No.

BASIC DESIGN STUDY REPORT
ON THE PROJECT
FOR
WIDENING OF KILWA ROAD
(FROM THE JUNCTION OF BANDARI ROAD
TO MBAGALA RANGI TATU)
IN
UNITED REPUBLIC OF TANZANIA

MARCH 2006

JAPAN INTERNATIONAL COOPERATION AGENCY
CONSTRUCTION PROJECT CONSULTANTS, INC.

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PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct a basic design study on the Project for Widening of Kilwa Road (from the Junction of Bandari Road to Mbagala Rangi Tatu) in the United Republic of Tanzania and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team from August 8 to September 4, 2005.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tanzania in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the teams.

March , 2006

Seiji Kojima
Vice-President
Japan International Cooperation Agency

March, 2006

Letter of Transmittal

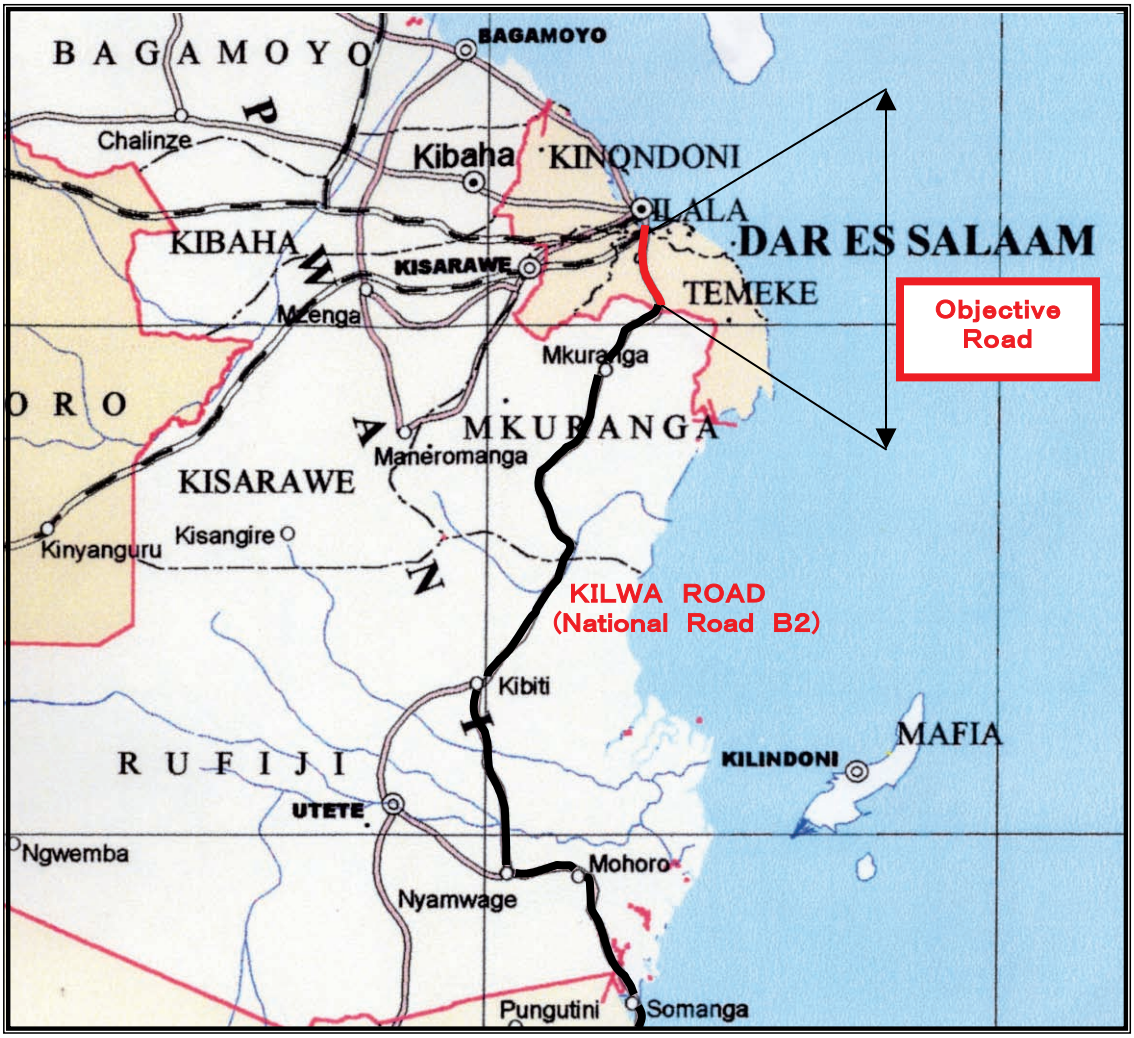
We are pleased to submit to you the basic design study report on the Project for Widening of Kilwa Road (from the Junction of Bandari Road to Mbagala Rangi Tatu) in the United Republic of Tanzania.

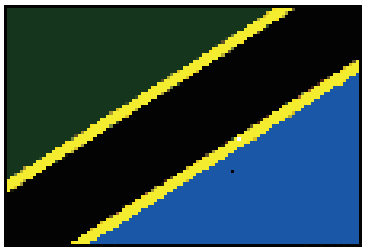
This study was conducted by the joint venture between Construction Project Consultants, Inc. under a contract to JICA, during the period from July, 2005 to March, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

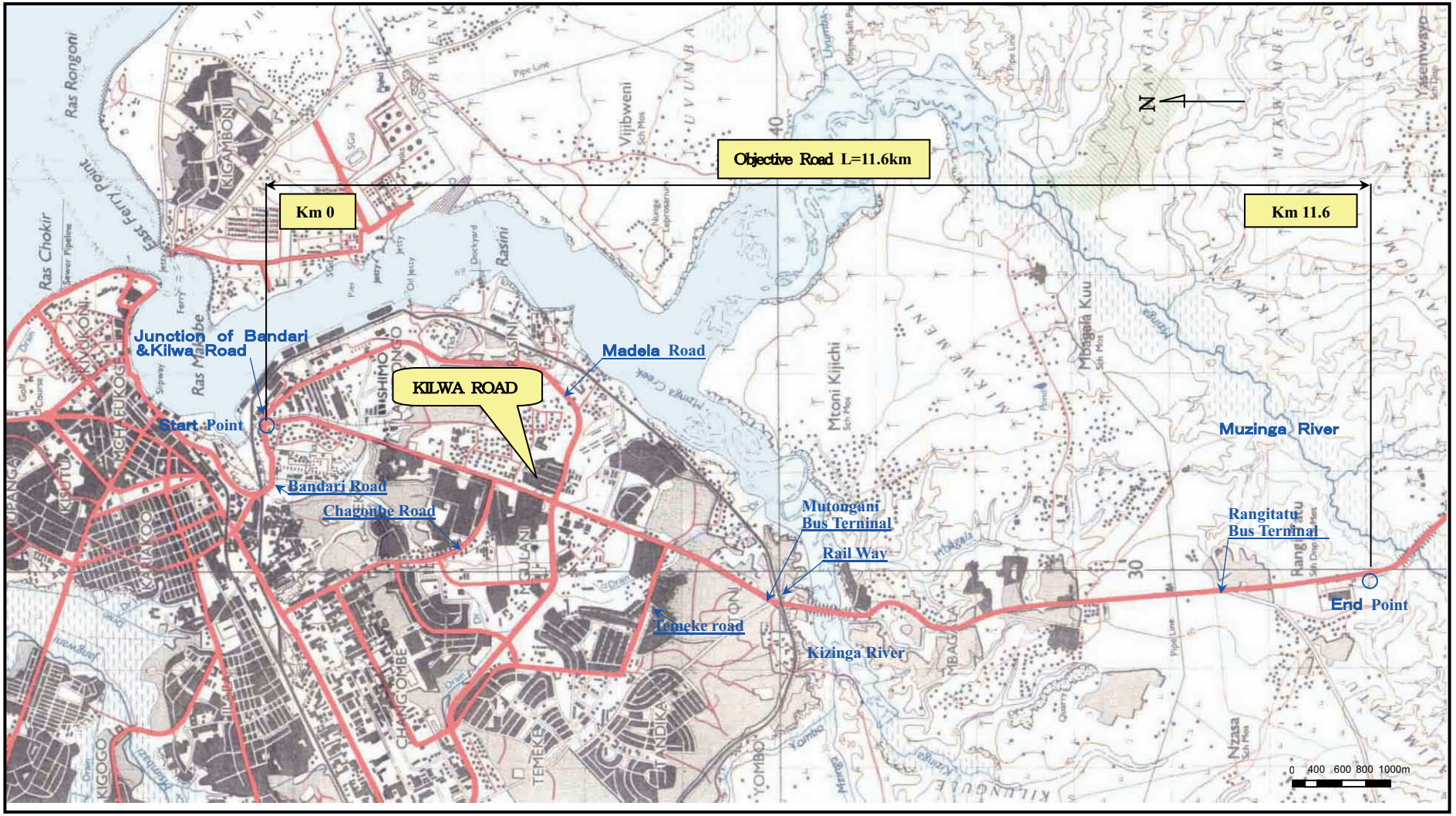
Very truly yours,

Shozo Inoue
Project Manager
Basic design study team on the Project for Widening of Kilwa Road (from the Junction of Bandari Road to Mbagala Rangi Tatu) in the United Republic of Tanzania
Construction Project Consultants, Inc.





