Chapter 3

Identification of Problems and Development Directions

Chapter 3 Identification of Problems and Development Directions

3.1 Economic and Social Aspects

3.1.1 Current Problems

Considering the current economic activities and road conditions, problems are identified as shown in Fig. 3.1.1.

Sector	Current Situation	Problems
Population	Widely distributed	Lack of road network covering widely distributed population
Daily trip	Long walking distance and highly dependence on Matatu for distant trip	Lack of well-maintained roads to meet community needs
Agriculture Maize, Sugar Cane, Cotton	Less competitiveness due to unification of Products and locally consumed	Lack of well maintained roads for local transportation
Tea leaves	Rotten without processing	Lack of well developed access roads to arterial roads
Fishery	Rotten without smooth and prompt transport for Nairobi and Mombasa markets	Lack of well developed access roads to arterial roads especially in the rainy season
Manufacturing	Long-haul for Nairobi and Mombasa	It takes long time to destinations under the current road network condition
Transport Business	Only one public transport for Nairobi and Mombasa	Small coverage and low frequency in rainy seasons

Fig. 3.1.1 Current Situation and Problems

(1) Population Distribution

Although there are several major cities and towns, not ribbon-typed development along side the roads, but area-development is observed in the Study Area with population widely distributed all over the area due to the widely spread agricultural cultivated areas. Most residents live beside farms dispersedly. The road network itself has been well developed forming international and national trunk roads, and rural roads, including unclassified

ones. Furthermore, the arterial roads such as Class A and Class B seem good and comparatively well maintained. On the other hand, the conditions of rural roads including unclassified roads have many problems and people sometimes cannot pass the roads due to their bad conditions during the rainy season. These bad conditions on the rural roads end up forming road network that is not continuous but grossly disrupted.

(2) Daily Trip

Many people, due to low vehicle ownership in this region, walk to their destinations for more than one hour for shopping and other purposes. Matatu is the only means of public transport for distant trips. As bitumen roads do not cover much area, part of gravel and earth roads have drastically deteriorated and, in extreme cases, transportation is usually interrupted during the rainy season resulting in serious damage on the daily lives of residents in the rural areas.

(3) Agriculture

One of the problems in the agricultural sector within the Study Area is uniformity of products. Although the Study Area can be divided into three zones according to geographic and climate conditions, similar major agricultural products such as maize, sugar cane and cotton are grown in the plain agricultural area (see Section 2.1). Tea and coffee, however, are special products in Kenya, while the other products mentioned above can be observed almost everywhere in Kenya as common agricultural products.

These agricultural characteristics have resulted in local consumption of the products due to lack of competitiveness with those in other regions.

On the other hand, tea and coffee are the special products in the Study Area. Nevertheless, a lot of tealeaves become rotten in the rainy seasons due to lack of transportation to processing factories. This has resulted in much economic loss to the region.

(4) Fishery Industry

As mentioned in the previous section 2.1, the fishery industry exhibits significant economic activities in the Study Area. Around 95% of the fish products, including marine fish in Kenya, is landed in the Study Area. Some of the raw Nileperch and Tilapia are transported to Nairobi and Mombasa under iced conditions. Freshness is an important factor when transporting fish to

distant markets, hence a prompt and stable transport system is the key to the success of such business. It takes 7 to 10 hours to Nairobi and 16 hours to Mombasa by truck at present. Although international and national trunk roads are of bitumen standard already and comparatively well-maintained even, access roads from landing beaches to those trunk roads often comprise non-bituminous gravel and earth roads, which sometimes become impassable in the rainy seasons particularly for large trucks.

(5) Manufacturing

There are small manufacturing factories such as tea processing, can-food processing and grain mill factories in the Study Area. The portion of wage employee is as small as 4% and the manufacturing is not particularly active so far.

As manufacturing factories are located in the cities and towns or surrounding areas, these are initially built at well accessible locations. In this view, major problems related to transport have not currently occurred. However, transport condition is always one of the major constituting factors for achieving competitive conditions in the sale markets. Consequently well-developed and well-maintained road network is a basic condition for local manufacturing development.

(6) Matatu Service

Matatu plays a very important role as a means of public transportation in this region by connecting villages to major local cities and towns and even to Nairobi and Mombasa, where high quality markets and high-ranking hospitals are located. Usually, Matatu is heavily loaded with passengers and sometimes with cargoes making it at times difficult for them to pass along gravel and earth roads due to the deteriorated surface condition, especially during the rainy season. When it rains for many days, this hinders subsistence of the residents.

(7) Problems from a Community Needs Point of View

The following problems are summarised as a result of community needs survey.

1) Price on Commodities

Prices of commodities in the areas with poor road conditions are higher than in those areas with good road conditions.

2) Long Access to Referral Hospitals

Referral hospitals such as the district ones are usually located far from villages and it takes more than one hour and costs Ksh. 70-100 by Matatu to reach there.

3) Lack of Commodity Supply in Villages

The variety of commodities is limited, since suppliers do not serve enough commodities in areas with poor road conditions.

4) Less Competitiveness in Selling Products

People living in the areas with the poor road conditions are forced to pay additional cost and time in transport to bring agricultural products to markets. This reduces competitiveness of the products in the markets, so that few outside agents come to buy local commodities as well.

3.1.2 Directions in Road Network Development

Road network itself is well developed in the Study Area with a relatively proper hierarchy structure. However, there are many problems in terms of surface conditions. People suffer from rutted earth and gravel roads, and even bitumen standard roads in their daily trips, particularly in the rainy seasons. This situation brings about serious problems on socio-economic fields.

The development directions in road network needed in order to alleviate the current socio-economic problems are summarised into the following two items:

1) Road Network to Support Local Economic Activities

Spoilage of fish products and rotten tealeaves often occurs in the rainy season due to lack of well-maintained road network. In this view, it is, therefore, important to develop high priority road sections with a view to connect producing areas with current trunk roads, which are connecting to processing factories and major inland markets. Especially road development for fish transport is imminent, since fish landing beaches are distributed away from towns and they are all located in the areas alongside Lake Victoria, which is served by earth and gravel roads. This also helps the commodity supply in fishery zones where the variety of commodities is sometimes in short.

2) Road Network to Support Daily Lives of Residents

People, who live in the Study Area have also suffered from inconvenience in their daily life activities caused by poor conditions of the rural roads. As the population is widely distributed in the rural areas, it becomes a key issue to

establish road network, which integrates efficiently the trunk roads and rural roads into one system, and which covers widely the residential areas.

In addition, it is also crucial to improve accessibility from villages to major public facilities in order to enhance the daily lives of the residents in the rural area.

3.2 Problems and Directions for Road Maintenance

Through the analysis on the current road maintenance situations, current problems and development directions are identified as follows:

(1) Budgetary Aspect

1) Scarce Road Maintenance Budget

Scarce maintenance budgets are unable to respond to full requests of good quality roads of road users, and affect badly all factors of sustainability, efficiency and effectiveness of road maintenance management. Limited budget is used for emergency operations and as hoc maintenance. This looses incentives of introducing planned maintenance for proper prioritisation and for long termed cost saving. Low availability of maintenance equipment and insufficient training for the staff are also one of the major problems due to the insufficient budgets.

2) Delay of Payment to Contractors

Due to insufficient road maintenance budget, delay of payment to contractors often happens. Most of maintenance contractors are small and medium scale, and local firms. They have not sufficient financial capacity. When delay of payment occurs, working capital is dried up. Although they try to continue the maintenance contract, crediting operation fund from the banks are quite difficult for them due to high interest rates. They are forced to suspend maintenance operation until payment is made, which causes delay of progress and poor quality.

In addition, as the LBM contractor could not pay salaries and wages to his workers promptly due to the delay of the payment, he lost credibility in the villages and faced refusal of recruiting the workers there. Under the above circumstances, many experienced and capable contractors intend to escape maintenance contracts to look for private projects, and unskilled contractors

come into maintenance contracts. The performance and quality of maintenance work are not fully assured.

3) Directions

The Road Maintenance Fuel Levy (RMFL) is a key word for sustainable financing arrangement for road management. However, road maintenance budget is still not enough to meet requirement of current road maintenance. In this context, the following items becomes the key issues from a view point of road maintenance budget:

-Transparency of using fuel levy fund

-Prioritisation of budgetary allocation

-Proper budgetary allocation to regions

(2) Insufficient Maintenance Work Method

1) Road Inventory

As routine patrol and periodic road inventory are not well organised, it is difficult to find damages that are still small and inexpensive for repairs. This causes delay of timing of the minor repairs, which requires expensive rehabilitation and reconstruction. This forces field offices into spending much more expenditures for unexpected repairs than planned budgets.

Under the current road inventory system, total road maintenance management system and Highway Design and Maintenance Manual (HDM) are not able to work for planning and prioritising effective uses of Road Maintenance Fuel Levy.

As road inventory is one of basic information for road maintenance, the following items become the key issues:

-Provision of milestone system to know exact places for maintenance

-Periodic patrol or monitoring system to seize road conditions

-Data-base system to record the past maintenance activities

2) Aged Equipment and Unskilled Staff

a) Aged equipment

Operation and maintenance of aged equipment are expensive because of beyond of economic life of machine. Machine operations are frequently stopped and the repairs are needed a long time.

This problem decreases availability of equipment that is suitable for using the small contractors under LBM. In addition, they can not find proper machines for economically optimal combination of LBM and equipment.

In addition, lack of suitable equipment loses opportunity of staff training to use construction machines. This is also one of the causes of increase of unskilled staff in MOR&PW.

b) No standardisation

Various donors provide aid for provision of construction equipment without a policy of standardisation, which worsen availability of spare parts for the machines. Most of the temporal local dealers have no capacity of stocking the spare parts. In addition, their poor maintenance and repair service capability makes the situation worse. MOR&PW capacity is limited to maintaining and repairing the machines of the major companies. For efficient use it is recommended that the equipment and machines, of which dealers should have full ability for back-up services such as repair and sufficient stock of spare parts, have to be standardised.

c) Rearrangement of Workshops for Maintenance Equipment

Each District Offices have maintenance equipment at present. This means that scarce equipment is distributed to every office, and some of the equipment are not available due to lack of proper maintenance and over-age. In extreme cases, some District Work Offices have not available equipment in a "ready-for-use" status.

A higher level of concentration of equipment is, therefore, desirable from a viewpoint of effective use and easy maintenance of the equipment, so that the necessary equipment become commonly available and more effective maintenance of the equipment can materialise.

3) Labour Based Method

a) Problems

Labour Based Methods (LBM) is fairly well developed and has to a certain extent appreciably contributed to rural road development in Kenya in the past

under International Labour Organisation's (ILO) initiative since enough available equipment for road maintenance has not been observed due to lack of budget. One of the ILO's major objectives in introducing LBM was to generate employment opportunities for the rural areas that are characterised by poverty. This has been considered as a strategic social security policy for poverty alleviation through off-farm incomes, and trade off of complete economic benefits generated from improving the road.

The Government of Kenya, due to inflation and other factors, has recently introduced a minimum daily wage of 135ksh for a casual labourer, which translates to approximately two US dollars at the current exchange rate.

In addition, this wage level is much higher than that of an agricultural worker in the local labour market at present. It negatively affects farmers during the cultivating and harvesting seasons.

Taking these situations into account, it is important to bear in mind that LBM is only practical both economically and socially, when cost of LBM is viable under economic cost and benefit criteria.

b) Introduction of Appropriate Equipment

i) Proper Engineering for LBM

Proper engineering application is required for construction and maintenance of roads by LBM. There is no technical aspect in compacting roadbeds by traffic for an instance. Soil compaction to optimum moisture content guarantees the strength and durability of the pavement structure against the traffic loads. A sheep foot roller is deemed a more suitable compactor in terms of efficiency, cost, and its easiness in visual inspection for clay soils that are prevalent in the Study Area.

ii) Combination of LBM and Construction Equipment

Major advantage of LBM is to use local resources such as casual labourers and simple equipment. However, it is difficult for LBM to maintain bituminous standard roads and to carry out large-scale road maintenance works. In addition, LBM is facing some difficulties from a viewpoint of economic justification due to increase of labour wage.

Taking these conditions into account, appropriate combination of machines and equipment into LBM must be considered in order to maximise economic efficiency and to secure engineering standards.

On the other hand, although a combination of the equipment and labour Based Method approaches is recommended, the Labour Based Methods will still be effective for rural road maintenance for the time being, since enough equipment will not be provided soon. Community participation alongside the rural roads through the Labour Based Methods for routine road maintenance is necessary with the support by MOR &PW.

4) Insufficient Research and Development

The current road construction and maintenance follow the MOR&PW standards that were established in 1987. The present standards are applied widely and equally to the maintenance work without consideration of specific and local climate, geological conditions, and material resources. There are a lot of problems in the field of very expensive operations and short durable life of road and pavement. Material Testing and Research Department (MTRD) has intention to solve them through research and development in his laboratories and the field offices. However, they have insufficient capability and inadequate budget. This forces eventually to use expensive ways for road maintenance.

As road maintenance budget is inadequate, a research and development (R&D) operation is extremely important for the purpose of reducing the present road improvement and maintenance costs. This will alleviate financial constraints currently imposed on MOR&PW.

The Material Testing and Research Department reviewed the present pavement standards through application of field experiences, which MOR&PW has achieved over a period of more than ten years. The review concludes that ultimately there is a necessity of future research and studies in order to improve the durability and strength of the road. This will extend the life of road and pavement structures and develop cost-saving design and construction methods within a framework that considers local climate, materials and geological conditions.

5) Introduction of Total Maintenance Management

A clear strategy and direction for road maintenance has not been established so far, though the Roads 2000 Maintenance Programme is implemented based on

the Labour Based Methods. Consistency with the budget, staff and category of maintenance management criteria for contracting out and the force account is precondition under the privatisation scheme and forthcoming structural reform in order to ensure prompt and proper road maintenance works.

(3) Institutional Aspect

1) Surplus Employee

Surplus employee is a real burden to the MOR&PW. The budgets are bound by payment for their salaries, and efficiency of road maintenance is reduced by idle staff. The MOR&PW intends to reduce 15,778 staff current in-post to an optimal level of 8,073, a reduction of 7,705 that is equivalent to 48%, of the staff in-post with resultant savings amounting to K£15,333,759 on salaries alone.

The policy and institutional reforms and the consequent staff reductions aimed at improving the performance and effectiveness of the MOR&PW. However, the retired staff can not find easily employment opportunities in rural areas. Meanwhile comparing to ones of the private firms, the engineers and technical staff in core functions is not satisfied with the salary levels. It is difficult to adjust it due to budgetary restriction. The incentive and morale of employee seem to become low. Experienced staff quit the job with the MOR&PW to join the private firms enjoying full compensation of his engineering and technical carriers.

2) Lack of Institutional Efficiency

Overall institutional efficiency was reviewed by the study on "Policy and Organisational Review and Staff Reduction Targeted for the Ministry of Public Works and Housing (Dec. 1998)". It concluded the major causes of inefficiency depended on functional definitions and over-staffing, and recommended to apply commercialisation, regional approach, and reduction of number of redundant staff. This is a policy of GOK to recover efficiency of the ministry. In rural road maintenance in the Study Area, problems of a lack of institutional efficiency in maintenance operation are found as follows:

a) There are no clear functions for planning and operation in the Provincial and District Works Offices. Therefore, a plan-do-control-monitoring cycle does not work. This causes poor monitoring and feedback in maintenance management.

b) PWO and DWO co-ordination has not worked well in bituminous road maintenance. This leads delay of timing in patching activities and further damages on pavement structure.

c) As mentioned the above report, equipment distribution to DWO does not function well to respond to maintenance requests, in particular, for gravel and earth road grading after rainy season. This causes complaints from road users.

d) In addition, all districts do not always need engineers or technicians for mechanics, architecture and electricity, because their tasks are specific. There is idle number for them. Optimal numbers on the region base must be reviewed.

e) As currently headquarters and field offices have no institutional arrangement for public involvement in planning and monitoring, road users' voices do not come into road maintenance. They argue that transparency and effectiveness in usage of their taxes are sound. Without local co-operation based on consensus, the overall policy and operations of road maintenance become more difficult.

