311 miles from Iyayi to Morogoro are subject to this appraisal report. The plans call for completion of the Zambian sections by the end of 1969 and for the Tanzanian sections by early 1971. The improved and

realigned Copperbelt-Dar es Salaam road link will be about 1,170 miles in length, including the section along the Line of Rail north of Kapiri Mposhi.

12. In addition to the pipeline and improved road connection, the Zambian and Tanzanian Governments have announced their intention to construct a 980 mile rail link from Kapiri Mposhi on the Zambian Railway system to the Kidatu railhead of the East African railway system in Tanzania, which would provide a 1,300 mile route from the Copperbelt to the Indian Ocean, at a cost of roughly US\$400 million equivalent including line construction, rolling stock, and additional deep water berths at Dar es Salaam. The idea of this link predates the emergency by many years and has been the subject of a number of engineering and economic investigations. The latest investigation took place in 1966 with financial assistance from the U.K. and Canada. The Bank has reviewed the consultants' report in conjunction with the UNDP and the African Development Bank. This review concluded that three technical and one economic supplementary investigations were necessary to complete the feasibility analysis of the project. The major technical investigation has been undertaken with UNDP financing. The Governments of Tanzania and Zambia, however, have so far not indicated their intention to proceed with the economic enquiries. The detailed engineering of the link is now underway with the assistance of Mainland China, which has also given some assurances with respect to the financing of eventual construction. The timing of construction is uncertain. Detailed engineering is to be completed by the end of 1969. A five-year construction period is probably a minimum feasible schedule. Presumably, the commitment to invest this magnitude of capital will remain subject to further decisions based on final cost estimates and the foreseeable demand for the facility.

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Probability Analysis of the Economic Rate of Return

1. Due to the uncertainties surrounding the major variables of the economic evaluation, the selection of single values for these variables and use of them in the rate of return calculation would give a misleading impression. A probability analysis was conducted to reflect the full range of possibilities, and the likelihood of various results within this range.
2. The first step of the analysis consisted of writing a computer program for the calculation of the rate of return of the project. The inputs of the program were the Bank staff's best estimates of the volume and composition of future traffic, project costs, vehicle operating and road maintenance costs with and without the project, the price elasticity of demand for transport, and the economic life of the assets as variables; the output was a single rate of return.
3. In the second step a sensitivity analysis was made of the rate of return. For this purpose, each of the parameters was varied one at a time, and the corresponding values of the rate of return computed. Each parameter was tested by a 10 percent variation around the value which had been chosen in the determination of the initial rate of return, and for those parameters which had ranges of uncertainty estimated to be larger than + 10 percent of the initial estimated value, the rate of return for the two extreme values of the range was also computed. The results of this sensitivity analysis 1/ indicated which parameters had an important effect on the value of the rate of return, and allowed the number of variables to be considered in the probability analysis to be limited to these.
4. The third and final step in the analysis was the probability analysis proper, which was done by way of a simulation (Monte Carlo technique). For this purpose a probability distribution was estimated for the values of each of the parameters selected in the sensitivity analysis. These distributions reflect the Bank staff's judgments of the uncertainties with respect to data, and its judgment as to probable future developments. The rate of return was then computed repeatedly (300 times) using each time, for each of the selected parameters, a value drawn at random from the range of its probability distribution. The frequency of a particular value's selection is governed by its probability weighting. Care was taken to correlate interdependent variables. Finally, the distribution of the rate of return was statistically deduced from the sample of values obtained.
5. The hypotheses employed in the analysis are shown in the accompanying table followed by a graphic presentation of the results in terms of cumulative probability of earning more than a specific rate of return with and without Zambian transit traffic.

1/ Technically a partial analysis since combinations of parameters were not varied simultaneously.