PROJECT LOCATION MAP



OBJECTIVE ROAD MAP

PERSPECTIVE

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Abbreviation

TANROADS:	:	Tanzania Roads Authority
MOID	:	Ministry of Infrastructure Development
km	:	Kilometer
JICA	:	Japan International Cooperation Agency
BRT	:	Bus Rapid Transit
HDM-4	:	Highway Development and Management System-4
EU	:	European Union
DANIDA	:	Danish Development Agency
DRS	:	Dar es Salaam
TS	:	Tanzanian Shilling
ADT	:	Average Daily Traffic
AADT	:	Annual Average Daily Traffic
ROW	:	Right of Way
C-BOX	:	Culvert Box
SIDO	:	Small Industry Development Organization
RS-ES	:	Road Sector Environmental Section
IEE	:	Initial Environmental Evaluation
LEA	:	Limited Environmental Analysis
CRB	:	Contractors Registration Board
BS	:	British Standard
SATCC	:	South African Transport Communication Committee
ESAL	:	Equivalent Standard Axe Load
CBR	:	California Bearing Ratio
DBST	:	Double Bitumen Surface Treatment
E/N	:	Exchange of Note

SUMMARY

Summary

The United Republic of Tanzania (hereafter referred to as “Tanzania”) is located on the eastern coast of the African continent, in the middle of the coastline. With its total area of 884,000 km^2, the territory has a vast inland plateau of 1,000 to 2000 m in elevation that starts from the coastal region on the Indian Ocean and it has Mt. Kilimanjaro (5,895 m) in the north. Dar es Salaam, the target area for this study, is a harbor city on the Indian Ocean, with a population of 2.5 million (7 % of the country’s population in 2002 of 34.6 million after national census) living in an area of 1,350 km^2. The climate of the city is tropical with an average annual temperature of about 26℃ and an annual precipitation of approximately 1,140 mm. The weather is hot and humid with an annual average humidity of 77%.

The road network in Tanzania includes 10,300 km long sections of trunk roads managed under TANROADS (Tanzania Roads Authority), an agency under MOID (Ministry of Infrastructure Development) and 24,700 km long sections of regional trunk roads, both totaling 35,000 km. In addition, it includes 20,000 km long stretches of local roads managed under local governments, their branches of 27,550 km in length, and a 2,450 km long section of urban roads. All these sum up to be as long as 85,000 km in length. For both trunk and regional trunk roads, the paved sections are relatively in good conditions. However, the unpaved sections are not fair and this is posing serious maintenance problems. The recent economic recovery in Tanzania created a sprawl of urban areas and remarkable increase in demand for traffic. The urban traffic in Dar es Salaam is greatly increasing and serious congestion problems have started to emerge within the sections where double-lane roads can no longer accommodate the traffic. Lack of proper bypasses roads around the urban areas adds to this traffic congestion problem in the urban center and the situation is worsening.

As an important part of the national development plan of Tanzania, there is the Strategic Plan for the Elimination of Poverty (established in October 2000). Under this plan, high priority is placed on the betterment of services relating to the transportation of people and goods by upgrading access to both urban and rural areas based on the improvement of trunk and regional roads and on the implementation of management and maintenance for trunk and regional roads that have already been improved. Under the national development plan, there is the 10-year road sector development plan (established in July 2001) covering the period from 2001/2002 to 2010/2011, as a superior program of this project. The first five years of this program is devoted to the completion of the unfinished portion of the previous 1990’s projects (TANZAM road linking Tanzania and Zambia), a central major trunk road that runs through the center of Tanzania, and the repairing of the El Nino

damage sustained in 1998. The last project is also called the Emergency Road Improvement Program. In the subsequent five years, unfinished portions of the first five-year plan will mainly be completed, together with the improvement of trunk roads whose development priority has been reassessed. The expanding of the Kilwa road to a four-lane road is also included in the latter half of the program as part of a plan for expansion of main urban roads and circular roads interconnecting the radially extending urban main roads for the city of Dar es Salaam. These improvements proposed in the program are deemed high priories from the viewpoints of not only socio-economic activities and also improvement of urban life for the residents.

The 11.6 km long section of the project road has a steepest gradient of 6 – 7 % around 6 km from the start point and the other sections run through a plain of milder topography. The horizontal alignment of the existing road has no sections that would cause traffic problems except for the two relatively tight curves in series after the Kizinga river towards the end point of the project road. However about 27 % of the sections has been deteriorated with damaged pavement over time. Lack of drainage facilities, and reported flood problems in the low-wetland at around 6 km point suggest necessity for planning of such facilities and examination of the causes of the floods. In addition, current double-lane road (with 6 m for roadway + 2 m for shoulder) can't accommodate a traffic of over 10,000 vehicles/day without causing any problems. As a matter of fact, it is already causing serious traffic congestions in rush hours in the morning and evening. The situation is especially worst during peak commuting time, where traveling over the 13 to 14 km distance from the end point of the project road to the city center takes about two hours.

In this context, the Tanzanian government requested to the Japanese government the grant aid of a road improvement project for expanding the single-lane (per direction) Kilwa road to a double-lane (per direction) road. In response to this request, the Japanese government decided to conduct a basic design study and Japan International Cooperation Agency (JICA) dispatched a study team to the site for field study for the period starting from 25th July to 5th September 2005.

The study team, through discussion with TANROARDS, obtained consensus over the exclusion from the project of improvement work that can be implemented by the Tanzanian side alone, such as World-Bank-led Bus Rapid Transit plan (BRT plan) that aims to achieve a comprehensive bus transport system improvement with an implementation of exclusive bus lanes. The both sides agreed to delineate the scope and project components to be implemented in a grant aid project. Upon returning to Japan, the study team, based on the results of the field study, decided on the scope and components of the grant aid project as follows.

Item		Detail of Project
Project road section		11.6km
Pavement structure	Surface course	Asphalt concrete 7cm (trunk roads, main access roads etc.)
		Asphalt concrete 4cm (access roads etc.)
		Asphalt surfacing (road shoulder, side walk)
	Road bed	Base course 20cm (sieved macadam – trunk road, main access roads etc.)
		Base course 15cm (sieved macadam – access road)
		Subbase course 26cm (cement stabilization – trunk road, main access roads etc,)
		Subbase course 15cm (cement stabilization – access road etc,)
		Subbase course 10cm (cement stabilization – road shoulder, side walk)
Width and lane	Paved width	Trunk road：15.0m (7.5m, 2 lane x 2), side walk: 2 - 5m
	Shoulder width	Standard 0.5m
Improvement of transversal drainage structures		18 sites (including 2 box culvert), road side ditch
Other related facilities		Common ditches, retention walls, street lamps, bus stops, protective fence, traffic signs

The above project was compiled as a summary report of the basic study. A study team was, then, dispatched to explain on its contents to the Tanzanian side from 4th to 15th February 2006 and the team obtained general agreement from the Tanzanian side on the draft report.

If the project is implemented under the grant aid scheme of the Japanese government, the required project period would be 5.5 months (including tender) for detailed designing and 26.5 months for construction, and the estimated total project cost was 2,497 million yen (21 million US$). The cost for the projects conducted by the Tanzanian side (relocation, land acquisition) was estimated to be 400 million yen (3.5 million US$).

The project road, Kilwa road has a function of an urban road and many public utilities are found along the current road. Relocation of these utilities is a responsibility of the Tanzanian side and sufficient financing and proper execution are required. The two sides discussed and confirmed this matter as well as the implementation schedule during the explanatory meeting on the summary report of the basic design.

Kilwa road has a function of an urban road for the municipality of Temeke (0.8million residents) which it runs through and trunk road leading to the southern regions (2.7 million residents). Thus the implementation of the project is considered to benefit the 3.5 million residents living in the city and along the entire southern coastal regions. The expected benefit from implementation of this project is listed in the following sections.

Direct benefit

Upgrading of Kilwa road from the current single-lane (per direction) to double-lane road is expected to improve the actual traffic average speed: 7km/hour to 20km/hour during the peak

commuting hours in the morning and evening. As a result、the moving time will be shortened.

Indirect benefits

- Improvement of the road by this project is expected to contribute to reduction of traffic accidents rate per kilometer so that the safety of citizen life will be assured.
- Improvement in bus services to go to school and to work is expected to benefit the lower income families.
- Rehabilitation of drainage facilities is expected to improve the hygienic conditions to the residents in the area.
- The project is expected to promote the accessibility of the agricultural product from the southern region to the area that can act as a center of regional development in future.

This project aims at securing smooth traffic by upgrading Kilwa road from the current single-lane road to a double-lane road. The implementation of the project will directly contribute to alleviation of traffic congestion on the urban roads in Dar es Salaam, which is considered to be the major rationale for the project implementation.

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Chapter 1 Background of the Project

Chapter 1 Background of the Project

As an important part of the national development plan of the United Republic of Tanzania (hereinafter called Tanzania), there is the Strategic Plan for the Elimination of Poverty (implemented in October 2000). Under this plan, high priority is placed on the betterment of services relating to the movement of people and goods by upgrading access between urban and rural areas based on the improvement of trunk and rural roads and the implementation of maintenance management for trunk and rural roads that have been improved.

Under the national development plan, the top-ranking projects concerning the road sector are those of the 10-year road development plan (implemented in July 2000) covering the period from 2001/2002 to 2010/2011. The first five years of this plan is devoted to the completion of the unfinished portion of the previous 1990s plan (mainly the Tazam road linking Tanzania and Zambia) and the repairing of the El Nino damage sustained in 1998. This is also referred to as the Emergency Road Improvement Program.

Unfinished portions of the first five years of the plan will mainly be completed in the subsequent five years, together with the improvement of trunk roads whose development priority has been reassessed as a result of the use of such software as HDM - 4 for assessing the economics of road development. The expanding of the Kilwa road to a four-lane road is also included in the latter half of the program.

The request to the Japanese government for grant aid in relation to the Project was made in July 2004 including a reassessment of the traffic volume of Kilwa road and the results of environmental screenings. While only 3.2 kilometers of Kilwa road was subjected to survey in the JICA development survey of March 1996, a distance of 11.2 kilometers was proposed for survey in the current request for grant aid. As a result of field surveys, however, it has been agreed with the others concerned that the distance for the basic design will be 11.6 kilometers, which is the distance to the portion already improved by other donors.

Chapter 2 Contents of the Project

Chapter2 Contents of the Project

2.1 Basic Concept of the Project

The study team, through discussion with TANROARDS, obtained consensus over the exclusion from the project of improvement work that can be implemented by the Tanzanian side alone, such as World Bank-led Bus Rapid Transit plan (BRT plan) that aims to achieve a comprehensive bus transport system improvement with an implementation of exclusive bus lanes. The both sides agreed to delineate the scope and project components to be implemented in a grant aid project. Upon returning to Japan, the study team, based on the results of the field study, decided on the scope and components of the grant aid project.