3) Role of MOR&PW

After establishment of Roads Board, which is expected to be in effective in the near future and through practice of the reform plan of MOR&PW, strategic function and actual work function should be clearly separated. Current Planning Branch will play a key role in order to draft original budget allocation plans, implementation priority plans of road maintenance and other important strategic plans.

On the other hand, Roads Department and other Departments, which are currently in charge of actual road maintenance and affiliated works, are expected to play an agency function. Main tasks of the agency are, under the implementation plan drafted by the Roads Board, routine road maintenance work by force account, management and supervising of contracting-out work, training of staff including private contractors.

These situations are the preconditions for forthcoming road maintenance operations so that it is important to take full advantage in establishing a future road maintenance plan.

(4) Strengthening the Construction Industry

There is only one large-scale construction contractor. Medium and small-scale contractors are dominant in the Study Area. The current medium and small-scale contractors have not enough construction equipment due to lack of own funds. In addition, payment to contractors by the Government is sometimes delayed due to budget constraints. These conditions prevent contractors from participation in tenders for road maintenance.

However, it becomes crucial for these contractors to cater for future road maintenance in Kenya, especially for the rural roads, which extend all over the country. Contracting-out of major road maintenance works is expected, though some are still on a trial basis.

Moreover, after the institutional reform of MOR&PW, many employees will have to leave their jobs, and medium and small-scale contractors are one of possible job opportunities.

It is necessary to strengthen and foster the construction industry with a view to meet the road maintenance requirements and also to promote the local economy. In this context, the following direction is of importance:

- creation of equipment leasing or rental market for the medium and small-scale contractors, and

- creation of basic conditions such as credit facilities for improving cash flow, and provision of a guarantee facility for tender and performance bonds for the medium and small-scale contractors so that they can easily participate in tenders for road maintenance works.

(5) Human Resource Development

1) Training for Government Staff

Reductions in the member of staff of MOR&PW and privatisation are a basic feature of the institutional reform, which is currently planned. Senior staff has to quit the job in MOR&PW due to early retirement, and matured engineers and administrators have also to leave their positions. In addition, further introduction of the contracting-out system in road maintenance will deprive middle and young age staff of the opportunity of practical road maintenance works.

These may accelerate the situations of lack of management capability and experienced staff.

Training for maintenance management and actual operational work becomes inevitable in this context.

2) Training for Private Contractors

As previously mentioned, strengthening of private contractors becomes important to meet the road maintenance needs. Training objectives and target-groups must be extended to include the private contractors as well.

Chapter 4

Road Network Improvement Plan

Chapter 4 Road Network Improvement Plan

4.1 Roles and Functions of Rural Roads

Two main aspects represent the roles and functions of rural roads: the promotion of local economy enhancement and the enhancement of the quality of life of the residents through supporting their daily activities. With regard to the promotion of local economy enhancement, the transport of raw materials and products is a focal point specifically for the support and development of economic activities in the agricultural, fishery, industrial and tourism sectors. As for the enhancement of the quality of life, the functions of the rural roads with specific reference to the ability to meet trip demands generated from daily life activities, are mainly discussed from the viewpoint of accessibility to various social facilities such as schools, hospitals, markets and other major public facilities. In examining the development priorities for rural roads, these two aspects are combined to form the basic criteria.

(1) Local Economy Enhancement

1) National Development Policy

In the 8th National Development Plan, which covers a five-year period from 1997 to 2001, the following development issues are to be realised:

- industrialisation for sustainable economic development and job opportunity,
- minimising economic gaps between urban and rural areas to attain equivalent development,
- agricultural development for self-sufficiency,
- poverty eradication to provide better quality of life,
- privatisation for an active national economy and mobilisation of human resources, and
- provision of infrastructure for economic development.

All issues described here have also to be realised with rural economic development. Without doubt, the provision of well improved and maintained rural roads will greatly contribute to rural development as well as national development.

2) District Development Issues

Each District has a District Development Plan and the following high priority development issues have in most cases been featured as major district development policies:

- improvement of infrastructure facilities,
- development of human resources,
- development of local raw materials,
- improvement of marketing system, and
- improvement of accessibility to credit.

Considering current local and rural economic activities, it is important to promote the local economic activities in order to stimulate current industrial activities and consequently increase in household income levels. In this view, there are two important policy issues; one is promoting current economic activities and the other is enhancing potential economic activities in the region.

The agricultural industry is dominant in this region taking advantage of geographic conditions such as comparatively high rainfall and abundant water resources. In addition, fishery is one of the unique industries in Kenya taking advantage of Lake Victoria.

In relation to rural road development, tea leaves and fishery transport become important issues due to the necessity of urgent transport to avoid spoilage and rotten.

3) Local Economy Enhancement

The roles and functions of the rural roads from a viewpoint of local economy enhancement are summarised as follows:

a) Material Transport

Most material comes from local sites in the Study Area and long distance transport can seldom be observed and as a consequence it is local transport that is of major concern.

b) Product Transport

Some major products such as fish, processed tealeaves, coffee, tobacco and cotton are transported to Nairobi and Mombasa. In this view, maintaining accessibility to arterial trunk roads is a key issue. In terms of fishery transport, as cold storage system is not prevailingly spread in the region, speedy transport becomes important.

c) Transport in the Rainy Season

Almost all of the road users consider transportation in the rainy season as a major headache. In the worst case, rural roads become impassable and this brings about serious damage to the economic activities and daily life behaviour of residents.

d) Effects on Shipping to Outside Major Cities

The Study Team conducted the Community Needs Survey. The results of this survey revealed that road improvement for the transport of fish products and tealeaves are two major issues necessary to support and enhance the local economy in the Study Area. Especially in the rainy season, a proportion of fish products and tealeaves become rotten due to lack of transportation to markets and processing plants. In addition, fish products such as Nileperch can be traded at a higher value in distant markets such as Nairobi and Mombasa, yet the volume currently traded is not much. For instance, the price of Nileperch in Mbita is around Ksh 30 per kilogram and that in Nairobi is around Ksh 50 per kilogram. The price of raw fish shipped to Nairobi and Mombasa is around 1.5 times higher compared to that of local markets.

(2) Enhancement of Quality of Life

1) Improvement of Accessibility

Many daily activities such as shopping, commuting to schools, visiting to hospitals for medical treatment and going to administrative centres can be observed even in rural areas. In the urban areas, utility of public transport is prevalent while the use of private vehicles is reserved for persons in the high income bracket. However, most people in the Study Area walk to their destinations or go to by bicycle riding for daily activities and Matatu for distant travelling due to low private vehicle ownership. Considering these facts, accessibility to the major facilities mentioned above is one of the criteria of

quality of life in the rural area, and therefore improvement of accessibility will greatly contribute to the enhancement of quality of life.

2) Comparison between Fish Area and Tea Firm Area

In comparison between fish industry area and tea firm area, improvement of accessibility will be of benefit to the fish industry area, since commodity supply for subsistence in the fish industry area is usually inadequate than that in the tea firm area.

(3) Roles and Function of Rural Roads

Taking the facts mentioned above into consideration, the major composition of trips can be summarised in the following manner (see Table 4.1.1):

Table 4.1.1 Trip Composition by Purpose

Item		Local Trips	Distant Trips
Local Industrial Development			
	Material Transport		
	Tea leaves	-to local processing factories	
	Others	-from local places to local factories	
	Product Transport		
	Fishery transport	-to local major markets for local consumption	-partly to Nairobi and Mombasa
	Others	-to nearby local markets	-partly to Nairobi and Mombasa
	Tourism Transport		-from whole of Kenay
Enhancement of Quality of Life			
	Go to School	-walk to nearby school	
	Go to Market	-walk to nearby local markets	
		-walk to nearby major markets	
	Go to Hoapital	-walk to nearby despensaries	
		-to referral hospitals(high rank ones) by Matatu	
	Go to Administraive Centre	-to major administrative centres by Matatu	

1) Local Economy Enhancement

As roles and functions of the rural roads, there are two major aspects:

- to maintain accessibility to the existing arterial trunk roads such as A1, B1 and B3, and
- to maintain accessibility to the local major cities where relevant factories are currently located.

In this regard, the following are the roles and functions of the rural roads with some implications of road development direction.

- stable transport without delay and interruption throughout the year
- transport without damage to loaded goods,
- speedy and stable access to arterial trunk roads, and
- establishment of road network without interruption even in the rainy season in the local area.

2) Enhancement of Quality of Life

From a viewpoint of betterment of quality of life, there are various trips generated from daily life activities. However, the trips can be divided into two categories; namely daily trips and non-daily trips. In terms of daily trips, most trips consist of walking or bicycle riding, where the destinations are not so far though walking time sometimes exceeds over 60 minutes. On the other hand, Matatu is a major means of transport to far distant destinations.

Taking these facts into consideration, the following are summarised as the roles and functions of the rural roads:

- to provide facilities for stable and safe walking trips even by earth and gravel road,
- to provide routes for public transport such as Matatu, and
- to maintain accessibility by bitumen roads to major public facilities (higher rank facilities) such as large markets, high ranking hospitals and administrative centres which are usually located around local major cities.

4.2 Level of Service and Design Standard of Rural Roads

(1) Service Level of Current Road Network

Table 4.2.1 shows a road length, road density and road development index, which indicates an average road length per area and population (see foot note in Table 4.2.1) by district and that of the whole of Kenya. According to this, the following features can be observed.

a. In terms of road development index, that of the Study Area is almost twice in comparison with that of the whole of Kenya.

b. In terms of road density, the same tendency as above can be observed.

c. In terms of road length per person, the national index is larger than that of the Study Area.

d. Generally, every index for the districts within the Study Area is similar.

According to the road development index, the Study Area shows comparatively well developed road network.

When comparing the service level of the road network among districts within the Study Area, the road development index indicates equal distribution of the road network in the districts.

Table 4.2.1 Road Development and Service Level

No.	District	Land Area(A) (Km2)	Population(P) (1999) (x10,000)	Road Length(L) (km)	Road development Ratio Road Development Index	Road Density (km/km2)	Road Service Level Km/1,000 person
1	Nation	583,000	3,052.0	63,290.7	3.5	0.11	2.07
2	Study Area	14,447	544.0	8,077.9	2.9	0.59(0.78)	1.48
3	Bondo	972	27.1	515.4	3.2	0.55	1.90
4	Busia	1,262	36.9	540.8	2.5	0.43	1.47
5	Gucha	657	46.0	507.3	2.9	0.77	1.10
6	Homabay	1,126	29.4	495.9	2.7	0.44	1.69
7	Kisii	645	51.6	558.2	3.1	1.30	1.08
8	Kisumu	2,250	92.8	1,654.1	3.6	0.74	1.78
9	Kuria	574	15.7	280.6	3.0	0.49	1.79
10	Migori	2,030	56.5	1,002.1	3.0	0.57	1.77
11	Nyamira	879	62.1	639.9	2.7	0.73	1.03
12	Nyando	N.A	N.A	N.A	N.A	N.A	N.A
13	Rachuonyo	931	31.4	471.0	2.8	0.53	1.50
14	Siaya	1,542	59.5	805.1	2.7	0.52	1.35
15	Suba	1,048	16.9	352.0	2.6	0.34	2.08
16	Teso	527	18.0	255.5	2.6	0.48	1.42

Source :1) Schedule of Classified Road in 1995
2) JICA Study Team in 1999

Note 1) Road Development Index $D = \bar{L} / \sqrt{A \times P}$
2) NA = included in Kisumu
3) ( ) exclude lake area

(2) Traffic Volume

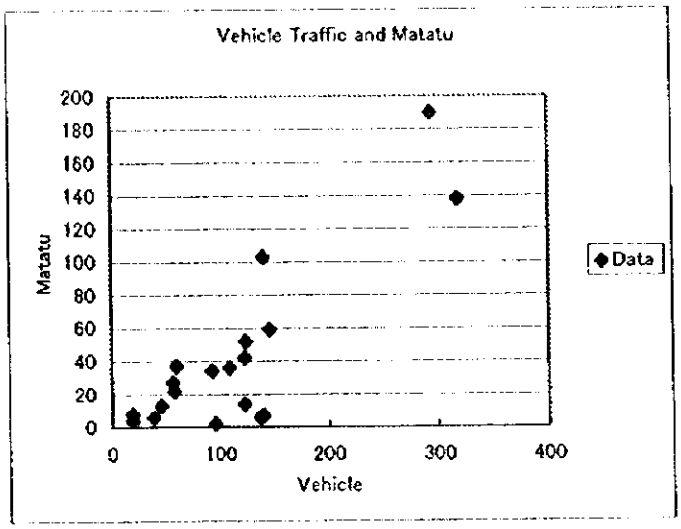
According to the results of the traffic count held by MOR&PW and the Study Team, much vehicle traffic could not be seen. On the other hand, many bicycles and pedestrians were observed on the rural roads, though this tendency could not be seen around five years ago in rural areas in Kenya.

(3) Matatu Traffic

As annual household income levels are not so high, car ownership is consequently low in comparison with large cities such as Nairobi and Mombasa.

This implies that most people mainly depend on Matatu as a means of transportation for long distance trips that cannot be covered by foot. Matatu greatly contributes to accessibility to various facilities, which are directly concerned with daily life in rural areas. Fig. 4.2.1 shows the relationship between vehicle traffic volume and Matatu traffic. It can be seen that almost half of the vehicle traffic consists of Matatu on rural roads.

As Matatu mainly transports passengers, though goods are also loaded, a well-maintained surface condition is preferable to provide comfortable and safe transportation services.



Source: Traffic Count by the JICA Study Team

Fig. 4.2.1 Matatu Traffic

(4) Geometric Conditions

1) Cross Section

Most of the Class C roads seem to have kept the necessary pertinent right of way and carriageways, though narrow carriageways can be partly observed. On the other hand, the width of the carriageways of Class D and E roads varies from place to place depending on the surrounding conditions, since no improvement to meet the design criteria has been undertaken for a long time.

2) Horizontal Alignment

Generally speaking, most of the rural roads have comparatively good horizontal alignment except for some sections, where the roads cross small rivers in mountainous areas.

3) Longitudinal Alignment

Longitudinal gradients over 8% can be observed at some road sections in mountainous areas. In other areas, the condition seems good in terms of longitudinal alignment.

(5) Design Criteria

1) Current Design Criteria

Table 4.2.2 sets forth the current design criteria in Kenya.