SECOND NATIONAL PROJECT

PROBABILITY ANALYSIS OF ECONOMIC RISK OF RETURN

	Item	Consultants' Best Estimate (US\$) ^{2/}	Nature of Uncertainty	Probability Distribution
A. Reengineering & Construction Costs ^{1/}	<u>Road Section</u>			
	1.	1,962,300	Quantity	Uniform between +0% and +15%
	2.	3,611,700		
	3.	4,593,500	plus	50% probability 0% to 5% 50% probability 5% to 15%
	4.	3,308,200		
	5.	1,162,000		
	6.	7,259,000	Bid Uncertainty	
	7.	3,608,000		
8.	3,082,000			
B. Traffic Count in 1967	<u>Best Estimate</u>			
	1. Cars per section	)	Accuracy of traffic counts	Rectangular -20% & +10%
2. Trucks per section	)			Standard Rectangular
3. Truck trailers per section	)	See Table 3		AD-FRANCE
h. Zambian Import/Export traffic 1971				
	75	)	Capacity of Port at Salama Port	0
	)	)	Distribution of traffic over alternative routes.	1-33
	)	)	Central African Political situation.	33-66
C. Traffic Growth Rate	<u>Best Estimate</u>			
	1. Cars	5%	Forecasting uncertainty	10%
	2. Trucks	8%		10%
3. Truck trailers	8%		10%	
L. Zambian Import/Export traffic Period 1968-1975				
	0%	)	Duration of traffic	1-33
	0%	)	Probability of railway development or other solution	33-66
	0%	)		66-100
D. Elasticity of Traffic Demand	<u>Best Estimate</u>			
	1.0	)		10%
	1.0	)		10%
	0	)		10%
E. Vehicle Operating Costs (US\$/mile)	<u>Best Estimate</u>			
	1. Cars per section	)		10%
	2. Trucks per section	)		10%
	3. Truck-trailers per section	)		10%
New Road				
	1. Cars per section	)		10%
	2. Trucks per section	)		10%
	3. Truck-trailers per section	)		10%
Zambian Traffic per section				
	1. Cars per section	)		10%
	2. Trucks per section	)		10%
	3. Truck-trailers per section	)		10%
Old Road				
	1. Cars per section	)		10%
	2. Trucks per section	)		10%
	3. Truck-trailers per section	)		10%
Zambian traffic per section				
	1. Cars per section	)		10%
	2. Trucks per section	)		10%
	3. Truck-trailers per section	)		10%
F. Road Maintenance (US\$ per mile)	<u>Best Estimate</u>			
	1.20	)		10%
	1.20	)		10%
	1.550.0	)		10%
G. Traffic Unit Maintenance for Maintenance Cost Calculations	<u>Best Estimate</u>			
	1.20	)		10%
	1.20	)		10%
	1.550.0	)		10%
H. Time and Cost of Required Pavement Strengthening	<u>Best Estimate</u>			
	13,500	)		10%
	13,500	)		10%
	13,500	)		10%

^{1/} Net of estimated taxes, duties and other transfer payments.
^{2/} Net of transfer payment, and contingency allowances, and reflecting some adjustments by the mission.
^{3/} A very detailed breakdown of cost components and associated quantity and bid uncertainties for sections 6, 7, and 8, derived from dissection with the consultants was used for these three sections.
^{4/} A variable of low sensitivity or low range of variation. No variation according to probability within range considered necessary.
^{5/} This distribution is artificial in that aim to reflect judgement as to unit savings rather than level of operating costs.
^{6/} Ignored, because variation in savings fully taken care of by variation in estimated operating costs on old road.

According to aggregated distribution of traffic volume/duration/growth with own vehicle pass translated into equivalent 10 Kip axle passers.