There has been rapid development along Kilwa road in recent years. In particular, housing construction work is booming around the Rangitatu bus terminal area which is the terminal point of the current plan and the number of small buses leaving and arriving at the terminal is remarkable. Consequently, the area is rapidly becoming a bed town for people working in the central part of Dar es Salaam, with the capacity of the present two-lane Kilwa road being exceeded during peak hours. As the government and commercial offices generally start work around eight o'clock, peak traffic occurs around six to seven o'clock. A trip from the terminal point of the road in the current plan to the central part of the town (a distance of about 13 to 14 kilometers) takes two hours. Therefore there is adequate justification for the widening of Kilwa road to accommodate four lanes (two lanes in each direction) in order to ensure smooth traffic flows.

The people who live along Kilwa road are of the low income group compared with people living along other trunk roads. Per capita car ownership in the municipality of Temeke, which has jurisdiction over the roads concerned, is also low compared with other areas in Dar es Salaam. Consequently, a large number of pick-up buses are being used for commuting to work and school. By enhancing the convenience of pick-up buses under the current plan, more low-income people will benefit.

In the light of such background and with the aim of attaining the smooth flow of traffic, the objective of widening the Kilwa road from the current one lane in each direction to two lanes in each direction will be achieved by means of the grant aid project.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Policy

The rapid expansion of the cities and the growth of traffic demand following the revival of the Tanzanian economy in recent years are astonishing. As a result, the volume of traffic on the roads within the city of Dar es Salaam has greatly increased, causing serious traffic congestion in areas where the traffic-bearing capacities of two-lane roads are being exceeded. However, notwithstanding the fact that the widening of the main roads in Dar es Salaam and the maintenance of the existing network of radiating trunk and interconnecting roads have been placed on a priority footing, of the four trunk roads extending to the radiating roads of the city, Kilwa road alone has been left as a two-lane road. In the light of such situation, the basic policy for the plan to widen Kilwa road from a two-lane road to a four-lane road with the aim of achieving the smooth flow of traffic will be as follows:

1) The planned roads shall be 4-laned trunk roads of a geometric construction that will satisfy the necessary conditions.
2) The composition and characteristics of the vehicles, especially the mini-bus (Daladala) traffic, large vehicles, pedestrian traffic, and so on will be studied and reflected in the plan.
3) The Project will be studied so that it can be accommodated within the existing available land (45 m width).
4) Road drainage will be studied to use the existing water drainage system wherever possible by suitably connecting thereto.
5) Studies will be conducted with consideration to the existing bus system and the “bus only” lane concept (Bus Rapid Transit: BRT).

Further, the existing bridge over the Kizinga river and the box culvert will have to be replaced to accommodate the 4-lane road. The policy regarding this matter under the Project is to first study the hydrological records relating to this river, verify the river environment and then conduct studies on the scale of the river-crossing structure that will be required.

2.2.1.2 Policy Concerning Natural Conditions

(1) Topographic conditions

Concerning the 11.6 km portion of Kilwa road coming under the current plan, except for the central portion with a vertical-section gradient of 6 to 7%, most of the portion concerned consists of level land that includes some gentle undulations. As for curves, apart from two rather sharp curves in the portion running toward the terminal end subsequent to Kizinga river, the curves are relatively gentle. Consequently, there are no topographical features of the road that would constitute obstacles. There is a railway bridge over the road concerned at a point located about midway, slightly closer to the

starting point.

Here, there is currently a two-lane road with sidewalks on both sides. Under the present situation, it would be difficult to secure space for the BRT and a 4-lane road.Currently, there are two high earth-filled sections on the road concerned, namely, ① 1 km1.1 – km1.6 (average fill height, 3 to 5 m) and ② km7.0 – km7.6(average fill height, 5 to 10 m). Further, the Kizinga river which crosses Kilwa road is a single-stream river upstream and becomes a two-stream river just before Kilwa road. There is a bridge (Kizinga 1) at the starting point of the road concerned and a box culvert (kizinga 2) at the terminal point after which the river pours into the sea further downstream. According to a local hearing, a rise in the water level, attributed to El Nino, occurred in November 1998, causing the rivers in this section to cover the bridge and box culvert portion of the road to a depth of about 50 cm, thus creating a traffic bottle-neck.

Such topographic features will be adequately studied and the current road configuration will be adhered to wherever possible, as a matter of policy.

(2) Weather conditions

The local weather characteristics such as rainfall and temperatures are shown in Fig. 2.1. The rainfall and temperature data are based on figures for 1990 through 2005. Regarding rainfall, the monthly averages and maximum precipitation over a 16-year period are given according to the Western calendar.

Likewise, regarding temperature, the monthly maximum and minimum temperatures for a 16-year period are given. Rainfall graphs show a hump in April each year, with the dry season occurring from June through September and the rainy season starting from October, indicating a typical climatic pattern of repetitive rainy and dry seasons. Temperatures generally follow the same pattern as that for rainfall, with the maximum temperature for each month being about 30 . In this connection, the flooding that occurred in the low land region of Kilwaroad (Kizinga river, about 60 km) due to the El Nino of November 1998 is considered to have been caused by the rainfall at the time coupled with the rising tide in the area where Kilwa road runs close to the mouth of Kizinga river.

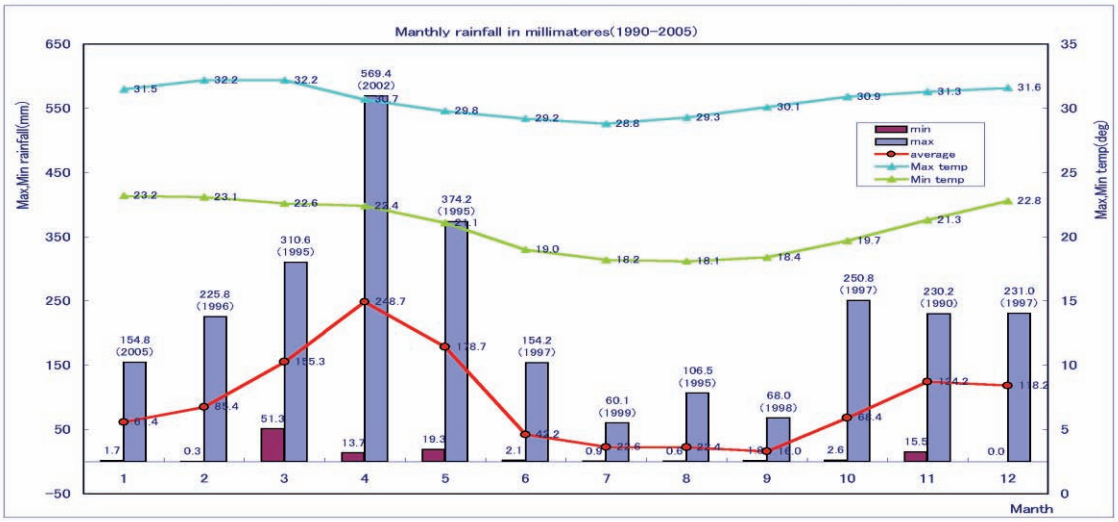

Figure 2.1 Rainfall and temperature variations in the area concerned

Arranging the existing data for 1966 through 1989, the flow rates at the upstream portion of Kizinga river is as shown in Fig. 2.2. These data give the maximum flow rates for each month of every year, which indicates that the biggest humps occur in April through June.

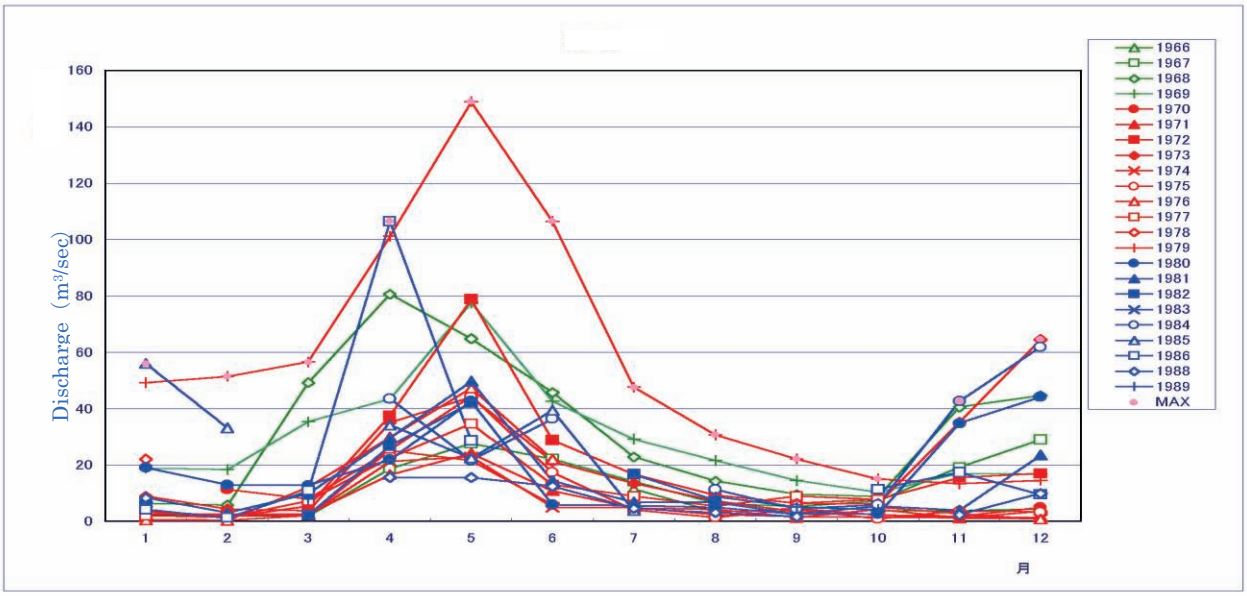

Figure 2.2 Hydrological Records flow rate data of Kizinga river

2.2.1.3 Policy Concerning Social Conditions

(1) Functions of urban roads

As the main traffic flow from the Mutongani bus terminal at mid-point of the section of road concerned and from the Rangitatu bus terminal near the terminal point is heavily oriented toward the

central part of Dar es Salaam, it is considered that, in the short term, traffic will be heavy in this section.