Table 4.2.2 (1) Current Design Criteria

Grade	Class	Item	Design Speed (level) (km/h)	Width			Cross fall	
				Carriageway (m)	Shoulder (m)	Total (m)	Carriageway (%)	Shoulder (%)
1	C.D	Bitumen	80 - 100	4.0 - 7.0	1.0 - 2.0	6.0 - 11.0	2.5%	4.0%
2	C.D.E	Gravel	Selected accordingly	-	-	8.0	4.0%	4.0%
3	C.D.E	Earth	-	-	-	6.0	5.0%	5.0%

Table 4.2.2 (2) Current Design Criteria

Grade	Class	Item	Design Speed (level) (km/h)	Alignment		Drainage (Type)	Material	
				Horizontal Curves (m)	Vertical Curves (m)		CBR (sorked)	PI
1	C.D	Bitumen	80 - 100	350 - 600	Depend on sight distance	A1,A2,B1,B2,B3 Cut-off 1,2	Sub grade ≧5 Sub base ≧30	Sub grade - Sub base ≧15
2	C.D.E	Gravel	Selected accordingly	Depend on site condition	Depend on site condition	Selected accordingly	≧20	≦15
3	C.D.E	Earth	-	Depend on site codition	Depend on site condition	-	-	-

Note: Grade is for reference.

2) Design Standard of Cross Section

The geometric road design manual was prepared in 1979. The number and width of carriageways and shoulders, therefore, appear to be rigidly set without giving proper consideration to the level of service and technical or economic road capacity criteria for assessing road service quality for justifying an appropriate widening. Accordingly, further geometric improvement should be based on sound economic justification and on engineering decisions that are subject to an appropriate selection of design speed that would govern the design.

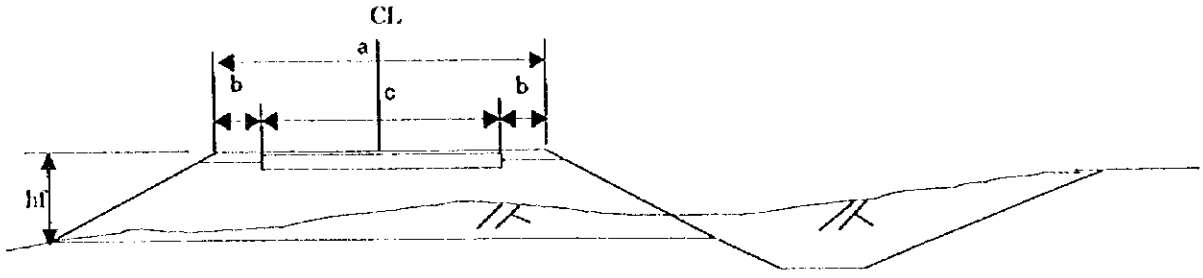
It is desirable that roads, which fall into one category, have a uniform road standard and that, for the benefit of traffic, all sections of the road are constructed in following the same road standard. It may require many years to create on the basis of conformity between the different classifications and standards, but immense user benefits would certainly be generated by this kind of conformity. The following are the major points needing revision and standardisation in future in order to meet national and users' needs:

- the current design speed of Class C Roads (90-100 km/h) on flat area is considered unnecessarily high,
- suitable shoulders width should be standardised in order to cater to pedestrian and the volume of bicycle traffic.
- Guideline on a more detailed and diversified drainage system should be included into the manual for mountainous areas in order to cope with intensive rainfall and also to furnish cost effective drainage systems.

The current standard cross-sections are shown in Fig. 4.2.2.

3) Drainage

One of the most important elements of road design, operation and maintenance is to provide adequate and functional drainage. Roads need good drainage to safely operate and adequately undertake necessary maintenance throughout their service lives. Poor drainage can cause operational effects such as splash and spray creating limited visibility while water films can lead to tire hydroplaning and flooded areas. These make roads impassable for vehicle traffic. Furthermore, water entering the pavement structure can weaken the layer materials, and cause the pumping of fine particles from beneath the pavement as well as other phenomena such as asphalt stripping.



Note: The slope of fill : 1:4 where hf ≦ 1m
1:2 where 1m < hf ≦ 3m
1:1.5 where hf > 3m

Cross Section			Dimensions in Metres			Normal Cross Fall in %
Type	Lanes	Surfacing	a	b	c	s
II	2	Bitumen	11.0	2.0	7.0	2.5
III	2	Bitumen	9.5	1.5	6.5	2.5
IV	2	Bitumen	8.0	1.0	6.0	2.5
V	1	Bitumen	7.0	1.5	4.0	2.5
VI	1	Bitumen	5.0	0.5	4.0	2.5
VII	2	Gravel	8.0			4.0
VIII	1	Earth/Gravel	6.0			5.0

Note: Type V and VIII are only interim solutions (stage construction)

Fig. 4.2.2 Typical Cross Section

As a whole, the current drainage structure in the Study Area appears to be poor. Most of the embanked roads do not have drainage, and non-embanked roads have simple side ditches.

The design scales of the drainage structures used are as shown below:

Drainage structure	Return period
Bridge	50 years
Culvert	50 years

In the design of hydraulic structures, peak discharge is required. Peak discharge has been calculated using the formula in the Road Design Manual of Kenya.

As the drainage system will be designed according to the natural conditions, the construction of stone masonry or concrete drainage is recommendable for roads with more than 8% of longitudinal grade, in order to prevent soil erosion.

In recent times the El Nino disaster has hit Kenya twice in 1961 and 1998. According to the Meteorological Department, the El Nino phenomenon occurs at an interval of 6~7 years.

According to the investigation by the Study Team, many existing box culverts and bridges in the Study Area were submerged by the El Nino disaster in 1998 and estimation by the Study Team revealed that the flooding in 1998 was the largest in the last 25 years. Considering the design scale of the drainage structures, of which 50 years is applied for bridges and culverts, the El Nino disasters would have been prevented by rigid application of the current design standard.

On the other hand, the return period for bridges and culverts are not described in the current design manual. This should be specified in the manual, since drainage is one of the important components in road maintenance.

4.3 Development Criteria

4.3.1 Development Criteria for Rural Roads

In terms of trunk roads, traffic volume may be one of the important indicators to analyse the improvement priority of the roads. The traffic volume of rural roads is, however, not so much (rated at 150-200 vehicles on average) and is not an indicator as a criterion to discuss the priority of road improvement. Two viewpoints have consequently been used to analyse these issues. One is the aspect of local economic development focusing mainly on the fishery and tea industries and the other is accessibility to major public facilities such as large market centres, health centres and administrative centres from a viewpoint of social amenity.

4.3.2 Local Economy Enhancement

(1) Fish Industry Enhancement

Taking the current road condition into consideration, the number of landing beaches, the latest fish product statistics and the investigation by the Study Team, the following six routes can be identified as candidate routes from a fishery industry enhancement perspective. Some candidates roads also have possible alternative routes (see Table 4.3.1).

Table 4.3.1 Candidate Roads to be Improved for Fishery Industrial Enhancement

Possible Alternative			Distance	Remarks
1 From Port Victoria			Km	
	A	D251-D250-D254	43.2	Gravel/Earth
	B	C29-C90-B1	29.9	Gravel/Earth
	C	C27-B1	75.8	Gravel/Earth/Bondo/Bitumen
2 Usigu to Bondo				
		C27	45.0	Gravel/Earth
3 Luanda Kotieno to Siaya				
	A	C28-D246-Siaya-C29-B1	58.7	GE/GE/Siaya/Bitumen
	B	C28-D245-B1	67.7	GE/GE/Bitumen(C27)
4	Mbita to Homa Bay			
		C19-Homa Bay	40.7	Gravel/Earth
5	Karungu to Homa Bay			
		C18 to C20	35.9	Gravel/Earth/Bitumen(C20)
6	Muhuru to A1			
		C13-A1	47.7	Gravel /Earth

Note: For the locations of the routes, refer to Fig. 2.3.1.

(2) Transport of Tealeaf

In terms of tealeaf transport, there are many small-size tea farms in the Nyamira District and its surrounding area, and there may be many necessary routes to be improved connecting to processing factories. However, it is very difficult to identify the roads to be improved for transport of tealeaves, because it is necessary to improve roads not as a single route but as a network in this area in view of the fact that the tea farms are widely spread out. Taking the condition into consideration, well-established road network becomes a focal issue in order to cover the tea farms as a first step in this area.

Several candidate roads were selected from a viewpoint of accessibility to pivotal major facility centres in the Nyamira District, and these routes also play an important role for transport of tealeaves as well.

(3) Other Industries

As for manufacturing industry, most factories were located near existing towns. In this view, not rural roads but trunk roads improvement is essential.

In terms of tourism industry, as improvement of access roads to bitumen standard leading to tourism spots such as national parks is not always pertinent in many cases from a viewpoint of environmental conservation, no special access road is proposed for the tourism industry.

4.3.3 Accessibility Index Analysis

A concept of accessibility index was introduced to analyse the accessibility to major public facilities such as large market centres, health centres and administrative centres, since an estimation of traffic volume on the rural roads is difficult.

(1) Major Public Facilities

Administrative centres, major market centres and health centres were examined to analyse the accessibility from villages to these facilities. The distribution of the facilities is shown in Fig. 4.3.1.

1) Administrative Centres

Governmental and district offices were taken into consideration to analyse their accessibility.

2) Market Centres

Market centres such as town markets and rural markets are considered through interview, reconnaissance survey and the District Development Plan.

3) Health Centres

The following health centres are considered in this analysis through the District Development Plan, information by each District, the study on Strengthening the District Health System (JICA), reconnaissance survey by the Study Team and others.

- Provincial hospital
- District hospital
- Mission hospital
- Health centres

Dispensaries are excluded due to their numerous locations.

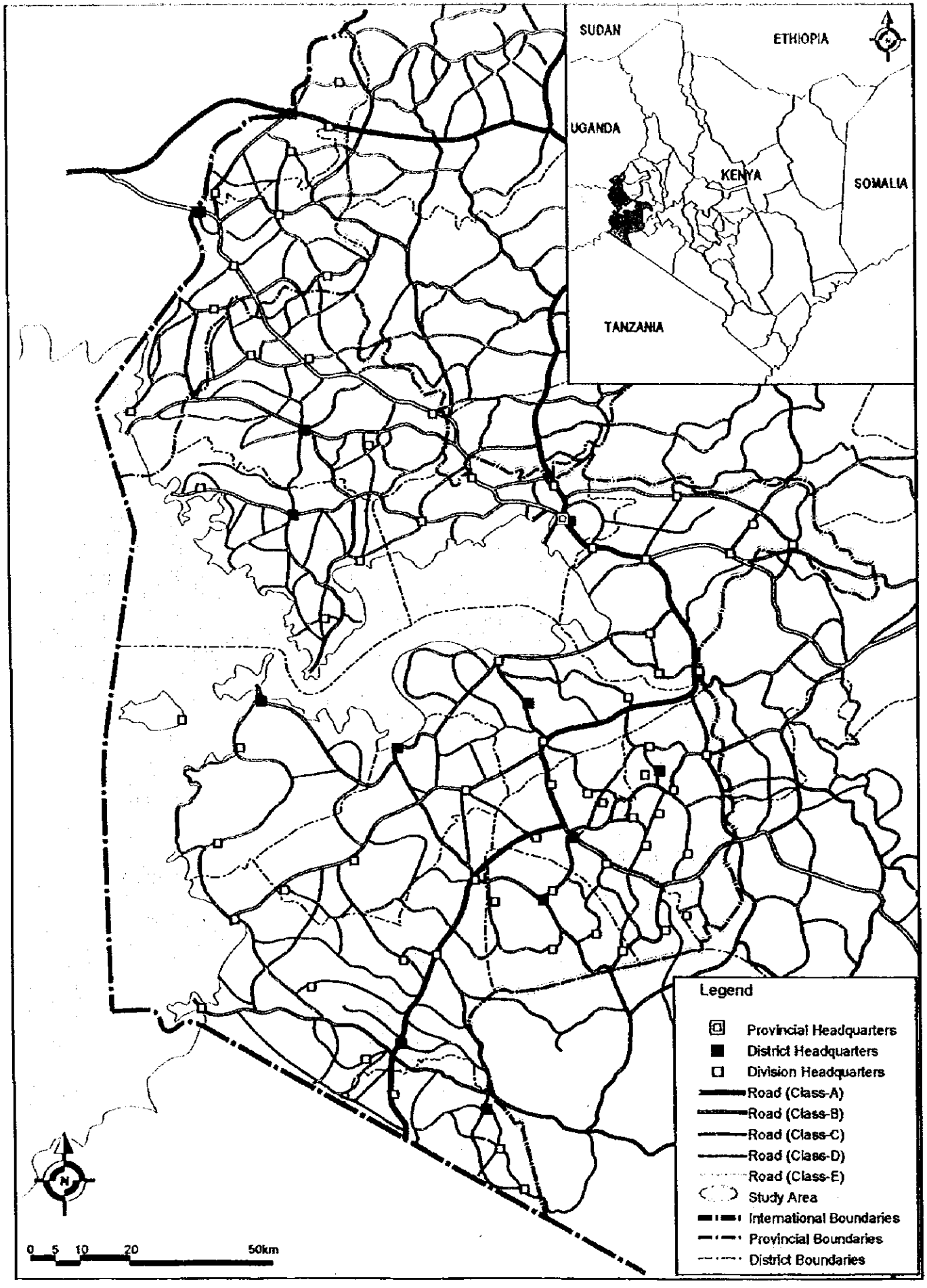


Fig. 4.3.1(1) Facility Distribution (Administrative Centres)

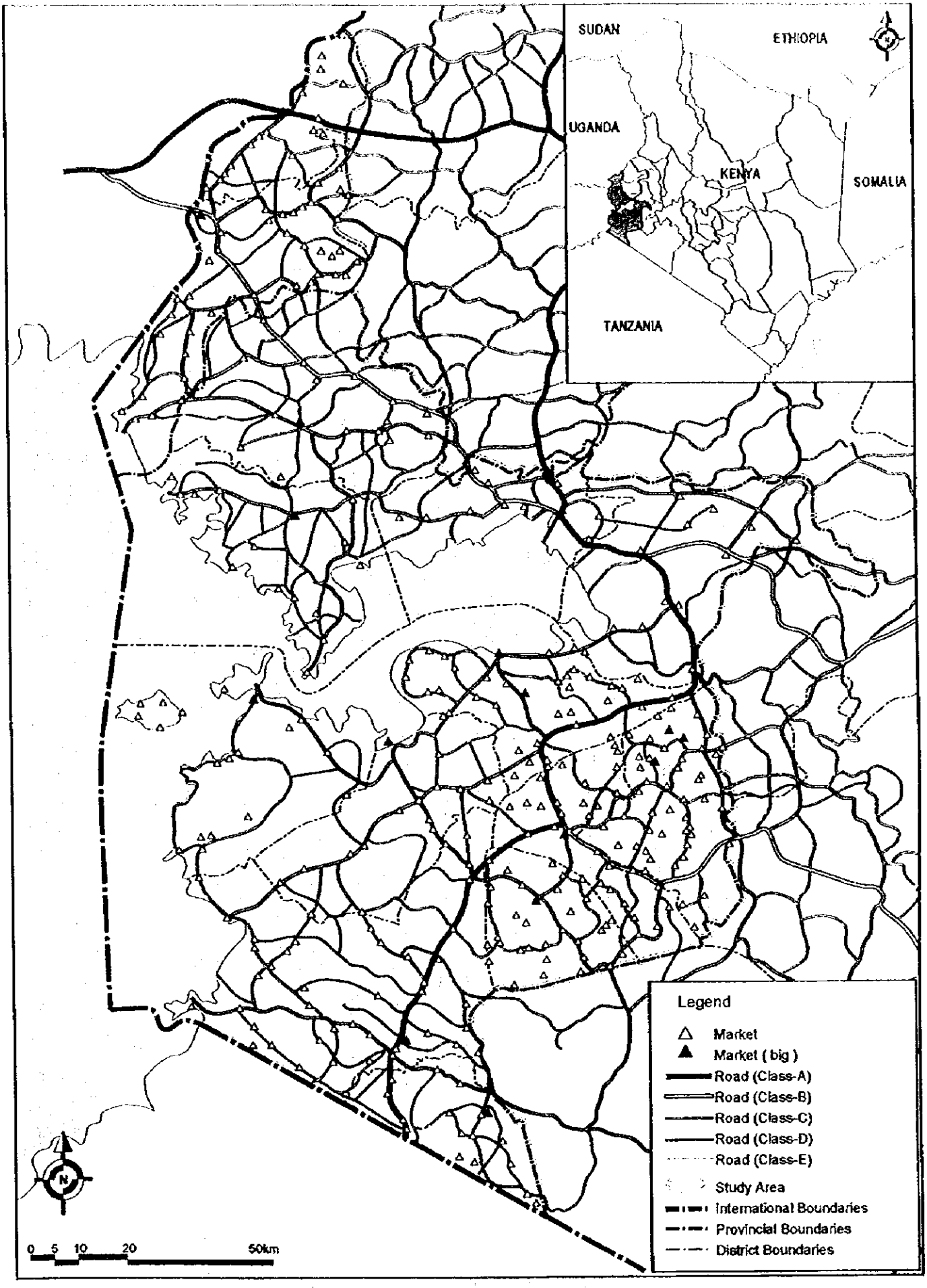


Fig. 4.3.1(2) Facility Distribution (Market Centres)