TANZANIA

SECOND HIGHWAY PROJECT

PROBABILITY ANALYSIS OF ECONOMIC RATE OF RETURN

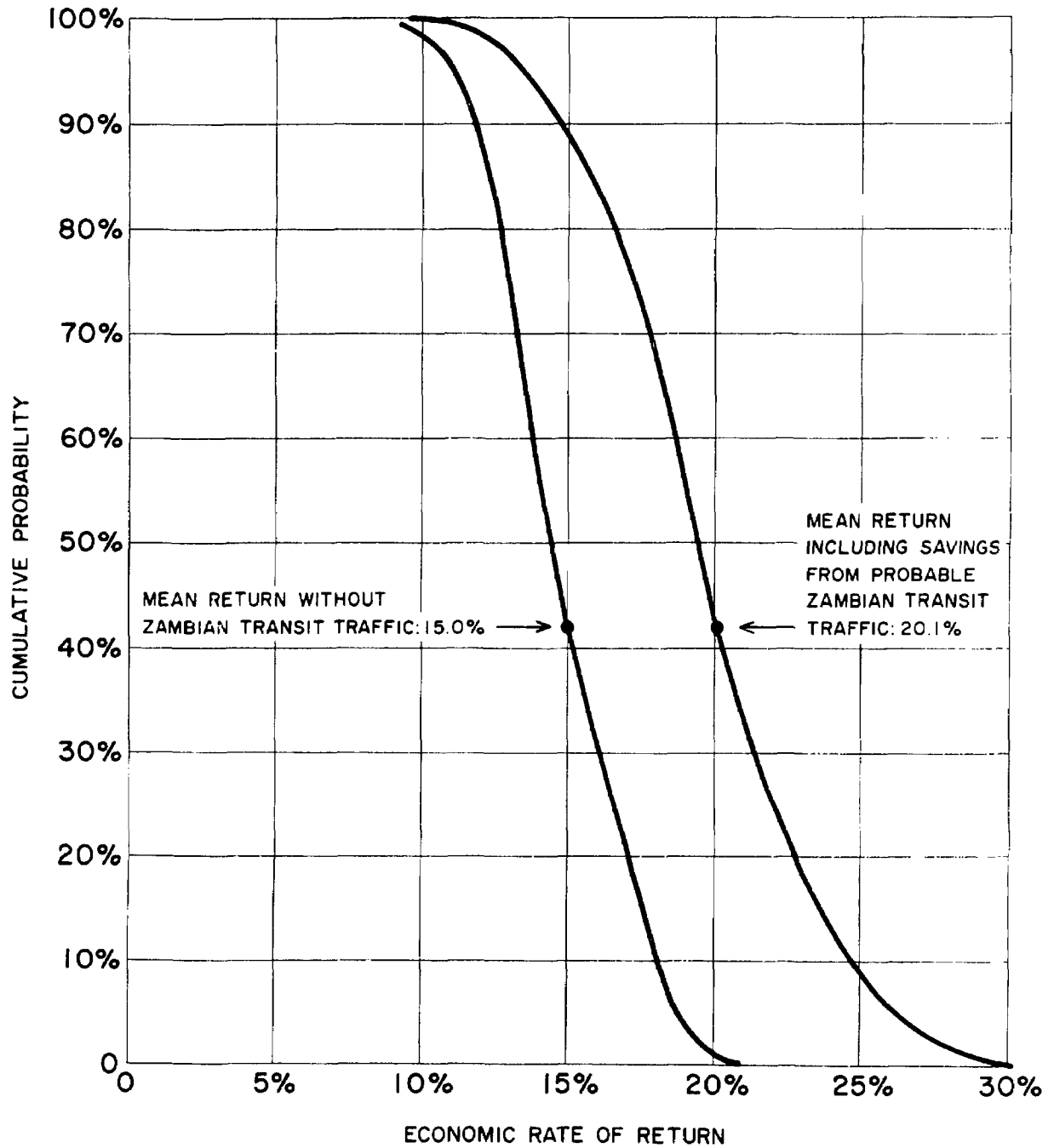


TABLE 1

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Central Government Road Expenditures
(in Sh millions)

<u>Year</u>	<u>Administration^{a/}</u>	<u>Maintenance</u>	<u>Construction</u>	<u>Total</u>
1961/62	8.0	30.0	24.0	62.0
1962/63	12.0	28.0	20.0	60.0
1963/64	12.0	30.0	20.0	62.0
1964/65	14.0	28.0	24.0	66.0
1965/66	14.0	34.0	28.0	76.0
1966/67	14.0	60.0 ^{b/}	64.0	138.0
1967/68 (Est)	15.0	60.0 ^{b/}	101.0	176.0

a/ Estimated

b/ Including an estimated 24 million for increased maintenance of the Tan-Zam Highway necessary in 1966/67; and 20 million in 1967/68.