However, with the development of the loop lines accompanying the progress of the maintenance program for the road network in the Dar es Salaam metropolitan area and their linking with and maintenance of other radial trunk roads, inbound and outward traffic on these roads is expected to increase. Additionally, the World Bank-backed BRT plan for the supervised repair and maintenance of the bus transportation network, is currently being carried out by the authorities of Dar es Salaam city.

Under these circumstances, it is necessary to establish the basic concepts and plans relating to the roads concerned through studies on the main traffic flows, the overall harmony between the section concerned and the entire Kilwa road, local features and so on. Furthermore, with regard to basic policy concerning the improvement plans, the program has been studied with consideration to the functions required of the section of the roads concerned by reviewing road widths, alignment, compatibility with structural objects and the like so as to utilize the existing roads to the maximum possible extent.

(2) Environmental considerations

The Tanzanian road authority (TANROADS), the organization implementing the current plan, submitted an Environmental Application Form to the Road Sector Environmental Section; RS-ES) in accordance with the road sector environmental assessment and control guidelines promulgated in 2004. The RS-ES concluded that that the project would have no major permanent environmental impacts. It is stipulated that a plan defined as such a project must undergo an Initial Environmental Examination (IEE) or a Limited Environmental Analysis (LEA). As shown in Table 2.1 below, The difference between IEE and LEA with regard to the Environmental Application Form lies in whether there is even a single object to be moved or a borrow pit to be newly developed. As there are a mosque and other objects to be relocated under the current plan, the Road Sector Environmental Section deemed that it would be necessary to conduct an LEA.

Table 2.1 Classification of environmental considerations

5. Indicate aspects that are relevant to your project and areas that may be directly or indirectly affected by your project		
EIA	LEA	IEE
Resettlement of households (> 100)	Resettlement of households (1 to 100)	No resettlement
Located near a Conservation Area (CA) (<10 km)	Located near a CA (10 to 20 km)	More than 20 km from a CA
Located near a National Park (NP) (<10 km)	Located near a NP (10 to 20 km)	More than 20 km from a NP
Located near a Forest Reserve (FR) (<10 km)	Located near a FR (10 to 20 km)	More than 20 km from a FR
Located 30 m from a river bank (length 300 m)	30 m from a river bank (length 100–300 m)	30 m from a river bank (length < 100
Flooding area (length more than 300 m)	Flooding area (length between 50 to 300 m)	Flooding area (<50 m)
Major induced development	Induced development	No major induced development
Influence on sensitive areas (see under)	No influence on sensitive area	No influence on sensitive area
	Opening of facilities	No opening of facilites
	Opening of borrow pits	No opening of borrow pits

Implementation procedures for the above-mentioned LEA are as shown in Table 2.2

Table 2.2 LEA implementation procedures

Implementation items	Implementation (Tanzanian road auth.)	RS=ES (Public Works Dept)	National environmental	Time required	Condition of Kilwa road
Application	Preparation	Inspection		5 days	Finished
Screening		Supervision		10 days	Finished
Prepare TOR for LEA	Preparation	Inspection		10 days	
Prepare LEA, Environmental control plan	Preparation	Inspection		20 days	
Project implementation contract	Preparation	Inspection		5 days	
LEA certificate		Issue			
Environment monitoring	Preparation	Supervision			Based on environment control plan
Environmental audit			Supervision		Supervision

Source: Environmental Assessment (EA) and Management Guideline for Road Sector, December 2004, Page 4

The final LEA certificate is issued by the RS-ES of the Ministry of Infrastructure. As mentioned above, because the LEA certificate is issued subsequent to the project implementation contract, the certificate is considered to possess the characteristics of a work implementation permit. Furthermore, investigations will be conducted with regard to any necessary item of the LEA that is considered to have a negative environmental impact. An impact mitigation plan must be drawn up and an implementation control plan for the aforesaid plan must be additionally prepared.

On examining the current plan, items such as the following are considered to constitute implementation control matters:

- Relocation of mosque
- Relocation of graves
- Treatment after development of borrow pits
- Disposal of surplus soil
- Drainage of water used in the work
- Dust problem associated with the work
- Safety issues related to the work

2.2.1.4 Policy Concerning Construction Matters

(1) Labor recruitment policy

Concerning labor recruitment, the employment of workers will be in line with the labor laws of Tanzania (Employment and Labour Relations Act, 2004). The labor standards law of the labor laws revised in 2004 includes regulations governing working hours, working conditions, social insurance, extra pay conditions, and so on. This study has been followed to the said law stipulated that the number of working days shall be six days per week and shall not exceed 45 hours, while private enterprise generally adopts a five-day workweek.

(2) Construction material procurement policy

It is possible to procure the main types of constructions materials such as road aggregate, bitumen, cement, reinforcing bars, concrete aggregate, timber and the like in Tanzania. However it will be difficult to locally procure other materials such as geotextile shee， joint materials, water stops, etc. Considering assured procurement, quality and economic factors, such materials will be procured in Japan, rather than from neighboring countries.

(3) Construction equipment procurement policy

As TANROADS currently entrusts road construction and maintenance management to local construction companies, there are no road construction equipment available for hire. Furthermore, there are no specialized rental / lease firms in Tanzania. However, the individual construction companies that possess various items of construction machinery mutually borrow and lend equipment and hence it is possible to procure ordinary construction equipment locally. Therefore the policy regarding the procurement of construction equipment under the current plan will be to engage local firms as subcontractors. However, in cases where the availability of local construction equipment will be insufficient to meet the schedule requirements, procurement of the necessary construction equipment from Japan will be studied.

Further, the policy regarding the procurement of such items as asphalt plants, aggregate plants, concrete plants and so on, will be to carry out comparative cost studies on renting / leasing them locally versus importing them.

2.2.1.5 Policy Concerning Utilization of Local Firms

All private construction firms in Tanzania permitted to undertake construction work are registered with the officially approved Contractors Registration Board (CRB). Registration is divided into that for locally capitalized firms and that for foreign capitalized firms and is classified into seven classes,

namely 1 through 7, based on annual sales per category of work, construction equipment available, assets, and so on.

With regard to road construction work, it is considered that firms registered with the CRB as Class 1 (20 firms) and Class 2 (11 firms) in the civil division will be capable of working as subcontractors for Japanese contractors. As it is common practice among the construction firms concerned to mutually borrow and lend personnel and equipment, the policy will be to actively engage the services of Tanzanian construction firms.

2.2.1.6 Policy Concerning Operating and Maintenance Capabilities of Implementing Agency

The government organization responsible for the current plan is the Ministry of Infrastructure development. This Ministry is the organization that supervises TANROADS, which will implement the current plan. TANROADS was established five years ago as the sole public organization having jurisdiction over the entire country's trunk roads and regional trunk roads. While expectancy is being placed on its organizational performance, it is currently endeavoring to strengthen its management of road maintenance work. In addition to the maintenance management work that is being financially assisted by the World Bank and the EU, the provision of assistance by the government of Japan and others in the enhancement of project management capabilities on a country- to- country basis has commenced. Progress is also being made in improving efficiency relating to contracts to be awarded for maintenance work, improving work supervision capabilities relating to work to be directly performed, and so on. It can be adequately anticipated that road maintenance supervision capability will be enhanced by the time the current plan is completed (around 2008).

TANROADS currently has an office in each region (21 offices) and four zonal offices to supervise the regional offices in each zone. Kilwa road in the current plan comes under the jurisdiction of the Dar es Salaam regional office. As an office having jurisdiction over roads in the metropolitan area, it undertakes the management of the daily and periodic maintenance of about 200 km of trunk roads and 500 km of regional trunk roads. As road maintenance in 2004 / 2005 was carried out with the expenditure of almost 100 percent of the budget allocation of about 2.3 billion TS (230 million yen), maintenance management for the current plan can also be adequately coped with.

2.2.1.7 Policy for Determining the Scale and Details of the Planned Facilities for the Project

(1) Start and termination points of the project

This project covers a 11.6 km long section of Kilwaroad, starting from the crossing with Bandari road, via Rangitatu bus terminal, to the end point of the road section that is already improved by the project funded by the Tanzanian and Kuwaiti governments.

(2) Geometry of the road

The horizontal alignment of the existing road has two tightest curves in series between the Kizinga river and the high earth fill section connecting to the river. However, even for this section, the radius of curvature is more than 150 m that is the standard required by the design speed. Thus the horizontal road alignment will be examined and designed based on the existing one.

The longitudinal alignment of the existing road is steepest in the approach section to the Kizinga river. However even in this section, the longitudinal gradient is 4 to 5 % that is within the standard for the design speed and the other sections of the road have relatively mild longitudinal topographic profiles. Therefore the longitudinal alignment will be designed based on the existing one in consideration of minimizing elevation differences from adjacent landforms. However, some earth filling will be required for the section across the Kizinga river flood plain that experienced flood damage. The earth fill should be raised to the elevation determined based on the designing of the structures that consider high water levels of floods.

(3) Existing Right of Way

The target section of Kilwa road for the study is composed of a 45 m wide strip in general: 22.5 m on both sides from the centerline of the existing road. In the section around km 0+000 where Kilwa road perpendicularly crosses Bandari road, there is a concrete wall of the department of port along Bandari road on the opposite side of Kilwa road, and in the section around km 4, right after the crossing point of Kilwa road and Mandela road, there is another concrete wall of a Military facility on the right hand side. In these cases, the existing structures (such as walls and fences) constitute one boundary of Right of Way (ROW) and the area up to 45 m from this boundary is defined as the target strip for the study. The following figure shows a schematic of the existing Right of Way for the road.