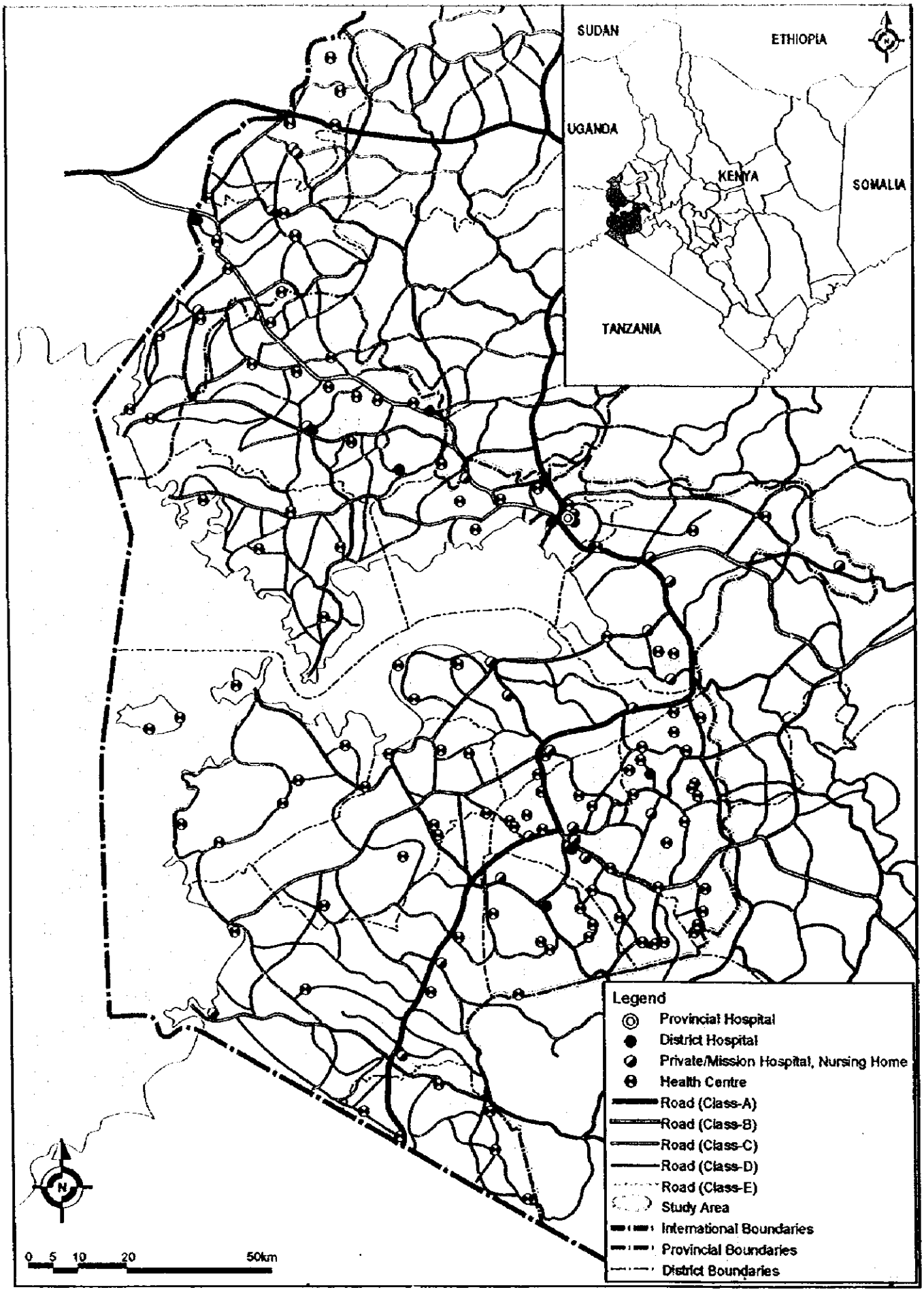


Fig. 4.3.1(3) Facility Distribution (Health Centres)

(2) Territory and Major Centres

1) Cluster Tree

Cluster tree analysis was applied to analyse the accessibility to the major public facilities. Examination by the Study Team resulted in the conclusion that the location of pivotal major administrative centres and major market centres is almost overlapping each other.

Cluster trees by administrative centres and health centres are shown in Appendix 4.1 and the results of the analysis indicates that the major administrative centres can represent the major market centres. In addition, many ferry services have been operated in Lake Victoria. Kisumu and Homa Bay are the main ports for these services. Moreover, Kisumu has a commercial airport. The major administrative centres mentioned above cover even these terminus points for ferry and air transport services.

2) Territory and Location of Pivotal Major Facilities

The analysis of the cluster tree by administrative centres (representing market centres also) divided the Study Area into six (6) territories (see Fig. 4.3.2). In terms of health centres, the area was initially divided into ten (10) territories (see Fig. 4.3.3). However, these two categorised territories show a similar pattern because the distribution patterns of the pivotal administrative centres, major big market centres and important health centres such as provincial and district hospitals are located at similar places.

Considering these facts, the zoning drawn for cluster tree by the administrative and market centres was applied in this analysis as an integrated territory.

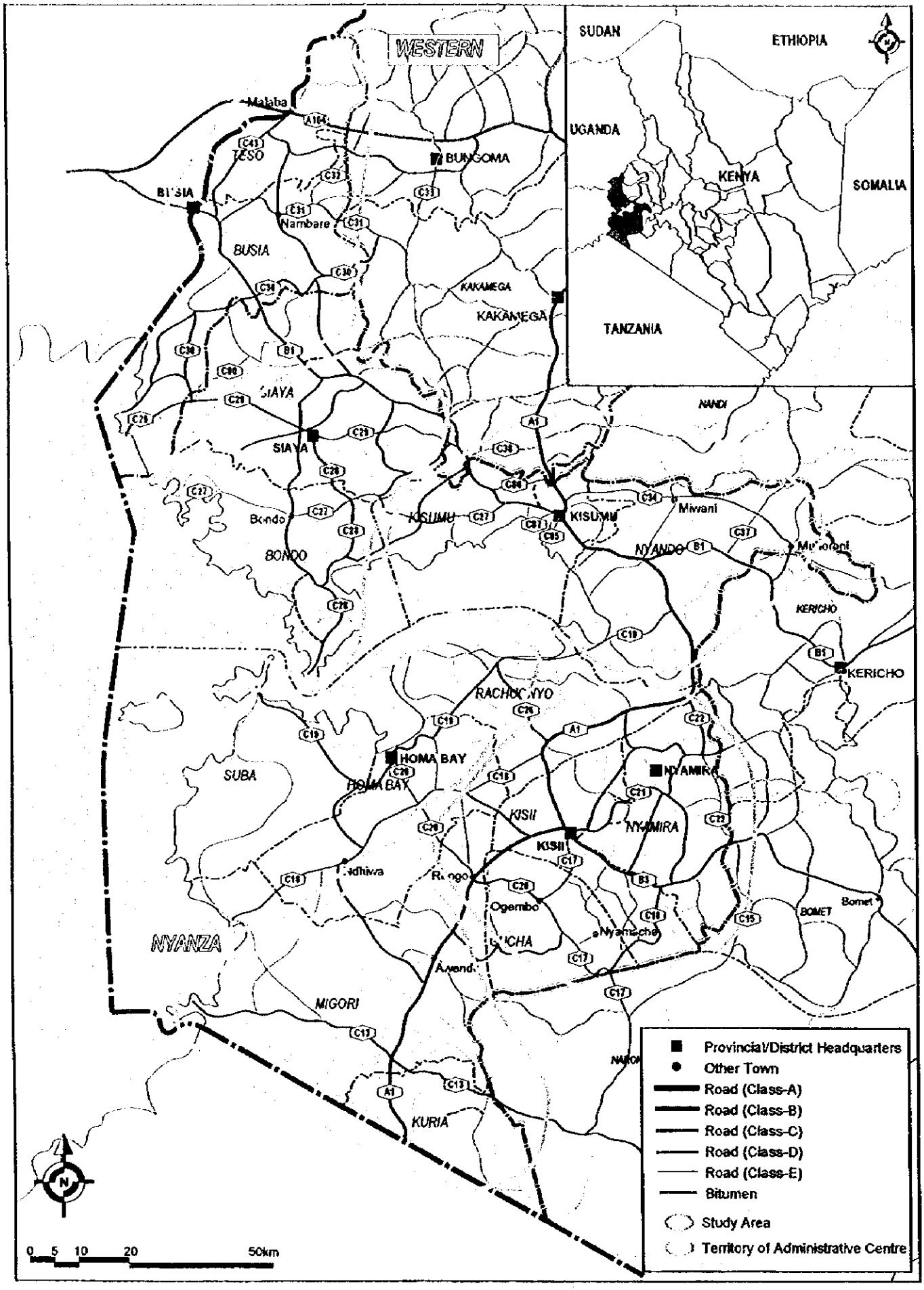


Fig. 4.3.2 Territories by Administrative Centres

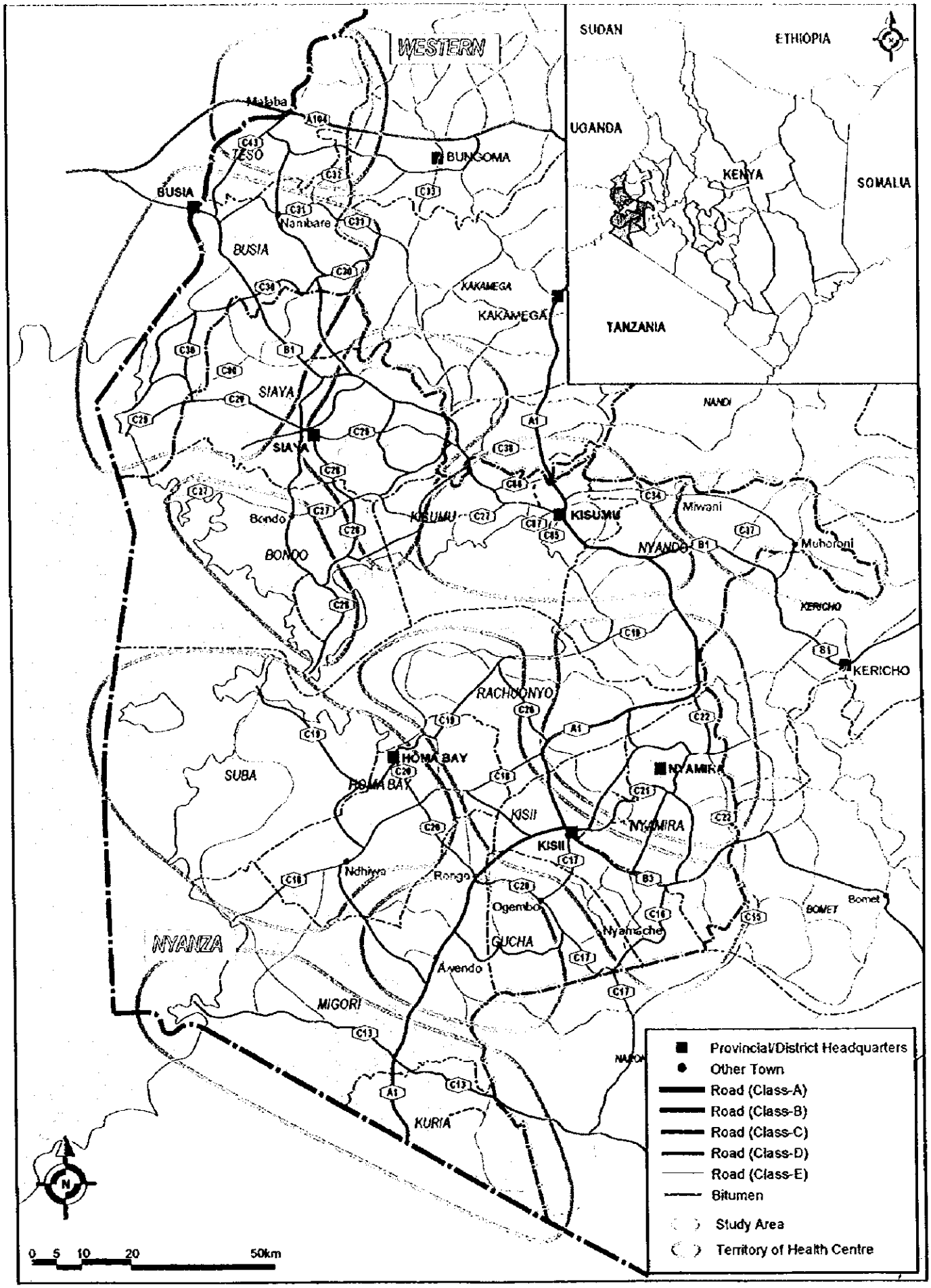


Fig. 4.3.3 Territories by Health Centres

(3) Accessibility Analysis

1) Road Network Condition

The accessibility is presently restrained by the road network condition, which is defined by mainly two components, the road network itself comprising classified roads and the surface condition. Both components are closely interactive in determining the average speed of vehicles. These conditions were investigated on the basis of information obtained from MOR&PW and the reconnaissance survey by the Study Team.

2) Accessibility Index

In the next stage, accessibility from villages in each territory to the pivotal major facilities of each territory was analysed. For this purpose, the concept of accessibility index was used. The accessibility index indicates the number of access routes from villages to pivotal centres in each territory based on the links of the road network as well as the importance of these roads from an accessibility viewpoint. The higher the number of routes a road has, the higher improvement priority it shows. A rough schematic explanation is shown Fig. 4.3.4.