TABLE 2

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Design Standards

	- - - - - Terrain - - - - -			Kitonga Escarpment
	Flat	Rolling	Mountainous	
Design speed, mph	70	50-60	40	25
Width, ft.				
Roadway	32-34	32-34	28-30	Pavement width plus curbs
Pavement	22	22	22	23
Shoulders	5-6	5-6	3-4	none
Grades, percent	4	5	7	12
Minimum radius of horizontal curves, ft.	1,500	1,050	700	100
Stopping sight distance, ft.	600	350-475	350	350
Pavement:				
Subbase course		Selected soil		
Base course		Crushed stone or stabilized soil		
Surface course		1½ inch asphalt concrete		
Design axle load		18,000 pounds		
Bridges:				
Width, ft.				
Spans less than 30 ft.		Equal to roadway width		
Spans more than 30 ft.		24 ft. curb to curb		
Design load		AASHO H20-S16-44		

TABLE 3TANZANIAAPPRAISAL OF THE SECOND HIGHWAY PROJECTEstimated Tanzanian^{1/} Traffic on Project Road Sections
(Average Daily Traffic 1967)

<u>Project Road Section</u>	<u>Cars</u>	<u>Trucks and Buses</u>	<u>Truck-Trailers</u>	<u>Total</u>
Morogoro +20	120	165	20	305
Morogoro +20 - +38	80	130	20	230
Morogoro +38 - Mikumi	54	118	14	186
Mikumi-Mahenge	36	79	9	124
Mahenge-Kitonga-Iringa	58	120	10	188
Iringa-Sao Hill	62	89	6	157
Sao Hill-Makumbako	36	74	6	116
Makumbako-Iyayi	24	54	5	83
Annual Growth Rate	6%	8%	8%	

^{1/} Not including Zambian transit traffic

TABLE 1

TANZANIA

APPRAISAL OF THE SECOND HIGHWAY PROJECT

Estimated Vehicle Operating Costs (1967-1968)^{1/}
 on: (I) Engineered Bitumen/Asphalt, (II) Engineered Gravel, and (III) Unimproved Earth
 (US cents per vehicle mile)

A. Flat to Rolling Terrain

Vehicle Category	Average Car			Pick-up Truck			Average Truck 7 Ton Capacity			Average Bus 50 Passengers			Truck-trailer 30 Ton Capacity		
	Gasoline			Gasoline			Diesel			Diesel			Diesel		
Road Type	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Fuel	1.11	1.24	1.38	1.62	1.68	1.81	1.86	2.26	2.68	1.82	2.28	2.70	4.15	5.18	6.15
Lubricants	.06	.08	.10	.08	.11	.15	.14	.17	.26	.15	.19	.26	.42	.50	.63
Maintenance															
Labor	.22	.29	.39	.26	.32	.55	.88	1.39	2.32	.77	1.31	2.29	6.30	10.47	22.30
Parts	.44	.56	.82	.48	.69	1.10	1.48	2.44	4.00	2.16	3.71	6.40			
Tires	.20	.40	.68	.32	.62	1.20	1.18	2.68	6.05	.64	1.80	4.48	4.30	5.88	11.30
Crew Wages	1.12	1.40	1.85	1.24	1.56	2.08	1.40	1.77	2.34	1.77	2.34	2.80	1.95	3.55	6.30
Interest	.78	.97	1.30	.63	.79	1.05	.40	.49	.66	.87	1.15	1.40	1.10	1.60	2.52
Insurance	.37	.46	.61	.32	.40	.53	.34	.43	.57	.79	1.05	1.26	.40	.60	.90
Depreciation	2.12	2.79	4.14	2.02	2.74	4.54	1.52	2.32	3.97	4.17	6.28	10.32	6.80	12.40	20.05
TOTAL	<u>6.42</u>	<u>8.19</u>	<u>11.27</u>	<u>6.97</u>	<u>8.91</u>	<u>13.01</u>	<u>9.20</u>	<u>13.95</u>	<u>22.85</u>	<u>13.14</u>	<u>20.11</u>	<u>31.91</u>	<u>25.42</u>	<u>40.18</u>	<u>70.15</u>

B. Rolling to Hilly Terrain

TOTAL	<u>6.65</u>	<u>8.58</u>	<u>11.80</u>	<u>7.41</u>	<u>9.11</u>	<u>13.90</u>	<u>9.75</u>	<u>15.05</u>	<u>25.02</u>	<u>14.49</u>	<u>21.21</u>	<u>34.43</u>	<u>26.81</u>	<u>43.49</u>	<u>76.65</u>
-------	-------------	-------------	--------------	-------------	-------------	--------------	-------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------	--------------

^{1/} Net of taxes, license fees and other transfer payments. Costs of terminal operation, waybills, company administration, which are not directly affected by road improvement, are not included.