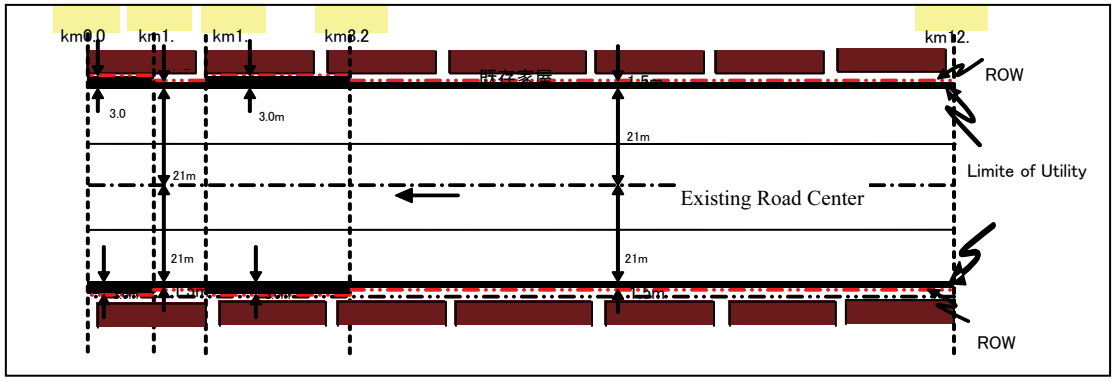

Figure 2.3 The existing Right of Way (ROW)

Mandela road that crosses Kilwa road around km4+000 is planned to be renovated by another donor (EU) and the land has already been allocated. Thus the 60-m-wide strip, 30 m on both sides from the

center of the intersection, of Mandela road is excluded from the project as illustrated below.

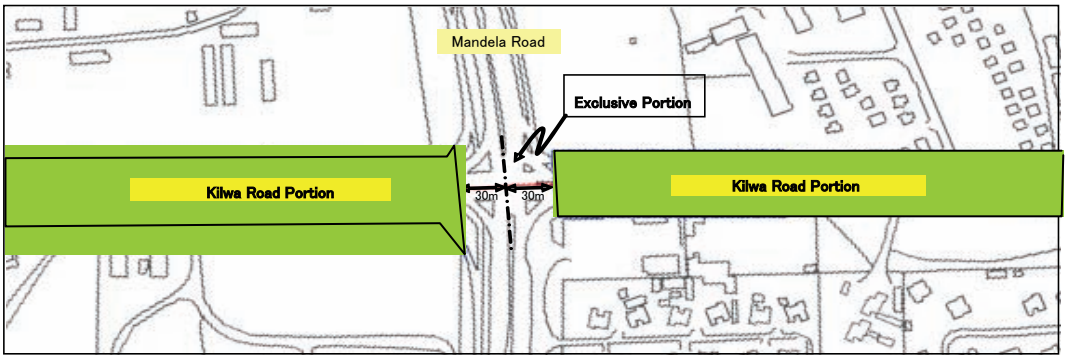

Figure 2.4 Section excluded from the project

(intersection betweenKilwa road and Mandela road)

In addition, acquisition of extra portion of land will be necessary for the starting point of the target section and for the locations where construction of a roundabout is expected. However the required land is not large.

(4) Minimizing the influence of the construction work

The width of the ROW in this project is 45 m as described earlier. The planned road passes through well-developed urban areas and, thus, facilities should be planned within the ROW. Additional land acquisition is considered only if no other alternatives are possible.

(5) Elimination of flood damage

The issue for the planning of drainage facilities for the target section of the road is how to deal with the converging discharge water from planned facilities in the ROW at each release point. The conditions of existing drainage structures and flow ends will be examined to consider connections between the planned facilities in this project and those outside the ROW.

(6) Consideration of BRT plan

The city hall of Dar es Salaam is currently working on BRT plan. It was confirmed at a meeting with the TANROADS and Dar es Salaam city administration that the project would consider possible introduction of the BRT system in the central part of the planned road.

2.2.1.8 Policies on Construction Method and Schedule

The study examines the construction method and schedule for two principal items of road construction and transversal structures, in consideration of various methods and scale of construction works involved. As a result, an entire project implementation plan that includes division of construction work and the relation of the two items during construction will be established. The implementation plan is composed of two construction stages for the following reasons.

1) It is necessary to allow for the period for relocation of a mosque located around Km 5+400.
2) To reduce the load for financing and construction work of the Tanzanian side for the relocation of public utilities network (electricity, water supply, gas, and telephone) by dividing the work into two stages.
3) The project road is an urban road with increasing traffic congestion and many people living alongside. Thus a single year construction schedule would require multiple teams of construction workers and would lead to higher cost for traffic security measures such as detouring and deployment of security personnel. Therefore it is necessary to divide the construction period into two stages so that the work is performed more safely with fewer teams of construction and security personnel.

It is thus considered more advantageous to implement the project in two stages than in a single year/stage for the above reasons. The project division according to this two-stage implementation is outlined as follows.

1) The first stage is composed of completion of pavement for the entire section from Km 0 to Km 5.0. two transversal drainage structures near Km 6.5, and earth filling around Km 8.0.
2) The second stage is composed of completion of pavement for the entire section from Km 5.0 to Km 11.6, two transversal drainage structures near Km 6.5, and earth filling around Km 8.0.

2.2.2 Basic Plan

2.2.2.1 General Plan

2.2.2.1.1 Scope and Scale of the Facilities to be Realized in the Project

It is requested to widen the road from 2 to 4 lanes as well as to make improvements to the river crossing bridge and the Rangitatu bus terminal within the Project. The necessity of realizing such contents was checked through field survey. As a result, it was revealed that the Tanzanian government (supported also by the Kuwaiti fund, etc.) is willing to undertake widening of the 2-lane road only after a point of 11.6 km although the starting point for Tanzanian side was specified as 11.2 km in the original request to Japan. It is thus confirmed that the Project should cover road

widening also for this additional 400 m portion.

The existing bridge and the box culvert traversing the Kizinga river shall structurally be enlarged so that the bridge may not be covered by water on the basis of hydrological study and at the same time the road can be widened to 4 lanes.

The Rangitatu bus terminal is at present not provided with any special facility. Minibuses park randomly within the boundary line of ROW (22.5 m each on the right and left from the center line of the existing road) to wait for passengers. Proper facilities for betterment of such situation shall, therefore, be planned while sufficiently taking traffic safety, security and social environment into consideration.

2.2.2.1.2 General Outline of the Basic Scheme

The contents and results of design review based on the basic principles are as follows:

Table 2.3 Outlined design contents

Design item		Design contents
Length of the section covered by the Project		11.6 km
Pavement structure	Surface course	Asphalt concrete, 7 cm (main road, main access road, etc.)
		Asphalt concrete, 4 cm (access road, etc.)
		DBST pavement (shoulder, sidewalk, access road, entrance)
	Base	Base course, 20 cm (crushed stone for mechanical stabilization – main road, main access road, etc.)
		Base course, 15 cm (crushed stone for mechanical stabilization – access road, etc.)
		Subbase course, 26 cm (cement stabilization – main road, main access road, etc.)
		Subbase course, 15 cm (cement stabilization – access road, etc.)
		Subbase course, 10 cm (cement stabilization – shoulder, sidewalk, etc.)
Road width	Pavement width	Main road: 15.0 m (7.5 m, 2× lane× 2); sidewalk: 2 – 5 m
	Shoulder width	0.5 m
Improvements to cross traversing drainage structures		18 points (incl. box culvert at 2 points)
Other auxiliary facilities		Common ducts, retaining walls, street light, bus stops, guard fences, traffic signs, etc.

The norms and standards as the basis for design of the said facilities are given in Table 2.4.

Table 2.4 Norms and standards for design

	Item	Standards, etc. applied for the Project	Reasons for application
1	Section covered by the Project	11.6 km long	From Bandari intersection to the section having been improved by the Tanzanian government and the Kuwaiti Fund via the Rangitatu bus terminal
2	Road classification	Metropolitan ring road (municipal trunk road)	Classification by the MOW
3	Applicable design standards for geometric design	In principle, the design standards of the MOW (1989) and SATTC (1998) shall apply. International standards such as BS, etc. as well as the Road Structure Ordinance of Japan shall apply for a part.	Top priority is given to the road design standards of the MOW.
4	Road alignment	A design speed of 60 km/h shall be taken as basis.	According to judgment based on the result of field survey.
5	Road width	Roadway: 7.5 m; shoulder: 0.5 m; sidewalk: 3.0 m; service road: 5.0 m	Top priority is given to the road design standards of the MOW.
6	Pavement structure Roadway / sidewalk / service road	The road specifications of the MOW shall apply.	Top priority shall be given to the road design standards of the MOW.
7	Improvements to crosswise traversing drainage structures	Live load B according to the specifications for highway bridges of Japan shall apply. BS standards applicable to Tanzania (load HA, HB) shall apply.	It is possible and convenient for design to cover the local standards by the standards of Japan.
8	Auxiliary structures	In principle, the design standards of the MOW (1989) and SATTC (1998) shall apply.	Top priority is given to the road design standards of the MOW.

2.2.2.2 Facility Plan

2.2.2.2.1 Road Improvement Plan

(1) Section as the Object of Design

Study was made for the 11.6 km portion of Kilwa road from the intersection with Bandari road near the center of Dar es Salaam to the Rangitatu bus terminal according to the request.

The existing road is 6.0 ~ 6.5 m wide for roadway consisting of section paved with asphalt concrete (0 ~ 10.5 km) and that with surface-treated asphalt pavement (10. 5 km ~). The major existing structures are the bridge over the Kizinga river at 6 km, a culvert and other small-sized drainage conduits, gutters, etc. traversing the road.

The increase of the number of lanes from 2 to 4 in the Project makes it necessary to widen the existing road and structures as well as to construct new auxiliary facilities. Facilities incl. temporary facilities shall be of type and size which ensure the maximum effects for minimum cost.

(2) Design Conditions

1) Design standards

The design work for the Project shall be performed and reviewed mainly on the basis of the design standards of the Ministry of Construction of Tanzania (1989) and SATCC (1998) as well as by application of other international standards as required.