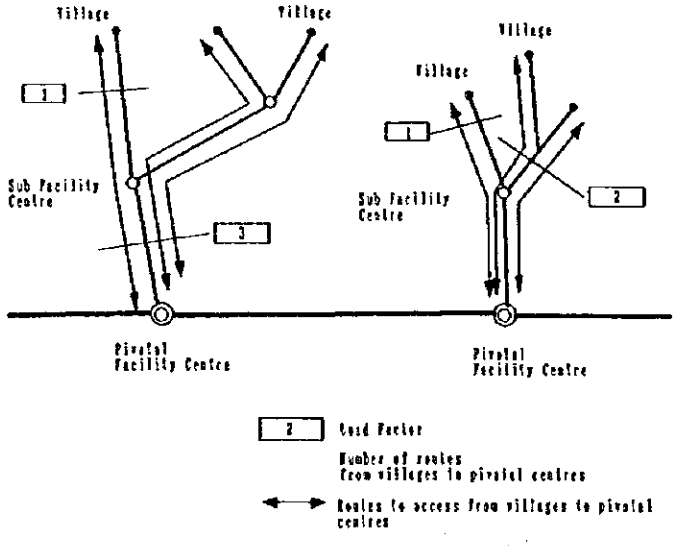


Fig 4.3.4 Explanation of Accessibility Index

Based on this concept, Fig. 4.3.5 illustrated the accessibility index of the rural roads in the Study Area indicating the kind of priority from an accessibility

viewpoint relevant to the resident's daily activities. Table 4.3.2 sets forth the roads section with the accessibility index of more than 8 in order.

Table 4.3.2 Road Sections in Order with Accessibility index

Sq. No.	Rd. No.	Accessibility Index	Section	Remarks
1	C20	83	Homa Bay - C19	
2	C19	50	C20-D213	
3	D246	41	C29 (Siaya)-C27(Bondo)	
4	C31	38	B1-D256	
5	C20	33	C19 - C18	
6	C29	21	East Siaya	
7	C13	20	A1 - D210	
8	C17	19	B3 -Ogembo	
9	C43	19	Connecting to D256	
10	D210	19	C13-Karungu	
11	E118	19	C19-D210	
12	C43	16	D256-A1	
13	C19	14	C20-D216	
14	D246	14	Siaya-C28	
15	D256	14	C30-C31	
16	C21	13	Kisii-D222	
17	C27	13	B1-D243	
18	C31	12	D256-C32	
19	C18	11	A1-C20	
20	E211	11	C18-C20	
21	C27	10	West Bondo	
22	C13	9	D202-A1	
23	C18	8	C20-D210	
24	C19	8	For Mbita from D213	
25	E212	8	D216-C18	

Source: JICA Study Team
Note: See appendix for all the roads

Considering the order of up to accessibility index 8, class C roads are dominant in this order except for the following road sections:

- D246 (Siaya to Bondo)
- D210 (C13 to Karungu)
- E 118 (C19 to D210)
- D246 (Siaya to C28)
- D256 (C30 to C31)

(As to location of the roads, refer to Fig. 2.3.1)

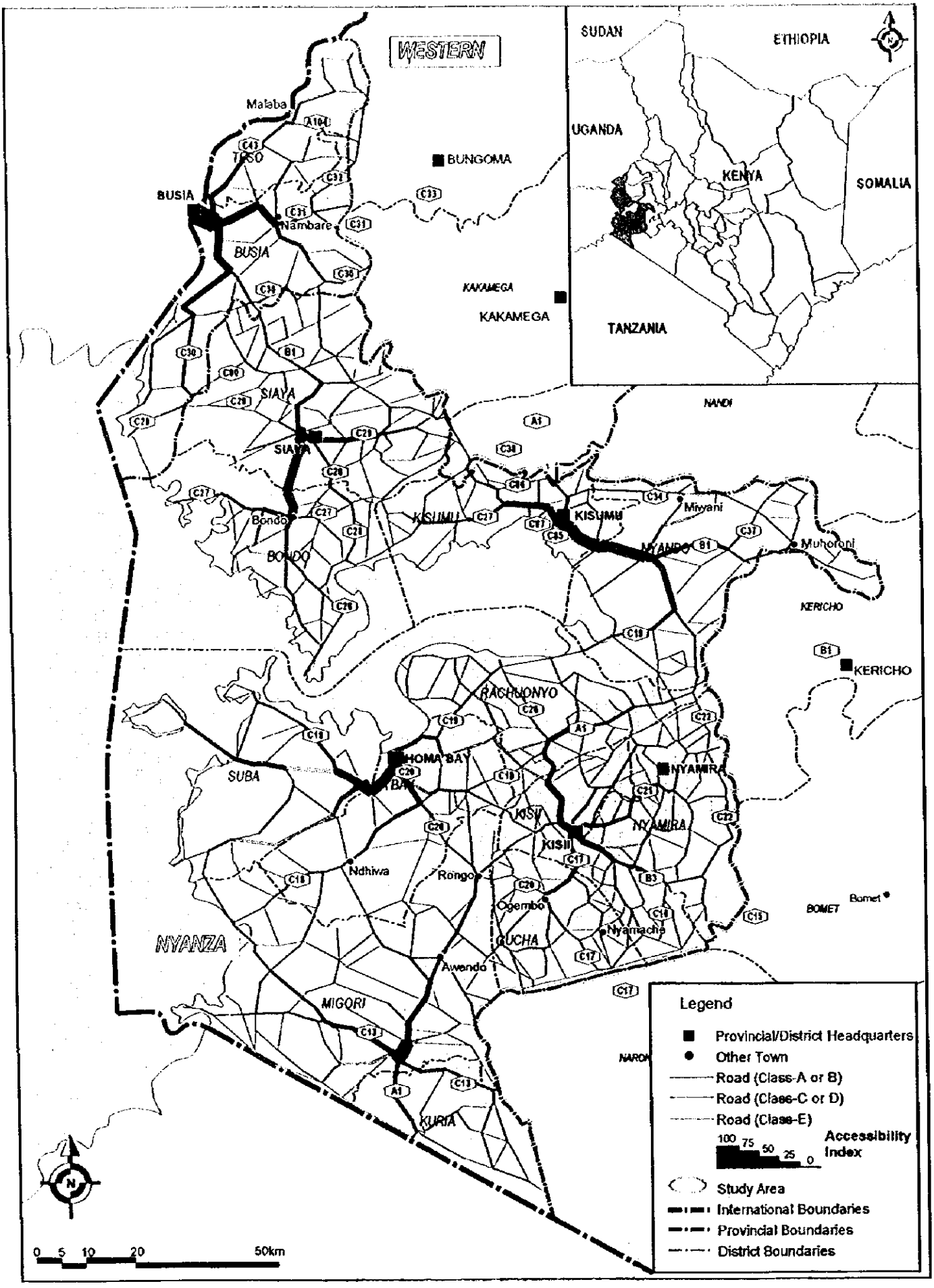


Fig. 4.3.5 Accessibility Index

4.4 Network Improvement Plan

(1) Current Plan

The Roads 2000 Maintenance Programme has been incorporated into the national policy and strategy on road development at present and has been intensively advanced in Kenya. Upgrading and large-scale improvement has been predominantly dependent on donors' assistance due to insufficient financial resources, while domestic budget resources for the maintenance work of roads have been mainly allotted by using the fuel levy fund. Although only large-scale upgrading and improvement projects are mentioned in the Five Years National Development Plan, no comprehensive and integrated road network plan assured by the financial budget can be authorised at present. Further foreign assistance to cater specifically to the 1999 El Nino disaster rehabilitation projects has been listed and confirmed by MOR&PW.

On the other hand, each district has a District Development Plan, in which the priorities of the road development were presented (see Fig. 4.4.1)

(2) Cross Section Type by Current Criteria

1) Traffic Volume and Growth

Based on the traffic volume by type on major road sections, cross section types were analysed according to the current design standard.

a) Current Traffic Volume

The traffic volume counted by MOR&PW and the Study Team was used for the analysis (refer to Section 2.4 Traffic Characteristics)

b) Traffic Growth

"A Road Network Development Master Plan Study "was conducted by JICA in 1995, and an annual growth rate of vehicle ownership and future traffic growth rate on arterial roads including limited Class C roads (C19 and 20 in the Study Area) were estimated in this report as shown in Table 4.4.1 and 4.4.2.

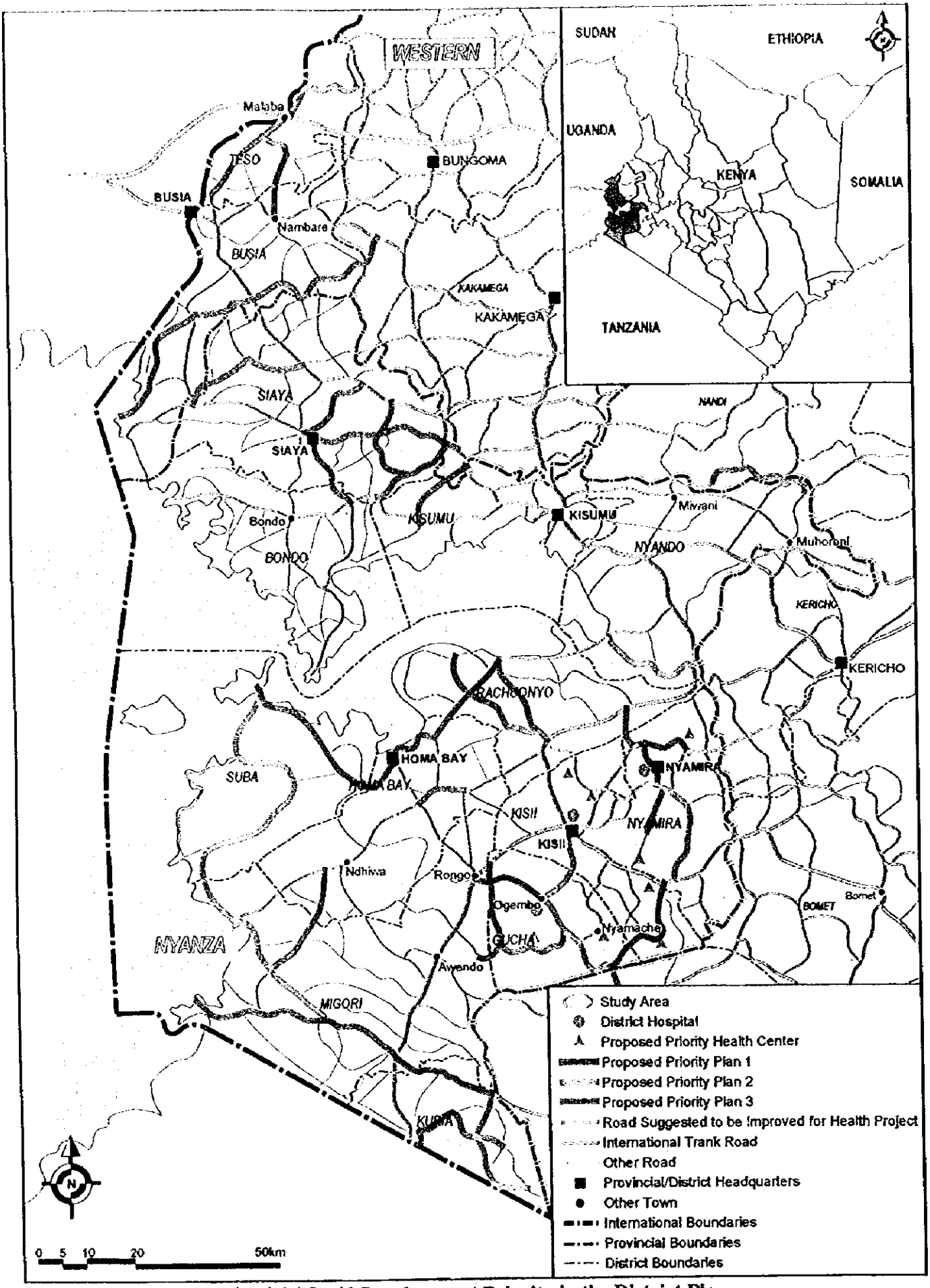


Fig. 4.4.1 Road Development Priority in the District Plan

Table 4.4.1 Annual Growth Rate of Vehicle Ownership

Unit: %

Car	Motor Cycle	Pick up	Bus	Truck	Trailer	Tanker
5.66	5.66	5.57	3.89	5.65	4.99	5.46

Source: Road Network Development Master Plan Study
Note: Over the period from 1994 to 2013

Table 4.4.2 Traffic Growth Rate

Rd. No.	Growth Rate
C19	5.30%
C20	5.30%

Source: Road Network Development Master Plan Study

On the other hand, the Road Design Manual in Kenya stipulates that consideration of a "7.5 % annual growth rate" is recommendable. Otherwise, an indication of likely traffic growth rate would be given by the national trends in the number of vehicles registered or by the consumption of motor fuel when more precise information is not available.

As it seems difficult to estimate the exact traffic growth on rural roads due to insufficient data, the higher annual traffic growth rate should be used in the preliminary design stage since much difference cannot be observed in the growth rates mentioned above.

2) Cross Section Type

Basic cross section types were decided according to the current design criteria (see Table 4.2.2). After that, wider shoulders of 1.5-2.0 m were applied to Class C roads and even some Class D and E roads having important roles and functions.

(3) Recommended Cross Section

1) Upgrade of Cross Section

Currently the classified roads are divided into five categories according to MOR&PW, Class A, B, C, D and E+Special Purpose Road. This classification category corresponds to the road function as follows:

Class A: International Trunk Road
Class B: National Trunk Road
Class C: Primary Road
Class D: Secondary Road
Class E: Minor Road

2) From a Viewpoint of Pedestrian, Bicycle and Matatu Traffic

a) Considering the pedestrian and bicycle traffic volume in the Study Area, shoulder width should have a clearance as wide as possible to cater to these types of traffic. The wide shoulder is obviously available for safe Matatu operations at the bus stops to separate other vehicle traffic.

b) In terms of pavement standard, instead of double surface dressing, Asphalt concrete is recommendable for roads over 8 % longitudinal grade to prevent abrasion by heavy vehicle.

As a whole, this classification is considered to be adequate in defining the existing actual characteristics of the roads. However, through the analysis on the roles and functions of the rural roads in the Study Area, it is recommended to apply a new cross section with a wider shoulder of 1.5-2.0 meters for the important rural roads (see Fig. 4.4.2).

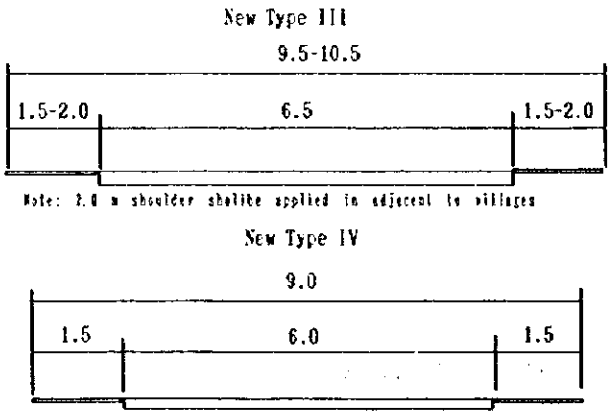


Fig. 4.4.2 New Cross Sections for Rural Roads

The roads to be upgraded are listed in Table 4.4.3 in order to cope with improvement of accessibility contributing to the enhancement of local economic development.

Table 4.4.3 Roads to be Upgraded

Rd. No.	Accessibility Index	Section	Remarks
C20	83	Homa Bay - C19	Fish transport
C19	50	C20-D213	
D246	41	C29 (Siaya)-C27(Bondo)	Fish transport
C31	38	B1-D256	
C20	33	C19 - C18	
C29	21	East Siaya	
C13	20	A1 - D210	Fish transport from A1 to Muhuru
C17	19	B3 -Ogembo	
C43	19	Connecting to D256	
D210	19	C13-Karungu	
E118	19	C19-D210	
C43	16	D256-A1	
C19	14	C20-D216	
D246	14	Siaya-C28	Fish transport
D256	14	C30-C31	
C21	13	Kisii-D222	
C27	13	B1-D243	
C31	12	D256-C32	
C18	11	A1-C20	Fish transport
E211	11	C18-C20	
C27	10	West Bondo	
C13	9	D202-A1	
C18	8	C20-D210	
C19	8	For Mbita from D213	
E212	8	D216-C18	
D250		D251-D 250-C30	Fish transport
D245		C28-D245-B1	Fish transport

3) Proposed Cross Section for All Major Roads

According to the assumptions mentioned in Section 4.2 Level of Service and Design Standard of Rural Roads and the examination in this section, the cross section types on each major road were proposed and the results are presented in Table 4.4.4.