^{2/} Account not taken of present fuel rationing and inflated fuel cost situation.

Sources: J. DeWelle - "Quantification of Road User Savings" IBRD Occasional Paper No. 2 (East African prices)
 United Research Incorporated, Consultant to the Government of Tanzania.
 Interviews with trucking firms in Zambia and Tanzania
 Mission estimates.

TABLE 5

TANZANIA

SECOND HIGHWAY PROJECT

Estimated Vehicle Operating Costs on Project Road Sections^{1/}
(US cents per vehicle mile)

Road Section	Old Miles	New Miles	Miles Saved	Passenger Cars			7 Ton Truck			50 Passenger Bus			30 Ton Truck Trailers		
				Old Road	New Road	Savings per mile	Old Road	New Road	Savings per mile	Old Road	New Road	Savings per mile	Old Road	New Road	Savings per mile
Morogoro + 38	38	38	0	8.2	6.4	1.8	14.0	9.2	4.8	20.1	13.1	7.0	40.0	25.4	14.6
Morogoro+38 - Mikumi	37	37	0	9.4	6.4	3.0	17.6	9.2	8.4	24.8	13.1	11.7	52.0	25.4	26.6
Mikumi - Mahenge	67	65	2	10.2	6.7	3.5	19.7	9.8	9.9	27.7	14.5	13.2	59.5	26.8	32.7
Mahenge - Kitonga	7	7	0	8.2	6.4	1.8	14.0	9.2	4.8	20.1	13.1	7.0	40.0	25.4	14.6
Kitonga Gorge	5	5	0	18.6	10.1	8.5	29.3	16.9	12.4	39.2	21.6	17.6	79.8	44.9	34.9
Gorge - Iringa	33	33	0	8.2	6.4	1.8	14.0	9.2	4.8	20.1	13.1	7.0	40.0	25.4	14.6
Iringa - Sao Hill	58	49	9	9.1	6.4	2.7	16.7	9.2	7.5	23.6	13.1	10.5	49.0	25.4	23.6
Sao Hill - Makumbako	58	49	9	9.7	6.4	3.3	18.5	9.2	9.3	25.9	13.1	12.8	55.0	25.4	29.6
Makumbako - Iyayi	30	27	3	10.7	6.4	4.3	21.1	9.2	11.9	29.4	13.1	16.3	64.0	25.4	38.6
Total	333	310	23												