2) Geometric design and design speed

The existing road shows the sharpest right- and left-hand curves in succession between 6.4 and 7.0 km, namely between the Kizinga river and the high embankment. The both curves show a radius larger than 150 m to be within the limit according to the design speed of 60 km/h.

As to the vertical alignment, the gradient amounts to 6 ~ 7 % before and after the Kizinga river to be the steepest portion within the planned road, but still within the limit according to the design speed of 60 km/h. In consideration that the planned road passes through gently sloping terrain in the remaining section, the design speed for it was set to 60 km/h as a result of examination of geometric design and the alignment of the road was determined to be the same as that of the existing road as far as possible. As for the region of the Kizinga river where flood damage arose in the past, however, embankment up to the design height was considered through study on alignment on the basis of assumed flood level and design of associated structures.

3) Consideration of the bus rapid transit (BRT) program

Possibility of installation of BRT system in the medial strip of the planned road was taken into consideration in the Project to cope with the BRT program which is now advanced by the city government of Dar es Salaam.

4) Standard cross section

① General

A few solutions were compared with each other and examined from various viewpoints such as width of land available for the planned road (45 m), function as 4-lane road, the intersection with railroad, public traffic, introduction of the BRT system, positional relation with obstacles along the road and traffic safety.

- Centerline of the planned road:

Assuming a case where the planned road centerline should be set at the center of boundary lines of ROW, it was examined to concentrate the road to either boundary line of ROW by totally considering influences upon existing traffic, construction cost, future land use, etc. As a result, it was determined as a direction for further examination to set the planned road centerline to the center

between the boundary lines of ROW for reasons that the available land for the road can maximally be utilized, that a considerable number of existing public facilities will have to be moved anyway and that influences upon the existing traffic must be minimized during construction and so on.

- Road structure in transverse direction:

In consideration of the design standards, the results of traffic count, assumed qualitative and quantitative traffic volume, specifications of other similar road sections, etc., the road shall be composed of 2 lanes each way (7.5 m wide) or 4 lanes in total. The width of shoulder and sidewalk was set to 0.5 m and 3.0 m, respectively, for further examination.

- Gradient of the face of slope at cut and embankment:

In consideration of the soil properties, the conditions of face of slope, etc. on the site, a gradient of 1:1 and 1:1.5 was set for cut slope and embankment slope, respectively, for further examination. The gradient of roadway, shoulder and sidewalk was examined on the basis of the functions expected for the planned road, the data on the existing road and the results of other related projects.

- Service road, medial strip:

It was determined to provide service road as required only where traffic from secondary roads to main road is physically difficult due to difference of elevation. The medial strip was so planned that the BRT system may be accommodated in the future.

In addition, it was determined according to the description in the TANROADS's letter to contractors to move public facilities on the planned road to a zone within a distance of 1.5 m from both boundary lines of ROW of the 45 m wide road site. Table 2.5 shows a list of numerical design values employed in this Project.

Table 2.5 List of design values employed for the Project

Item		Unit	Selective values
Design speed		km/h	60
Number of lanes		lane	4
Width of land for road use		m	45
Lane width		m	7.5/way
Medial strip width		m	9.0
Surface drainage gradient		%	2.5
Shoulder drainage gradient		%	2.5
Min. curve radius		m	135
Max. gradient		%	7
Superelevation (max. value)		%	6
Sight distance (min. value)		m	75
Embankment slope	Normal soil	-	1:1.5
Face of cut slope	Hard rock	-	1:0.5
	Soft rock	-	1:0.75
	Other than rock	-	1:1

The structure of the planned road in transverse direction is shown in Fig. 2.5.

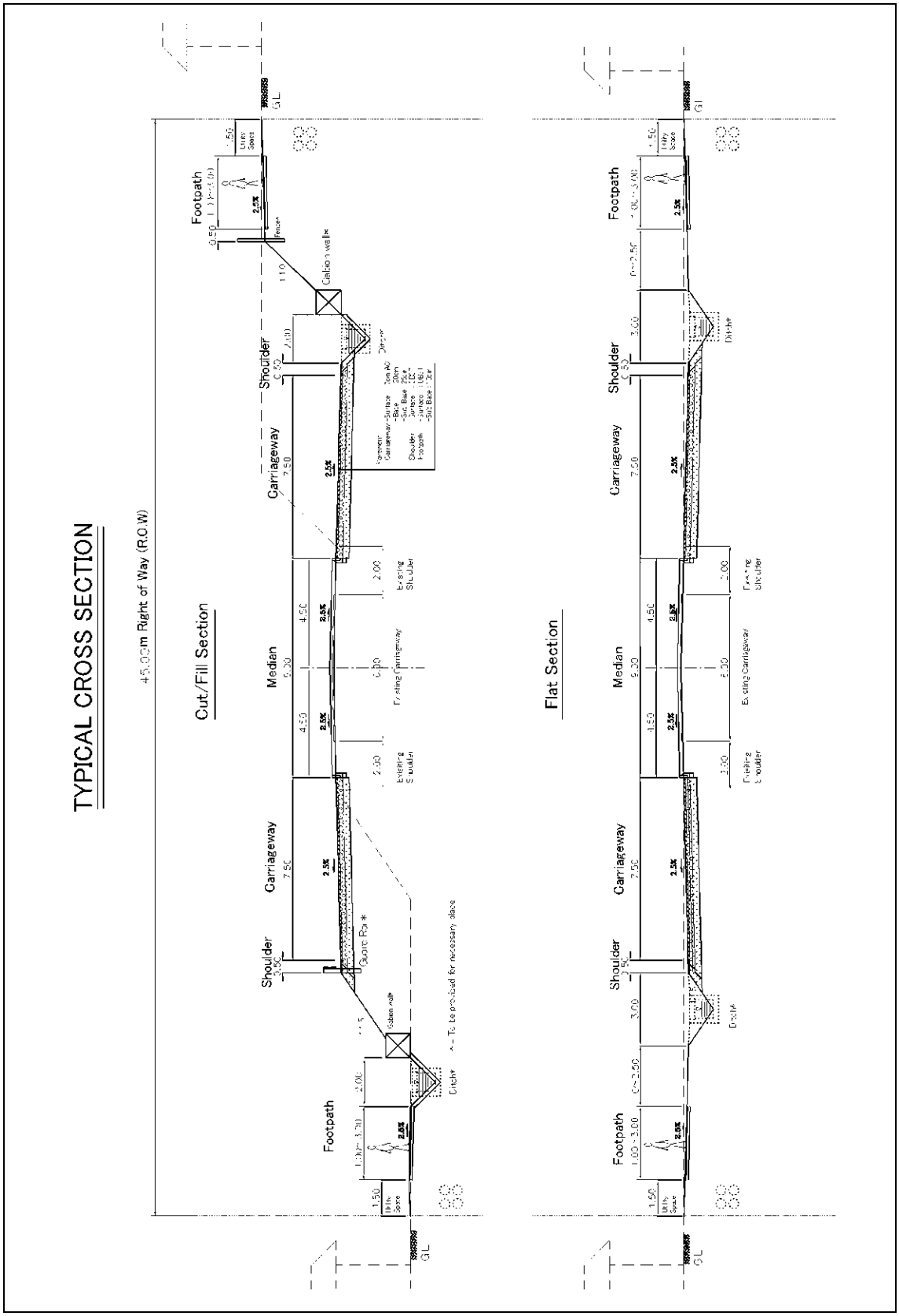

Figure 2.5 Typical road cross-section

② Intersection with railroad

As to the intersection with the railroad between 5.6 and 5.7 km, the planned road shall be composed in transverse direction of 2.0 m left sidewalk, 7.5 m roadway, 1.0 m medial strip, 7.5 m roadway, 2.0 m right sidewalk (20 m in total) as a result of examination how to ensure 4 lanes within the distance (20 m) of the right and the left abutments of the existing railroad bridge. A solution for adaptation to the BRT program (insurance of 9.0 m wide medial strip) shall be excluded from the Project as for the intersection with the railroad as well as for the run-off portion before and after the intersection because the existing abutment span does not allow it.

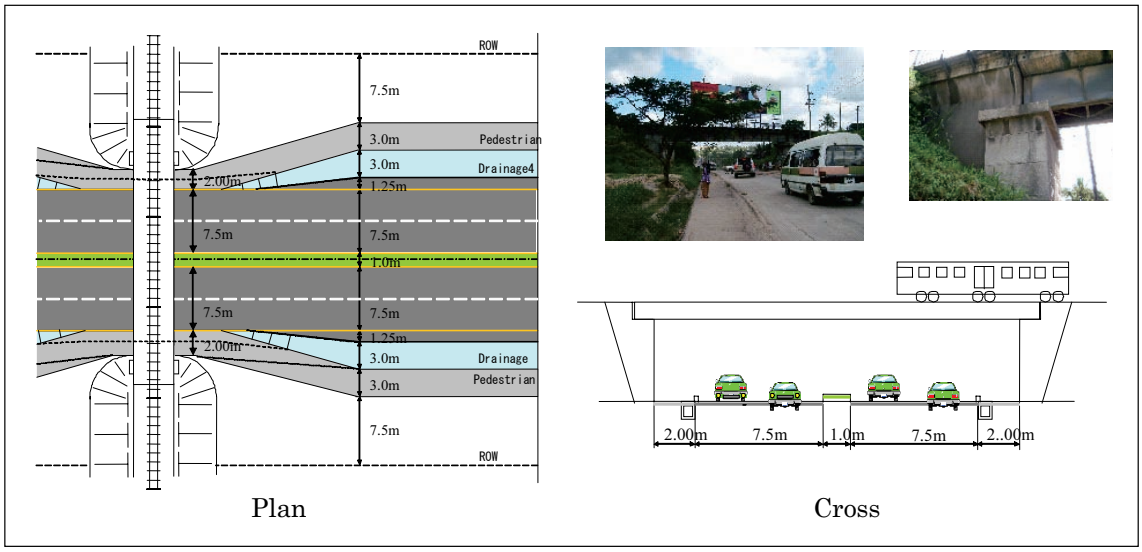

Figure 2.6 Road design for the portion intersecting with the railroad

5) Design of intersections, service roads and detours

① Major intersections

Runabout system was employed for the intersections of the planned road with other major roads as a principle for further examination due to ease of maintenance, adaptability to the BRT program in progress, etc. As to the intersection with Mandela road at 3.1 m, a reconstruction with the aid of other donor (EU) is planned so that the planned road shall be connected to it at the boundary line of ROW of Mandela road (30 m each distant from the center) according to the reconstruction plan obtained from TANROADS. It is further requested by TANROADS to take some measures to cope with serious traffic congestion at the intersection with Kilwa road at 3.6 km, which takes place during the trade fair held twice a year (for 1 week each in December and July) on the fair site near the intersection. It is also proposed by a South African consultant within another project for 2 km portion of Mandela road from this intersection to provide runabouts and service roads as well as

access roads to the parking places in accordance with the order placed by TANROADS last year.