Table 4.4.4 Cross Section Type on Major Road Sections

Seq.No.	RD No.	Census Point & Location	Cars/day	Light Goods	Medium Goods	Heavy Goods	Buses	Total	Standard axles	Type	DHV (Level terrain)	X-section Type	Preferable Cross Section
1	A1	South East of Kisumu	1209	1410	309	160	182	3270	31,173,574	T1	4315.5	II	
2	A1	West Jt. with Ahero	847	1331	290	201	177	2852	27,188,695	T1	3975.5	II	
3	A1	North Jt. with C22	122	372	43	12	17	566	5,395,793	T3	677.5	II	
4	A1	North of Oyugis	150	469	93	6	15	739	7,045,037	T3	908.5	II	
5	A1	South West of Jt. with C13	55	308	60	9	15	447	4,261,342	T3	574.5	II	
6	B1	East of Jt. With A1 near Ahero	309	550	199	133	138	1425	13,584,814	T2	2194.0	II	
7	B1	South East of Jt. with C33	193	666	95	131	60	1145	10,915,518	T2	1635.0	II	
8	B1	West of Jt. With C39	162	600	70	101	40	979	9,333,006	T3	1376.5	II	
9	B3	S.W of Jt. with C22	195	686	111	95	83	1170	11,153,848	T2	1657.0	II	
10	B3	S.E. of Jt. with A1 near Kisii	620	1940	274	68	166	3068	29,247,867	T1	3815.0	II	
11	C13	(D202-A1)	24	145	24	2	1	196	1,868,508	T4	238.0	IV	New IV
12	C13	(A1-D210)	23	126	13	3	4	169	1,611,111	T4	200.0	IV	New IV
13	C16	(E192 C17)	11	129	10	2	0	152	1,449,047	T4	172.0	IV	New IV
14	C17												New III
15	C18	(A1-C20)	25	109	7	4	5	150	1,429,980	T4	175.5	IV	New IV
16	C18	(C20-D210)	28	201	11	2	9	251	2,392,834	T4	281.5	II, III	New III
17	C19	(A1-C26)	271	604	108	62	61	1106	10,543,723	T2	1484.0	II	New III
18	C19	(E218-D216)	64	232	59	11	14	380	3,622,617	T3	510.0	II	New III
19	C20	(C19-C18)	146	642	78	16	39	921	8,780,080	T3	1117.0	II	New III
20	C20	(C18-A1)	87	296	62	11	43	499	4,757,068	T3	662.5	II	New III
21	C21		40	242	18	2	3	305	2,907,627	T4	340.0	II, III	New III
22	C22	(A1-B3)	25	132	21	1	4	183	1,744,576	T4	221.0	IV	New IV
23	C26	(C19-E213)	48	146	84	2	0	280	2,669,297	T4	411.0	II, III	New III
24	C27	(B1-D245)	96	362	63	21	20	562	5,357,660	T3	729.0	II	New III
25	C27	(D245-D246)	75	305	45	4	17	446	4,251,809	T3	540.5	II	New III
26	C27	(D244-E134)	50	275	44	3	8	380	3,622,617	T3	461.5	II, III	New III
27	C27	(D244-E245)	61	332	49	4	17	463	4,413,873	T3	563.5	II	New III
28	C28	(C29-C27)	63	177	22	4	8	274	2,612,098	T4	325.0	II, III	New III
29	C28	(Rangala-E127)	12	45	4	3	10	74	705,457	T5	97.5	VI	New IV
30	C29	D247-Siaya	52	224	39	5	10	330	3,145,957	T3	411.0	II, III	New III
31	C29	(Siaya West)	44	137	33	4	8	226	2,154,504	T4	293.5	IV	New IV
32	C30		13	67	16	4	1	101	962,854	T5	136.0	VI	New IV
33	C31		31	129	29	5	2	196	1,868,508	T4	254.0	II, III	New III
34	C32		16	42	15	2	2	77	734,057	T5	106.5	VI	New IV
35	C33	(Mayoni-B1)	180	421	77	30	4	712	6,787,641	T3	906.5	II	New III
36	C37		140	323	97	34	4	598	5,700,855	T3	832.5	II	New III
37	C38		127	443	32	4	5	611	5,824,787	T3	634.0	II	New III
38	C39	(E327-E231)	173	496	72	25	34	800	7,626,562	T3	1004.5	II	New III
39	C40	(Kakamega-D266)	271	681	107	32	13	1104	10,524,656	T2	1357.5	II	New III
40	C41	(D33-D267)	22	63	5	1	0	91	867,521	T5	101.0	VI	New IV
41	C43	(B1-D256)	21	70	19	4	2	116	1,105,852	T4	156.5	VI	New IV
42	C44	(D282-D284)	15	178	29	37	0	259	2,469,100	T4	395.0	II, III	New III
43	C85	South of Kisumu town	234	100	13	0	1	348	3,317,555	T3	368.5	II, III	New III
44	C86	North East of B1	61	131	46	11	3	232	2,211,703	T4	331.5	II, III	New III
45	C87	B1-Kisumu	788	596	254	192	0	1830	17,445,762	T2	2691.0	II	New III
46	D201	(C13-E163)	9	54	12	2	0	77	734,057	T5	100.0	VI	VI
47	D202	(D211-D203)	35	123	40	2	1	201	1,916,174	T4	267.0	II, III	IV
48	D204	(C17-A1)	12	64	15	3	1	95	905,654	T5	126.0	VI	VI
49	D205	(C20-E205)	7	77	8	1	1	94	896,121	T5	109.5	VI	VI
50	D206	(C17-D207-C17)	23	113	12	2	1	151	1,439,514	T4	175.0	IV	VI
51	D208	Near C16	4	54	5	0	0	63	600,592	T5	70.5	VI	VI
52	D210	(C19-E115)	9	44	6	2	0	61	581,525	T5	75.0	VI	New III
53	D211	(C18-E107)	1	24	3	0	0	28	266,930	T5	32.5	VI	VI
54	D212	(A1-E108)	9	62	7	1	0	79	753,123	T5	92.0	VI	VI
55	D213	Near C19	1	4	0	0	0	5	47,666	-	5.0	VI	VI
56	D214	(D210-E117)	3	15	2	0	0	20	190,664	-	23.0	VI	VI

57	D217	(C26 A1)	5	23	29	0	1	58	552,926	T5	102.5	VI	VI
58	D218	(C19 A1)	9	51	7	0	0	67	638,725	T5	77.5	VI	VI
59	D219	(C19 F215)	7	23	7	1	2	40	381,328	T5	55.0	VI	VI
60	D220	(A1 D221)	4	52	6	2	0	64	610,125	T5	78.0	VI	VI
61	D221	(A1 C21)	7	95	16	1	2	121	1,153,518	T4	149.5	VI	VI
62	D222	(D221 E217)	11	118	19	0	0	148	1,410,914	T4	176.5	VI	VI
63	D224	Near B3	6	67	6	0	0	79	753,123	T5	88.0	VI	VI
64	D237	Near D223	8	14	8	0	0	30	285,990	T5	42.0	VI	VI
65	D242/1	Near C30	3	13	4	0	0	20	190,664	-	26.0	VI	VI
66	D244	(C27 E136)	6	14	3	0	0	23	219,264	-	27.5	VI	VI
67	D245	(B1 E129)	14	46	10	3	1	74	705,457	T5	97.5	VI	New III
68	D246	(Bondo E126)	16	101	18	2	5	142	1,353,715	T4	179.0	VI	New III
69	D247	(C29 E382)	7	35	4	1	2	49	467,127	T5	59.5	VI	VI
70	D248	(B1 E382)	8	60	5	0	2	75	714,990	T5	84.5	VI	VI
71	D249	Near E138	11	27	5	2	0	45	428,994	T5	57.5	VI	VI
72	D250/251	(D251 E146)	7	38	5	1	5	56	533,859	T5	71.0	VI	New III
73	D253	Near C30	2	27	6	0	16	51	486,193	T5	76.0	VI	VI
74	D256	(D257 C30)	12	24	4	1	1	42	400,395	T5	51.5	VI	New III
75	D257	Near E155	4	13	4	1	2	24	228,797	-	34.5	VI	VI
76	D260	(D266 E292)	27	92	8	0	3	130	1,239,316	T4	145.0	VI	VI
77	D261	Near C33	330	709	252	23	11	1385	13,203,486	T4	1831.5	II	IV
78	D263	Near D262	13	17	3	0	0	33	314,596	T5	37.5	VI	VI
79	D266	(C41 D260)	31	86	21	1	0	139	1,325,115	T4	173.0	VI	VI
80	D267	(C40 F237)	13	36	9	1	3	62	591,059	T5	81.0	VI	VI
81	D267	Near E313	24	47	5	9	1	86	819,855	T5	117.0	VI	VI
82	D273	Near B1	15	2	0	0	0	17	162,064	-	17.0	VI	VI
83	D276/5	Near A104	14	22	20	3	0	59	562,459	T5	96.5	VI	VI
84	D283	Near B2	29	99	31	0	1	160	1,525,312	T4	209.5	IV	VI
85	D284	(C44 F307)	5	32	8	4	0	49	467,127	T5	71.0	VI	VI
86	D288	(A104 D304)	14	67	3	0	1	85	810,322	T5	90.5	VI	VI
87	D291	(C37 E289)	13	70	5	0	1	89	848,455	T5	97.5	VI	VI
88	D292	(A1 D291)	47	100	15	1	11	180	1,715,977	T4	216.0	IV	IV
89	D293	(C34 A1)	9	37	4	2	0	52	495,727	T5	63.0	VI	VI
90	D299	Near A1	56	144	11	2	7	225	2,125,904	T4	251.5	II , III	IV
91	E109	Near C18	0	16	0	0	0	16	152,531	-	16.0	VI	VI
92	E117		0	4	0	0	0	4	38,133	-	4.0	VI	VI
93	E118												New III
94	E127	Near C27	0	6	2	0	0	8	76,266	-	11.0	VI	VI
95	E140	Near D249	0	4	0	0	0	4	38,133	-	4.0	VI	VI
96	E157	(D256 C31)	9	16	5	4	0	36	343,195	T5	53.5	VI	VI
97	E206	Near A1,D202	4	40	4	0	0	48	457,594	T5	54.0	VI	VI
98	E211												VI
99	E212	Near D216	0	6	2	0	0	8	76,266	-	11.0	VI	VI
100	E231	(C19 C39)	38	63	17	8	2	128	1,220,250	T4	175.5	VI	VI
101	E248	(D311 C34)	29	40	12	2	9	92	877,055	T5	124.0	VI	VI
102	E299	(A1 D260)	7	23	3	0	0	33	314,596	T5	37.5	VI	VI
103	E385		3	12	2	0	2	19	181,131	-	24.0	VI	VI

Note: Type IV is applied to Class D roads having the large number of standard axles and heavy traffic.

Chapter 5

Road Maintenance Improvement Plan

Chapter 5 Road Maintenance Improvement Plan

5.1 Principal Policy for the Future Road Maintenance Plan

This chapter discusses and prepares a road maintenance plan and its implementation programme.

As reported in Chapter 2 and 3, the suspension of and/or delay in daily maintenance activities has resulted in the deterioration of the road network, and thereby increasing constraints to road users. Road maintenance work needs sustainability and the importance of sustainability in road maintenance work have been recognised as a key factor in the Road Maintenance Initiative (RMI, refer to Section 2.6), which has been undertaken in the past by the Government, the World Bank, and other donors.

Sustainability in road maintenance is required in the following areas:

1. Financial arrangement for full budget preparation;
2. Institutional capacity building with a view to respond to road maintenance requirements from all stakeholders;
3. Maintenance methods and technology development to meet the above requirements at the maximum effectiveness and efficiency;
4. Human resource development to train the staff, the public and the private sectors;
5. Information system development for road maintenance management; and
6. Policies to support construction industry development.

The above described maintenance sustainability will be considered in terms of external, institutional, and technical factors. The Road Maintenance Fuel Levy is an existing external factor to secure financial sustainability. The Road Board Act, that is now under deliberation, will be a principal institutional policy to review the maintenance organisation and its functions. Under this policy, MOR&PW is expected to be reformed into a Road Agency. These will be a precondition for the road maintenance improvement plan. The on-going Roads 2000 Maintenance Programme will be an actual road maintenance strategy. The Labour Based Methods proposed in the Roads 2000 Maintenance Programme are technical factors and will be developed in the road maintenance

improvement plan of the Study taking into account private sector involvement and construction industry development.

In addition, a new policy framework for commercialisation and privatisation is also proposed in the Study in order to achieve maximum effectiveness and efficiency, which should respond to road users' requirements.

Table 5.1.1 summarised major planning issues for the road maintenance improvement plan.

Table 5.1.1 Major Planning Issues for Maintenance Improvement

Factors / Issues	Technical Improvement	Institutional Improvement	External Factors
Current Policies	- Labour Based Methods - Contract Maintenance	- Roads Board & Road Agency	- Maintenance Fuel Levy Fund
Sustainability	- **Establishment of road inventory system** - **Total maintenance management** - **Appropriate technology development**	- New role of MOR&PW - **Rearrangement of equipment workshop** - **New relation between PWO & DWO**	- Structural reform
Commercialisation /Privatisation	- **Construction industry development**	- MTD privatisation	- Structural reform
Accountability/ Transparency	- **Community participation** - Computerised information system	- **Public involvement**	- Definite allocation method with clear priority
Human Resource Development	- **Private sector training** - **Total maintenance training**	- **Contract training**	- **Planning training**

Note: Items in bold letter are proposed by the Study

5.2 New Road Inventory System

(1) Phased improvement plan

The provision of a well-developed road inventory is basic information needed for establishing a road maintenance system. The current road inventory used in MOR&PW is a very simple one lacking needed information such as kilometre posts, grade of current surface condition and the past record of maintenance.

In this context, the following steps are recommended:

a. To establish a database system for recording road maintenance and repair works with a job scope and cost,

b. To develop and apply the World Bank initialised Highway Design and Maintenance (HDM) system for planning maintenance according to the site

monitoring and experiences instead of current maintenance budget preparation.

c. To carry out monitoring of periodical road conditions for carriage way, off-carriage way and structure in order to focus on the road deteriorating conditions and budget preparation for preventive maintenance.

For the above objectives a phased improvement plan is proposed for the following four stages.

a. Phase I: Kilometre posts installation and upgrading of the inventory capacity by identifying the types of damage through a road and pavement condition survey.

b. Phase II: Evaluation for specifying the repair jobs needed and prioritisation of the repair works.

c. Phase III: Examining future rehabilitation needs using the road conditions survey.

d. Phase IV: Establishing a preventive maintenance and road security system against disaster.

1) Phase I: Damage inspection

Visual inspection will be introduced to record road and pavement damages on a standard inspection report. The senior engineer will decide the contents of works for repair and maintenance by using this inspection report. Kilometre posts will be installed to facilitate the road conditions survey on class A, B, C roads at first.