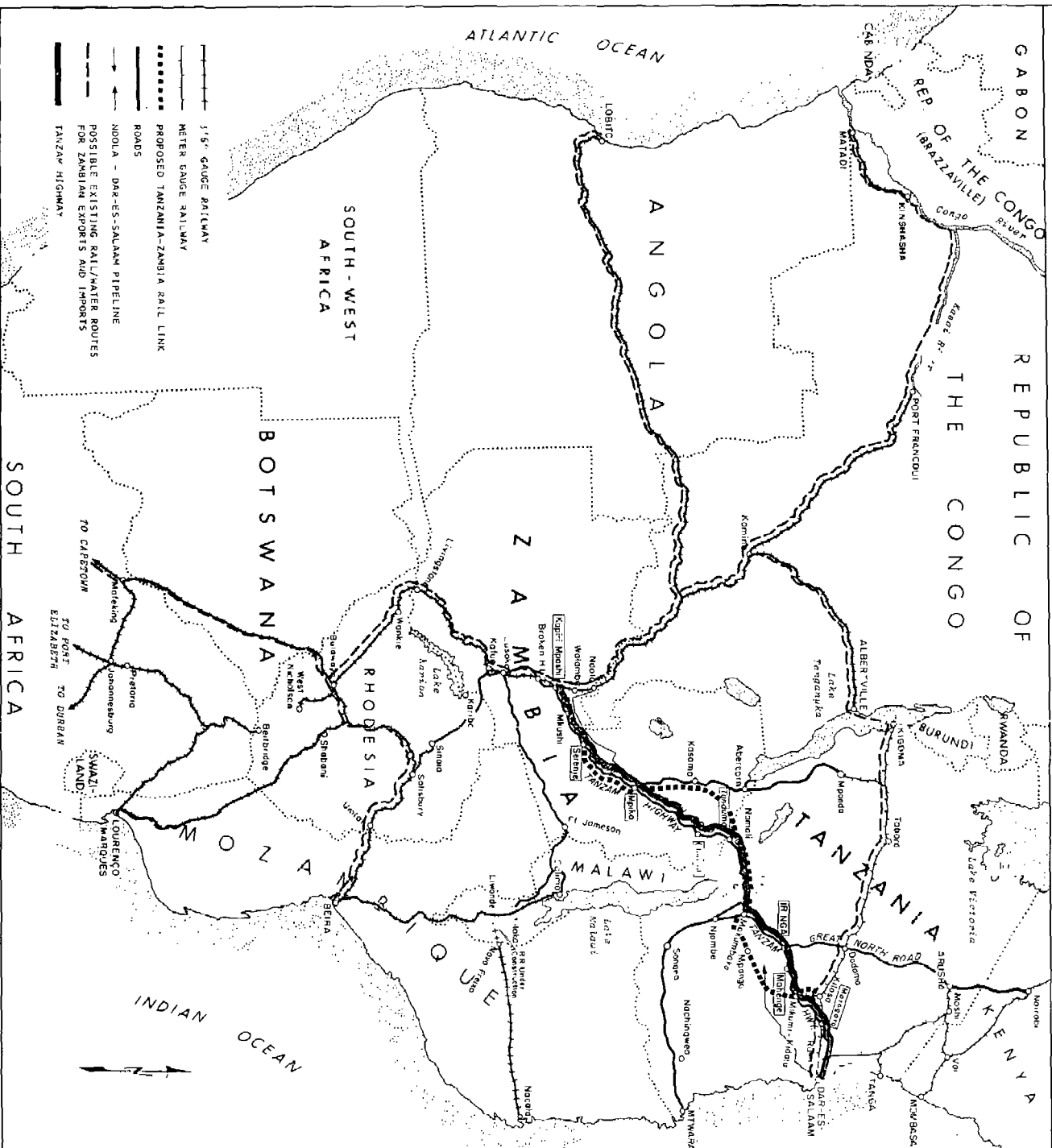
^{1/} Costs comparable to totals in Table 4.

TABLE 6

TANZANIAAPPRAISAL OF THE SECOND HIGHWAY PROJECTEstimated Vehicle Operating Costs - Kitonga Gorge