It was agreed in the deliberation during the field survey for the Project to provide only runabouts in the said area of intersection in consideration that service roads to the said portion may have adverse influences upon the main track of Kilwa road.

Table 2.6 Location of Roundabouts

No.	Location	Usage
1	0 km	Starting point, Intersection with Bandari road
2	2.5 km	Intersection with Chagonbe road
3	3.8 km	Near the trade fair ground
4	4.5 km	Teneke intersection
5	5.8 km	Near the Mutongani bus terminal
6	7.5 km	Near the textile factory
7	8.8 km	Near the secondary school
8	10.7 km	Near the Rangitatu bus terminal

② Service roads

Some existing roads are provided partially with service roads, about 5 m wide, on the side of the main road, which are, however, used in practice as sidewalk rather than for vehicles. Necessity of service roads was, therefore, examined on the principle that they are to be provided as required only where traffic of vehicles to and from the main road is physically difficult due to a large difference in elevation between the main road and secondary roads. It has been proved as a result that service roads are needed nowhere for the planned road section.

③ Detours

It will become necessary during the construction period to control in some way the current traffic volume of more than 10,000 vehicles a day on the existing road. Influences upon the current traffic may, however, be minimal since a new lane will be provided on each side of the existing pavement in the Project. Detour for existing traffic during the construction period will be required for only limited portions, namely for the starting point, for the intersection with the railroad at 5.65 km and for the bridge over the kizinga river at about 6.0 km where the existing structure has to be reconstructed.

6) Pavement design

① General

Pavement is classified into flexible pavement of asphalt basis and rigid pavement of concrete system. The former type of pavement which is most common in the region concerned shall be employed for the planned road. For the surface course of pavement, either asphalt with surface treatment (low-cost road pavement) or asphalt concrete is available. The latter solution which is more durable shall be applied in consideration of the classification of the planned road and the traffic volume in excess of 10,000 vehicles a day.

The MOW specifies the standard pavement structure which comprises asphalt concrete surface course, base course made of crushed stone for mechanical stabilization and subbase course made of granular materials. However, the materials suitable for such pavement structure is available only in a limited quantity from the suburbs of Dar es Salaam. Besides, the reserves at Kunduchi quarry have begun to show a sign of depletion due to consumption in a wide range and this seems to tend to get worse. Therefore, possibility of use of pavement materials from the coral rock quarry at Mjimwema was examined, which lies in the vicinity of the planned road and has sufficient reserves, although slightly inferior in quality. Also by combining with cement-stabilized base using less aggregates, the selected pavement structure is of type and size which will ensure the best cost balance. The surface course and base of sidewalk were designed on the premise that no heavy vehicles pass there since the sidewalk is separated from roadway for the planned road.

Traffic volume, traffic load, vehicle type mixture ratio, etc. for the planned road were estimated on the basis of the results of traffic analysis during the field survey and the results of traffic count performed by a South African consultant in 2003 for a 2 km portion of Kilwa road between Mandela intersection and Temeke intersection in the direction to the terminal point as well as on the basis of other relating data. Annual increase of traffic volume was estimated to be 4.5 % on the basis of the results of the said surveys, the statistic data obtained through the field survey, etc. The traffic load conditions for the planned road was examined according to the information obtained from TANROADS during the field survey and other related information in order to set the standard axle load equivalent for each vehicle type (8.2 t axle load equivalent, ESA) as given in the following table. The pavement design according to the Project shall ensure a design life of 15 years.

Table 2.7 Traffic volume and axle load equivalent for each vehicle type

Vehicle type		Traffic volume		Axle load
		Number of vehicles	Proportion	(ESA/vehicle)
1	Motorcycles	422	3.80%	-
2	Passenger cars, taxis	5128	46.20%	-
3	Minibuses	4629	41.70%	0.002
4	Midi-buses, large-sized buses	11	0.10%	1.385
5	Trucks (2 axles)	566	5.10%	4.670
6	Trucks (3 axles)	222	2.00%	8.840
7	Trailers	100	0.90%	10.840
8	Others	22	0.20%	0.002
Total		11000	100%	

Remarks: Small vehicles, etc. were excluded from examination as their ESA influences the pavement design very slightly.

② Examination of pavement type and structure

The pavement aggregates for road construction are procurable only with difficulties in the region of Dar es Salaam. Aggregates for surface course must be procured from remote places at a distance of more than 100 km. When aggregates for base are concerned, availability is substantially restricted. Only coral rock can be procured from a rather nearby site.

In the suburbs of Dar es Salaam, coral rock is available from the quarry in the northern part of Kunduchi district and that at Mjimwema near the Kilwa road. It is reported that the coral rock from Mjimwema is poor in quality and can be used for base course only with difficulties.

As a result of field survey, the foundation ground of the planned road is found to be sand for the section between the starting point and 4.5 km and sandy laterite for the remaining section. The way of utilization of coral rock for subbase course was examined by mixing with such foundation material or by combination with cement stabilization. Because the pavement occupies a heavy weight in every road construction plan, it is most important to draw up the plan by sufficiently analyzing and examining the said local conditions in order to reduce cost.

③ Pavement design

The structure and thickness of pavement were examined on the basis of the analysis and examination of the bearing capacity of the existing road, the traffic volume and the axle load of vehicles in consideration of the actual situations as stated above where the design service duration was assumed to be 15 years for the Project. The design criteria as well as the structure and specifications of the pavement shall be as follows:

- Design period

According to the pavement design manual, the design period shall be applied to basically 20 years and be able to be adjusted case by case. However, 15 years has been considered in this study, taking into the following factors.

・20 years of design period is judged to be rather long, taking into the consideration of the acceleration of the pace of urban development by BRT etc.

・15 years has been applied in the past executed similar grant aid on the basis of JICA Development study.

- Design criteria

Design service duration:	15 years
Design traffic volume:	11,000 vehicles / day / direction
Design axle load: (ESAL)	12.3 million cumulative passage of standard axle load
Subgrade bearing capacity:	CBR9 or more

- Structure and specifications of roadway

Surface course:	Asphalt concrete, 7 cm
Base course:	Crushed stone for mechanical stabilization, 20 cm
Subbase course:	Granular materials, 26 cm (locally available materials + cement stabilization)

- Specifications of sidewalk

Surface course:	Double-layered asphalt with surface treatment (DBST)
Base:	Granular materials, 26 cm (locally available materials + cement stabilization)

The surface course and base of sidewalk were designed on the premise that no heavy vehicles pass there since sidewalk and roadway are separated for the planned road.

7) Retaining walls

The face of slope on both sides of the high embankment at 7.7 km, that on the left side at 6.3 km and that of the intersection with the railroad are covered with the gabion. The gabion is 1×1×2m in size and filled with coral stone. Since no trace of fill slide has been detected also from the appearance of adjacent bushes, etc., covering with the gabion may be deemed as a structural solution suitable for the actual state so that its employment for the Project was examined.

Especially due to rather restricted width of available site of the existing road of 45 m, the toe of slope may exceed this width in some cases, for example, at high embankment, etc. Retaining wall with heaped-up wire cylinders before the toe of slope was studied. Employment of retaining wall with gabion was also examined for the inlet and outlet of culvert to the Muzinga river where influences by running water are very likely.

8) Common ducts

A common duct traversing the existing road has been found under the high embankment at about 7.7 km. This is a concrete duct with a diameter of about 450 mm and serves for leading the underground cables branched from the overhead line on the left side of the planned road to the right side as well as for leading many water pipes branched from the water main (300 mm diameter) laid aside of the common duct on the right side of the road to the left side. Installation of common duct at least in the area of major intersections and city blocks was examined for the Project.

2.2.2.2.2 Plan for Drainage Facility

(1) Defect of Drainage Facility

Road surface drainage facility serves for trouble-free drainage from the surface of roadway, shoulder, sidewalk, etc. so that road users can use them safely and comfortably. It is at the same time an important facility which has great influences upon the service life of both main road structures and pavement. End of May, 2005, shoulder of the existing road was scoured by rainwater at about 6.3 km, where the road is on the down grade from the railroad intersection toward the Kizinga river, because of defects of drainage facility and insufficient maintenance of it. Repair work in progress was observed during the field survey. The defects of drainage facility seem to be one of the major causes for advancing deterioration found for 27 % of the existing pavement. The said circumstances on the site were examined to find the optimal solution for complete drainage in the Project.

Actual state of drainage on site
(Surface water flows on shoulder and has damaged the pavement.)

Spot of scour due to defective drainage
Restoration of shoulder scoured by heavy rainfall, end of May, 2005
(water pipes, electric cables, etc. also broken)

The management of drainage facilities within the site of road is implemented by TANROADS. On the other hand, drainage facilities outside the site of the road concerned are managed by the competent local government (Temeke city government). It is, therefore, necessary to inform TANROADS and the Temeke city government of the said situation and to urge them to provide facilities for receiving discharge from the drainage facilities based on the Project.

(2) Description of the actual state of drainage along the planned road

The existing drainage system is shown in Fig. 2.7, which is based on the results of field survey and the topographic chart (obtained during the field survey).