Staff training and budget preparation as well as minimum logistic supporting facilities such as inspection vehicles and a computer reporting system will be required.

2) Phase II: Road and pavement conditions inspection

Measurement of road and pavement damages will be introduced. A site inspector will decide the scope of urgent repair and select appropriate detailed survey, if necessary.

A scope of repair work and further investigation will be recorded on the inspection report. Visual inspection training will be introduced to judge

pavement conditions so as to decide International Roughness Index (IRI) and to point out sections for further detailed inspection.

3) Phase III: Planing maintenance

Future repair and maintenance work will be predicted according to International Roughness Index (IRI). Preventive maintenance will be initiated by applying HDM.

Pavement deterioration will be measured by proper equipment and further visual inspection training will be carried out by using the calibration from the results of this mechanical measurement and that of visual inspection.

Site trial construction and monitoring will be introduced to develop experimental formula for predicting pavement deterioration for each specific climate area. Applicability and viability of the above formula will be tested at the site.

Future maintenance work will be estimated and budget preparation will be made.

4) Phase IV: Preventive maintenance

Geographic Information System (GIS) database will be introduced both for road conditions and for immediate investigation of damages and prompt actions against countrywide disasters. Further road inventory for the total road network of 150,600 km will be carried out using GIS. In particular unclassified roads in remote areas will be recorded.

Japan and other ODA donors have to be co-ordinated to establish a GIS standard for sustainable road maintenance. Jomo Kenyatta University, the Survey of Kenya, and other institutes will contribute to develop appropriate road inventory and maintenance system with GIS.

(2) Road Inventory Form and Inspection Manual

The current road inventory has no data and information on road conditions except distance and road pavement type. A road inventory manual including inspection form is proposed and attached in Appendix 5.1.

The process of proposed road inventory and maintenance work is explained below in accordance with Fig. 5.2.1.

a) Routine and Periodic Survey

Routine and periodic surveys are to find damages on roads and pavement. Survey parameters are mentioned in a proposed inventory form. If there is no damages found, it is recorded in a database of the data bank.

b) Analysis on Damage

The damages found are categorised and analysed by types of road deficiencies for the next actions. For categorising damages, it is proposed to use a "OECD Catalogue of Road Surface Deficiencies".

c) Necessity of Urgent Repair

If the damages are judged for immediate dangers to the traffic safety or causes of serious damages, urgent repairs will be carried out without waiting. A senior engineer will specify and carry out repair jobs using his force account or the contractor as emergency.

d) Evaluation of Maintenance and Repair Works

After the completion of emergency operation, the Engineer will decide whether rehabilitation work is needed on this spot. If required, appropriate detailed survey and investigation that the Engineer selects will be carried out and the scope and work time will be decided. Pavement assessment by International Roughness Index (IRI) and structure assessment will be made in order to judge the scope and timing of repair. If the damage is judged to be repaired now, the Engineer selects maintenance operations or repair works. If the maintenance are enough to prevent the further damages, the maintenance will be made, while if the repair is needed, the Engineer will plan and decide the scope and timing of work. After the design, maintenance and repair works will be implemented.

e) Recording

All road conditions, repair works, and maintenance operations will be recorded in the data bank, on which road maintenance information system is established.

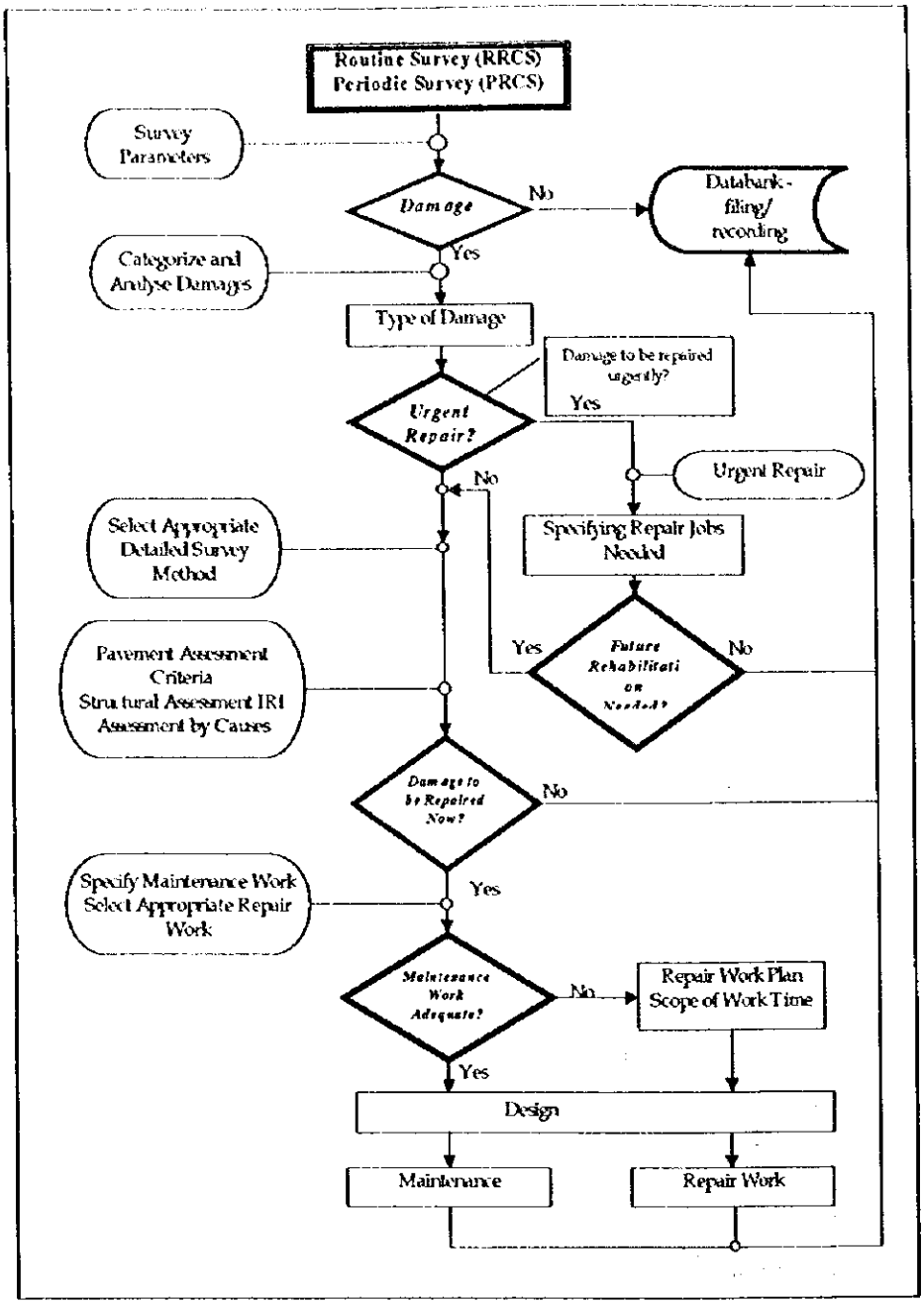


Fig. 5.2.1 Road Conditions Survey and Maintenance Flow

(3) Training

The training for road inventory system will be provided to the District Road Engineers and the Field Inspectors regarding the following items.

1) District Road Engineer

a. Road monitoring system.

b. Classification of road sections and sub-sections for inspection and maintenance purpose and processing of the results.

c. Organising of field survey by using the proposed form and the inspection manual.

d. Use of the damage catalogue and analysis the results.

e. Assessment of the road damages and design and supervision of repair work.

f. Processing of these data to develop a detailed maintenance programme for the short and medium term.

g. Assessment and review of performance of the road inspection system.

2) Road Inspector

a. Need for surveying road sections in general.

b. Structure, layout and use of the proposed inspection form.

c. Use of the inspection manual and the damage catalogue.

d. How to complete the forms and deal with potential problems.

e. Use of equipment required for the road condition survey and detailed visual inspection.

f. Reporting system of inspection results.

5.3 Improvement of Maintenance Activities

5.3.1 Maintenance Activities

(1) Classification of Maintenance Works

It is substantial and urgent to establish comprehensive road maintenance system to meet requirement for the future road maintenance. In this context,

maintenance activities should be clearly categorised into three work groups: routine maintenance, periodic maintenance, and special works. These are summarised in Table 5.3.1, 5.3.2, and 5.3.3 respectively, below. The routine maintenance needs to be undertaken each year. The periodic maintenance is undertaken at intervals of several years. The special works are those whose frequency cannot be estimated with certainty in advance, and are planned to be undertaken for research and training purposes for new maintenance method. These maintenance activities will be defined below by work definitions, budget type based on in-house and contract out method, work type description, and work activities for on-carriageway, off-carriageway, and structure.

1) Routine Maintenance

The routine maintenance is divided into two works types; cycle and reactive works. The cycle works are schedule works whose needs are dependent on environmental effects rather than traffic, while the reactive works are responding to a combination of traffic and environmental effects. The major cycle works are to clear side drain, to cut grass and bushes, and to clean culverts which will be done by labourers or a length person. The reactive works are cracking sealing, patching, and edge repair, which need more technical skills and proper tools and materials.

Table 5.3.1 Routine Maintenance Activities

Works Category	Routine	
Work Definition	Works that may need to be undertaken each year	
Budget Type	Normally recurrent budget	
Works Type	Cycle	Reactive
Description	Schedule works whose needs are dependent on environmental effects rather than traffic	Works responding to minor defects caused by a combination of traffic and environmental effects
Examples of Work Activities	Vegetation control Clearing side drains Clearing culverts	Cracking sealing Patching Edge repair
On carriageway		R8:Fill potholes and rut R9:Grub edge & reshape
Off carriageway	R5:Clean side drains R6:Repair scour checkes & side drain erosion R10:Cut, Grass, side drain	R6:Repair scour checkes & side drain erosion
Structure	R2:Clean culverts, inlets,outfalls R4:Clean mitre drain	R3:Repair culvert stone headwalls

Source: Development form *Road Maintenance Management* , R.Robinson et al, 1998
Note: R2-R10 activites are introduced from Road 2000 Maintenance manual

2) Periodic Maintenance

The periodic maintenance is divided into works of preventive, resurfacing, overlay, and pavement reconstruction. The preventive work entails the addition of a thin film of surfacing to improve surface integrity and waterproofing, but this work does not increase the strength of the pavement. The major activities are fog seal and slurry seal for bituminous surface rejuvenation in order to prevent further deterioration of the pavement. The resurfacing work is, in addition to the preventive work, to improve skid resistance. The overlay work is an addition of a thin layer to improve structural integrity and to increase the strength of the pavement. The major activities are regravelling on unpaved roads and DBST* on paved roads in the rural roads. The pavement reconstruction work is rehabilitation work that removes a part or the entire existing pavement and the addition of layers to restore or improve structural integrity and to increase the strength of the pavement. The major activities are DBST or Asphalt Concrete reconstruction and surface recycling. The off-carriageway and structures will be rehabilitated under this maintenance work.

Table 5.3.2 Periodic Maintenance Activities

Works Category	Periodic			
Work Definition	Planned to be undertaken at intervals of several years			
Budget Type	Typically recurrent or capital budgets			
Works Type	Preventive	Resurfacing	Overlay	Pavement Reconstruction
Description	Addition of a thin film of surfacing to improve surface integrity and waterproofing that does not increase the strength of the pavement	Addition of a thin surfacing to improve surface integrity and waterproofing, or improve skid resistance, that does not increase the strength of the pavement	Addition of a thick layer to improve structural integrity and to increase the strength of the pavement	Removing of part or all of the existing pavement and the addition of layers to restore or improve structural integrity and to increase the strength of the pavement
Examples of Work Activities	Fog seal/surface rejuvenation Slurry seal	Single surface dressing Porous asphalt Thin overlay	Dense-graded asphalt overlay Bonded concrete overlay Regravelling unpaved	Road cutting and replacing Full pavement reconstruction (asphalt or concrete)
On carriageway		SBST	L4:Regravelling DBST	DBST/AC reconstruction Surface recycling
Off carriageway	*Applied as Routine Maintenance*	*Applied as Routine Maintenance*	*Applied as Routine Maintenance*	Rehabilitation of all drainages and slopes
Structure	*Applied as Routine Maintenance*	*Applied as Routine Maintenance*	*Applied as Routine Maintenance*	Rehabilitation of all structures

Source: Development form *Road Maintenance Management*, R Robinson et al, 1998
Note: R2-R10 activities are introduced from Road 2000 Maintenance manual

* SBST and DBST are Single and Double Bituminous Surfacing Treatment

3) Special Works Maintenance

The special works have two categories; the unscheduled works such as emergency and rainy season and the scheduled maintenance training. As for the emergency and rainy season works, their frequency cannot be estimated with certainty in advance, while the maintenance training is planned to provide training of the actual maintenance activities and new methods for the staff. This special works for training will be carried out on a daily basis and be prepared to mobilise for the emergency and rainy season maintenance works.

The emergency work is to be undertaken to clear a road that has been cut or blocked by removing traffic accidents, remaining debris, and washout repairing. The rainy season maintenance work is activities to be undertaken to open a road that has been cut or blocked during rainy season by removal of obstacles, and spot repairing and improvement.

Table 5.3.3 Special Works Maintenance

Works Category	Special works		
Work Definition	Frequency cannot be estimated with certainty in advance		*Planned to be undertaken for research and training purpose for new maintenance method*
Budget Type	*Special allocation in recurrent budget for emergency work*	*Special allocation in recurrent budget for opening in rainy season*	*Typically special funds, but recurrent budget*
Works Type	Emergency	*Rainy Season*	*Training*
Description	Works undertaken to clear a road that has been cut or blocked	*Works undertaken to open a road that has been cut or blocked*	*Works planned and undertaken to reserch and train for introducing new maintenance method*
Examples of Work Activities	Traffic accident removal Clearing debris Repairing washout	*Removal of obstacles* *Spot Repair/improvement*	*Upgrading and maintenace training* *Cost saving maintenance* *New pavement materials*
On carriageway			
Off carriageway			
Structure			

Source: Development form *Road Maintenance Management*, R.Robinson et al, 1998
Note: R2-R10 activites are introduced from Road 2000 Maintenance manual

(2) Total Maintenance Management

The main objective of the total maintenance management is to manage contracting-out and in-house maintenance works. Contracting-out maintenance system has been developed firstly in periodic maintenance of which the scope of work and the cost are easily decided. Then the contract maintenance is developed for routine maintenance for off-carriageway by LBM. It is recommended to apply the contracting-out system to main maintenance operations excluding part of routine work on carriageway in order to meet the following requirement:

-Reduction of employees to meet the structuring reform of the government

-Privatisation for efficient road maintenance works

-In crease of efficiency of road maintenance work

However, as mentioned in Special Works, in-house operation or force account must be kept for the security of traffic and emergency of operation. The scopes of contract works and in-house operations for maintenance activities in operational function of DWO are summarised in Fig. 5.3.1.