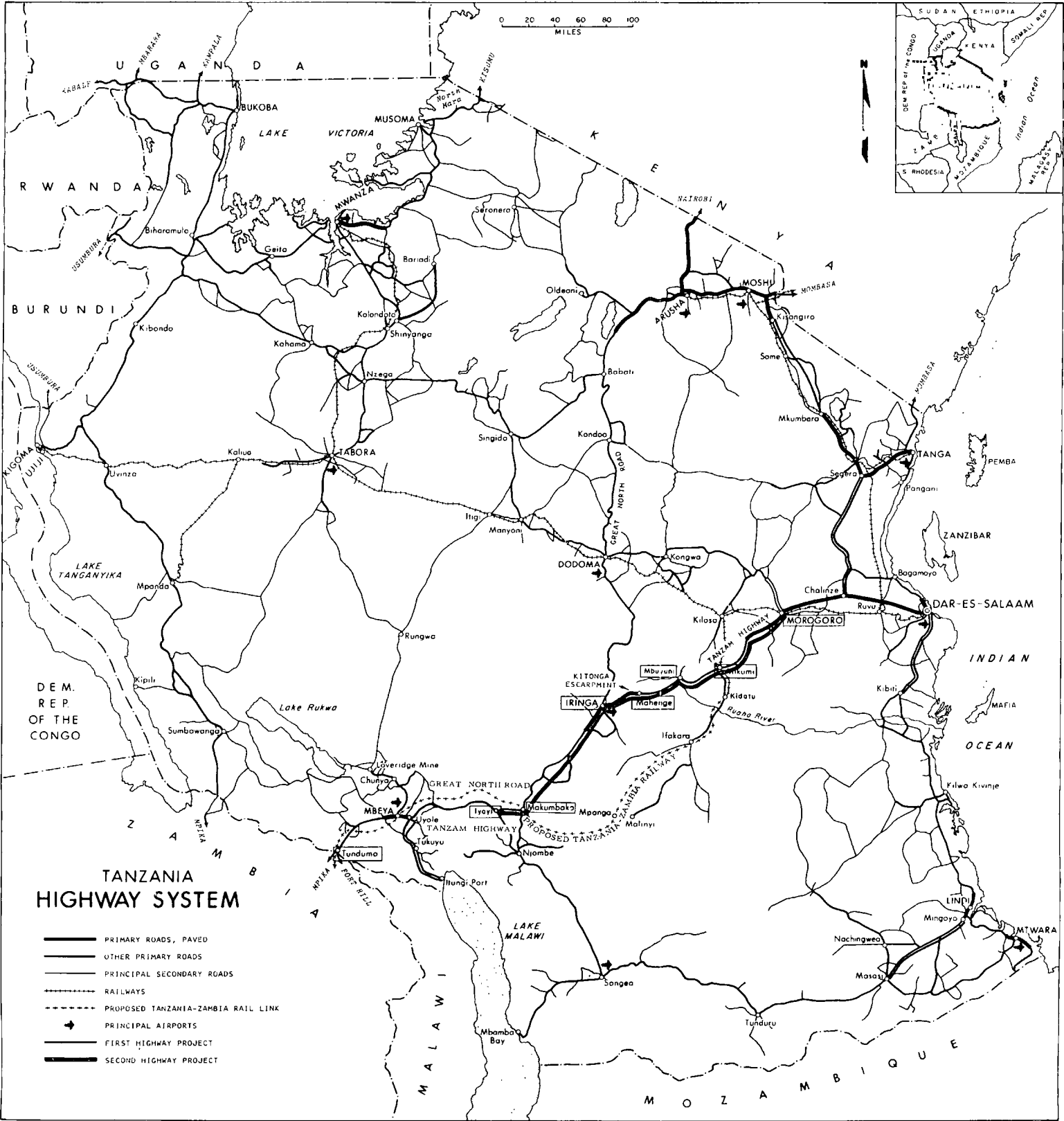
A. <u>WITHOUT Proposed Reconstruction</u>	<u>Cars</u>	<u>Trucks 7 ton</u>	<u>Buses 50 passengers</u>	<u>Truck-Trailer 30 ton</u>
Average speed Up (mph)	12	5	8	5
Average speed Down (mph)	18	12	12	10
Average transit speed (mph)	15	8.5	10	7.5
Average transit time (minutes)	20	35	30	40
Vehicle Operating Costs (US cents per vehicle mile):				
Fuel and Lubricants	1.37	2.53	2.47	5.73
Maintenance	.78	3.02	3.42	9.70
Tires	.32	2.10	1.34	5.40
Crew	4.00	7.00	6.00	12.00
Interest	2.60	1.83	2.80	5.04
Depreciation	8.28	11.20	20.62	40.10
Insurance	1.22	1.60	2.52	1.80
TOTAL	18.57	29.28	39.17	79.77
<u>B. WITH Proposed Reconstruction</u>				
Average speed Up (mph)	25	12	15	10
Average speed Down (mph)	35	20	25	20
Average transit speed (mph)	30	16	20	15
Average transit time (minutes)	10	19	15	20
Vehicle Operating Costs (US cents per vehicle mile):				
Fuel and Lubricants	1.20	2.00	1.97	4.57
Maintenance	.66	2.36	2.93	6.30
Tires	.20	1.20	.70	4.30
Crew	2.00	3.70	3.00	5.30
Interest	1.30	.97	1.40	2.52
Depreciation	4.14	6.05	10.32	20.05
Insurance	.61	.85	1.26	.90
TOTAL	10.11	17.13	21.58	43.94
<u>C. SAVINGS</u>				
(US cents per vehicle mile)	8.46	12.15	17.59	35.38

EAST & CENTRAL AFRICAN TRANSPORT LINKS



SEPTEMBER 1968

IBRD - 1253R8



TANZANIA HIGHWAY SYSTEM

- PRIMARY ROADS, PAVED
- OTHER PRIMARY ROADS
- PRINCIPAL SECONDARY ROADS
- RAILWAYS
- PROPOSED TANZANIA-ZAMBIA RAIL LINK
- PRINCIPAL AIRPORTS
- FIRST HIGHWAY PROJECT
- SECOND HIGHWAY PROJECT