- The planned road runs through a flat land (at altitudes between 10 and 30 m) on the north of the Kizinga river and lies on a ridge line (at altitudes between 30 and 60 m) on the south of it with valley on both sides.
- It has become clear that running water from drainage basins A to H gathers on the north side of the planned road due to the said topography as known from the figure.
- Running water from drainage basins A, E, F, G and H concentrates at a point through the valley and transverses the existing road. It was confirmed especially that running water from drainage basins G and H flows over the road from right side (owing to insufficient sewerage capacity) to erode the left shoulder.

Running water from other drainage basins than the above is led out of the area of the planned road because of the topography and the existing drainage system arrangement (see the running water direction in the figure). The existing drainage pipe traverses the existing road at 14 points, whose diameter is 450 mm in minimum, 1,400 mm in maximum and 600 mm for the most part.

(3) Description of the planned drainage facilities traversing the road

On the basis of the examination stated above, the drainage facilities shall be arranged as shown in Fig. 2.7. The facilities are described in the following:

- The minimum pipe diameter shall be 900 mm in order to cope with a flow rate increase expected due to advancing urbanization and to facilitate maintenance (cleaning, repair, etc.).

- Concerning the drainage basins A, E, F, G and H with a certain catchment area , a few pipes ranging from 1,200 to 1,500 mm in diameter shall be arranged for each of them on the basis of effluent discharge estimated by a rational formula. An hourly rainfall of 64.6 mm/h (the same design criterion as that for box culvert of the Kizinga river), an arrival time of 30 minutes and a runoff coefficient of 0.65 were the criteria for this dimensional design, while it was taken into consideration that the drainage basins accommodate urban area.

- 900 mm traversing pipe shall be arranged as required on the south side of the Kizinga river where only surface water will have to be drained from the road.

Thus, the drainage pipe traversing the road shall be installed at 16 points in total.

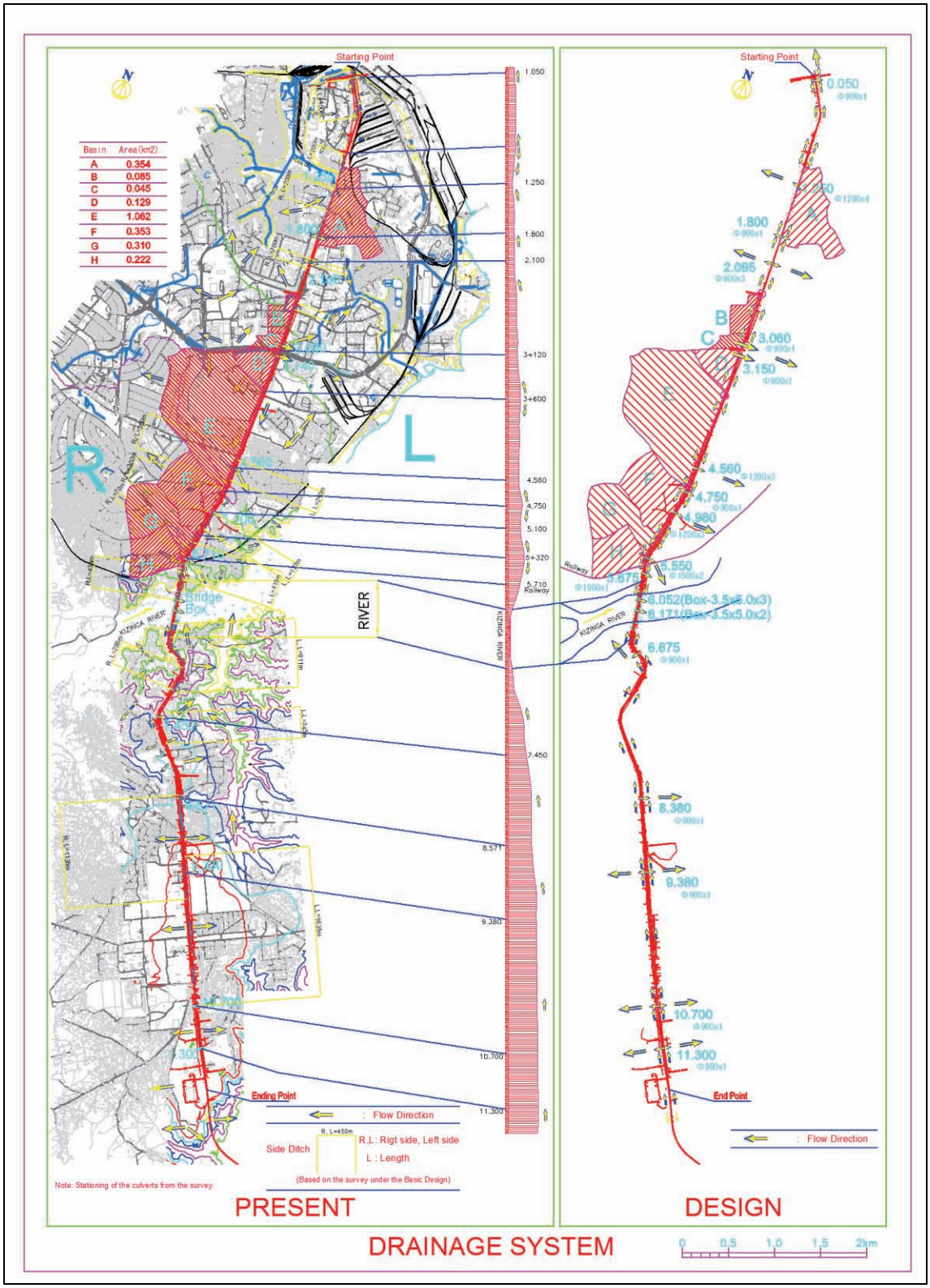

Figure 2.7 Drainage system diagram

(4) Description of the method for improvements to the structures traversing the road

1) Structural type (culvert proper)

The existing structures traversing the road are pipe culvert with a diameter between 0.45 and 1.40 m. All existing culverts traversing the road shall be removed since the main road has to be widened. The position of the existing culverts shall be utilized to a maximum for installation of new culverts on the basis of examination of the drainage system.

Planned culverts are summarized in Table 2.8.

Table 2.8 Planned culverts traversing the road

Culvert type	Size	Number of cells	Place of installation	Total length (m)	Number of inlets and outlets	Remarks
Pipe	0.9m Dia.	1	9	277	18	Structures traversing the road
		3	1	30	2	
	1.2m Dia.	4	1	34	2	
	1.5m Dia.	1	2	120	2	
		2	2	91	2	
		3	1	33	2	
Box	3.5m×5.0m	2	1	34	2	Structures traversing the river
		3	1	34	2	
Total			18	653	32	

2) Inlets and outlets

For the purpose of smooth drainage of running water of the river as well as prevention of scour of the stream bed and face of slope, the drainage facilities traversing the road shall be provided with inlet on upstream side and outlet on downstream side, respectively. As for the structure of the inlet and outlet, concrete shall be used for both vertical walls and ground sill for reasons of workability and durability.

(5) Examination of the method for improvements to the structures traversing the river

The existing bridge and the box culvert traversing the Kizinga river at about 6 km have to be widened to accommodate 4 lanes. Especially for improvements to the existing bridge, replacement with box culvert was examined expecting a cost reduction on the basis of study on possible flood flow, because a widening in the form of bridge will very likely make it necessary to drive piles into the foundation of abutments if considering the local foundation ground conditions. In addition, the

drainage structures were examined as to their type and dimensions on the basis of the circumstances around drainage such as the range of drainage basin, topography, flow-down conditions, etc. also in consideration of the report that the road has been covered with water in the past. It was also reviewed which influences the drainage structures may have on the height of embankment, the ground, etc. Possibility to install a temporary bridge in an area on the downstream side where a sufficient space can be ensured, to provide a detour aside the existing road, etc. was examined to find the optimal solution for ensuring traffic flow during improvement works.

These structures were designed in this Project on the basis of live load B according to the specifications for highway bridges of Japan, which sufficiently satisfy the BS standards (load HA, HB) applicable for such structures in Tanzania.

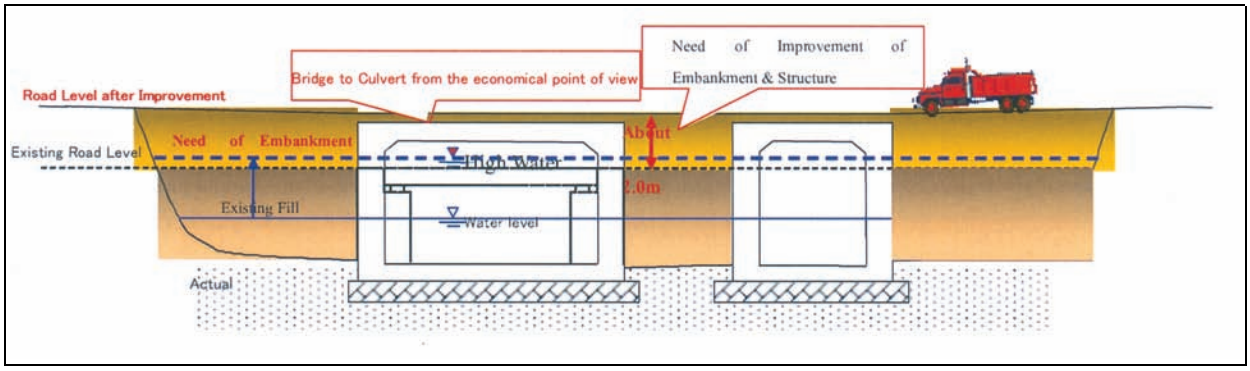

Figure 2.8 Replacement of the existing bridge with box culvert

(6) Road gutters

Soil gutter, stone-pitched gutter, soil cement gutter, etc. shall be used in combination for the road gutters. Soil cement gutter shall be used for any place where there is a danger of scour, while stone-pitched gutter shall be used for any place where a head may arise. The length of each type of road gutter will be as follows based on the said principle:

Gutter type	Total length	Remarks
Soil gutter	22,720m	Cutting section
Soil cement gutter	1,475m	Place in danger of scour
Stone-pitched gutter	1,000m	Place of potential head