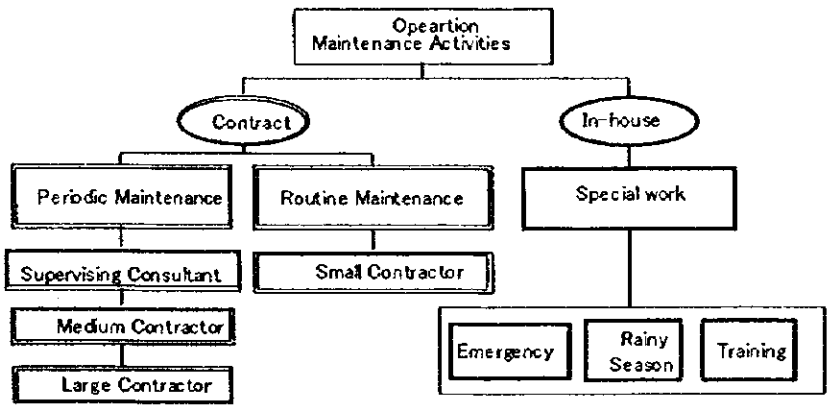


Fig 5.3.1 In-house and Contract-Out for Maintenance Activities

(3) Maintenance Activities Improvement

As mentioned in Chapter 2 and 3, the method and operation of the present maintenance activities are required to immediately improve in order to attain the cost effective and sustainability.

1) Temporary Repair to Permanent Work

In reply to emergency needs to deal with public traffic just after the rainy season, current spot repairs are carried on a temporary basis using unsuitable soils and improper work methods due to financial and technical constraints. During the rainy season, the same spots, where the critical and weak areas exist, become easily impassable and finally close to the traffic again.

In order to avoid the frequent repair, proper permanent works on the above spots must be introduced using the Labour Based Methods (LBM) with suitable equipment and materials. It must be understood that LBM does not mean poor technology, but more careful basic engineering and artisan skills are required for sustainable maintenance. For depression areas, the following permanent works must be applied.

i) Installing of a crossing culvert (critical material) to evacuate stagnant water to lower laying areas.

ii) Embankment with suitable materials, having sufficient height to avoid infiltration water coming up, and sufficient compaction by a hand tamper, an engine tamper or a hand roller. On the weak soil foundation, a net of tree branches or sand matting will be laid at the bottom of the embankment before the filling starts.

iii) Construction of sufficient long side ditches to evacuate the running water through crossing culvert. If the slope is considered so steep that it will erode the bottom of the ditches, stones and gravel, or tree stop should be installed.

2) Routine inspection for preventive maintenance

Routine inspection is planned to find any new damages on the above repaired spot to keep the road passable in all weather particularly before and during the rain season. Daily road conditions inspection will be carried out to find emergency, potholes, and washed away spots in order to prevent further damages.

3) Periodic maintenance for carriage way

Inspection will be carried out to count the number of potholes per km. in order to judge the timing of resealing and regravelling. Table 5.3.4 gives a temporary indicator for planing a further detailed survey.

Table 5.3.4 Number of Potholes and Pavement Conditions

Potholes per Km.			Condition
0	to	100	: good
100	to	300	: fair
300	to	more	: bad

5.3.2 Maintenance Methods Improvement

(1) Improvement of Labour Based Method

Tendering is proposed to introduce in Labour Based Methods (LBM) instead of mostly direct appointment system in order to solve the current problems of low efficiency of LBM. This will enhance competition in LBM and will create viable system.

Meanwhile labour management is one of the most difficult spheres in which the small scale contractor has limited capacity for management ability and financial capacity. Therefore, the following arrangements are recommended in the tendering preparation.

a. To minimise the size of the contract to limit the number of labourers under one contract, to be suitable to the small-scale contractor's capacity.

b. To protect worker's rights by enhancing labour laws and regulations. In case of a delay in payment, not only the contractor but also the client should have legal responsibility against the employee's claim. If the delay is due to negligent payment conditions in the maintenance contract by the Client, the Client must pay claim charges.

c. To prevent delayed payment, the Contract should proceed after the budget arrangement.

d. Decentralisation of the payment system to the local contracts should be introduced to prevent administration delay.

(2) Combination of LBM and Equipment Method

The Labour Based Methods have been applied in Kenya for a long time due to lack of equipment to meet the road maintenance requirements, and promotion of community participation in order to create job opportunities in the rural areas has also been introduced. However, this method faces a turning point, since minimum labour wages are rising to 135Ksh./hour, which results in an increase

of road maintenance costs by the Labour Based Methods. According to the Roads 2000 Maintenance Programme, the Labour Based Methods are recommended in combination with the use of a minimum of equipment such as small rollers but only in the case in which it is economically viable. However, even the Labour Based Methods recommended by the Road 2000 Maintenance Programme face still problems: it takes too long time to complete the necessary maintenance work, and the quality of works sometimes does not meet the required standard.

A combination of not minimum but proper equipment, such as bulldozers and graders, in combination with the Labour Based Methods should be, therefore, taken into account in order to effectively and economically meet the road maintenance requirements and also in order to keep the engineering quality of the maintenance works as a stable level.

(3) Establishment of Regional Equipment Centre

Many District Work Offices (DWO) receive only one grader by discomposing a complete fleet of road improvement and maintenance equipment in accordance with a scheme of distributing available maintenance equipment for each DWO equally. It is important to consider size and composition of mechanical maintenance fleet. Distribution of one or two motor graders to each DWO is not recommended. In addition, only a few and key District Mechanical Workshops (DMWs) have mechanical workshops and technicians at present, while others have neither workshops nor mechanics and the equipment management becomes worse than before.

In the present hiring system, MOR&PW has all maintenance equipment in Mechanical and Transport Department (MTD). MTD distributes the equipment to Provincial Mechanical Workshops (PMW) and District Mechanical Workshops under Mechanical Engineers. Roads Departments in the Provincial and District Works Office borrow the equipment for their maintenance operation. Recently the private Contractors are also allowed to borrow MTD equipment.

Contracting-out for all major maintenance works becomes inevitable through the forthcoming structuring reform of MOR&PW under privatisation climate except for special works including emergency work that will remain as in-house work as force account. In this end, marginal equipment has to be provided to DWO.

In order to progress the privatisation of MTD, it is proposed that all PMW and DMW equipment will be integrated into Regional Equipment Centres (RECs). The REC will provide necessary equipment both to the private Contractors and the DWO and PWO on rental base. The PWO and DWO use vehicles and equipment for their in-house routine patrol, supervision, and special maintenance.

Regional Equipment Centres (RECs) in key districts will be established to cover 14 districts (Busia, Siaya, Kisumu, Homa Bay, Migori, and Kisii). These RECs will facilitate to become area branches of equipment rental pool for the regions.

(4) Research and Development

To research and develop appropriate pavement structure is vitally important both for heavy loaded trunk highways and for less traffic feeder roads in terms of cost savings and life extension. Long-term monitoring on pavement behaviour will be introduced in co-operation with public-academic-private consortium. The Material Testing and Research Department (MTRD) is proposed to have responsibility of these matters.

However, the staff and the facilities concentrate on conventional quality control of the roadwork. MTRD lacks sufficient capability in Research and Development (R &D). Under the privatisation, their laboratory intends to enter a market of conventional services undertaken by private consultants and commercial testing laboratories. This policy is not recommended because local consultants market is still too small. MTRD should be involved in more activities of R & D.

In addition, MTRD need to play a role in co-ordinating an academic research centre with the universities and institutions not only in Kenya but also other international R & D institutes.

(5) Prioritisation of Maintenance Work

For the Roads Board, they need clear criteria of utilisation of the Fund by the defined priority. However, prioritisation methods of road maintenance, in particular, rural roads having less traffic volume, need to be developed taking specific social conditions and local economic environments into consideration. Appropriate planning and programming methods have to be developed with a

consortium of engineers, economist, sociologist, and environmentalists to meet the nation wide requirement for road maintenance.

For national road network undertaken by MOR&PW Headquarters in Nairobi, the prioritisation method is based on a cost-benefit analysis that takes prediction method of pavement deterioration into account.

In terms of rural roads, this cost-benefit analysis in deciding the priority on maintenance is inadequate since traffic volume on rural roads is as small as 200 vehicles per day on average. More simple method, accessibility index analysis and the routes to contribute to local economy enhancement, is available to decide the road maintenance priority in place of cost-benefit analysis (refer to section 4.3).

As for maintenance works, the priority puts on the following types of maintenance works to secure smooth traffic with less maintenance costs.

- Emergency work (emergency repairs to blocked and impassable roads)
- Cyclic drainage work (roads are seriously and easily deteriorated by damaged drainage system)
- Reactive work on pavement (patching and local sealing)
- Periodic preventive and resurfacing work (resealing)
- Other cyclic and reactive work
- Periodic overlay

(6) Introduction of Computerised System

1) Current Tendency

MOR&PW has intention to introduce computerised system for road maintenance: Maintenance Management Information System (MMIS).

Maintenance Management Information System (MMIS) belongs to total Highway Management Information System (HMIS) that has been tried to establish nation-widely through ministerial LAN by MOR&PW as shown in Fig 5.3.2.

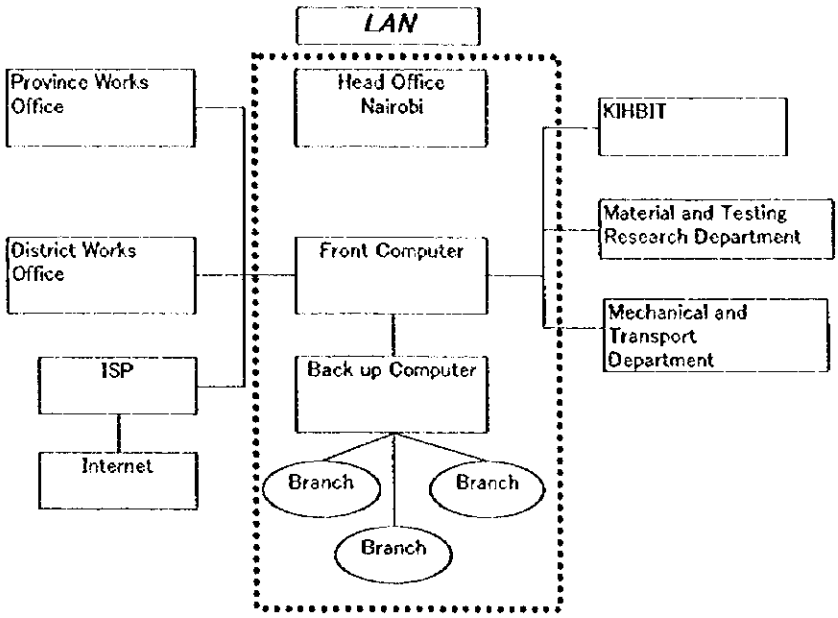


Fig. 5.3.2 MOR&PW LAN Concept

2) Currently Proposed Components of Subsystem

MOR&PW proposed to complete improvement of Highway Management Information System (HMIS) for integrating all road and maintenance data and information into computerised database in Nairobi. Fig. 5.3.3 shows the proposed concept of HMIS. HMIS consists of the following 15 subsystems as follows.

a. Road Inventory System: Recording and updating all relevant road inventory information.

b. Auto Cad Design System: Design of roads and bridges. Mapping and storage of design data and drawings for designs of a project.

c. Highway Maintenance Management System: Management and monitoring of all roads maintenance both for paved and unpaved.

d. Pavement Management System: Managing paved road information, planning, predicting, future expansion and maintenance for the paved road network.

e. Material System: Managing information of materials and material testing for roads, etc.

f. Road Safety System: Managing road safety, traffic counts, and axle load information.

g. Geographic Information System: Storage of the national road network's spatial information linked to the HMS road inventory database. Producing of maps by GIS.

h. Planning System: Economic evaluations of capital investment in road construction, rehabilitation and maintenance, using the HDM IV, HMS, Equipment Management System (EMS) and other programmes for road planning.

i. Contract Management System: Managing information on construction projects, records of contractors, consultants and project payments etc.

j. Donor Road Sector Secretariat: Manage information on donor assistance for the road sector.

k. Personnel System: Managing records of all roads and ministry staff resources.

l. Equipment Management System (EMS): Managing information of materials and material testing for roads etc.

m. Building Management System: Management of information both on government owned and on leased properties.

n. Financial System: Monitoring of financial transactions for all projects in the roads department.

o. Provincial / District Reporting System: Collecting road maintenance data from the districts and sending the same to the central database system in HMS.

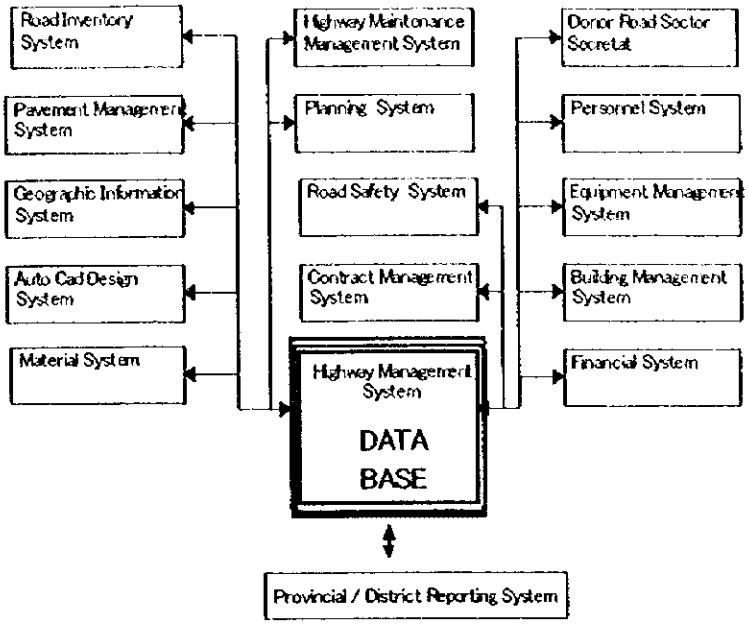


Fig. 5.3.3 Highway Management Information System

The computerised system mentioned above can cover all the road-related information required by users and MOR&PW. However, considering that it will take much time to complete all the comprehensive system, priority on development of the system becomes important. In this view, establishment of basic system such as road inventory system, traffic safety system, and contract management system should be developed in advance.

5.4 Institutional Improvement

5.4.1 Roads Board Act and New Agencies

(1) Roads Board Act

The Government of Kenya intends to create the Roads Board and the Road Agency under the Roads Board Act, which aims to meet the requirements of the road users and other stakeholders. A target for these institution building is to form efficient and effective organisation based on the current policy of commercialisation of the public services and works, which GOK and the World Bank have set forth.

Planning & programming, of which the planning branch is in charge, and preparation & operation, of which the feeder road and trunk road branches are in charge, have a new relationship under the Roads Board. The feeder rods and trunk road branches will offer road maintenance works according to maintenance plans that will be proposed by the planning branch with approval of the Roads Board. Fig. 5.4.1 shows New Relationship.

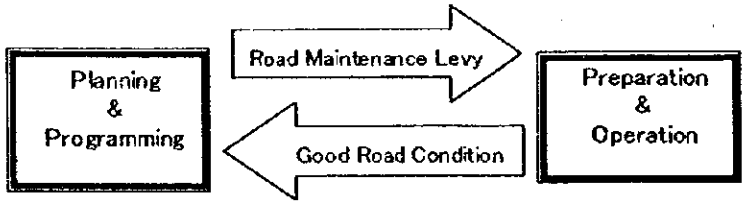


Fig. 5.4.1 New Relationship

(2) Roles of Roads Board and Road Agency

1) Functions and Responsibility

The establishment of the Roads Board is under deliberation in the Parliament and enactment is expected soon. One of the most important functions of the Roads Board is to decide on appropriate use of the Roads Maintenance Fuel Levy Fund, which is tax earmarked for road maintenance, and to monitor the road maintenance activities by this fund. Proper and transparent road maintenance budget allocation can also be expected after the establishment of the Roads Board. In this regard, public involvement as board members of the Road Board is significant.

When establishing the Roads Board, major parts of the Road Department, Material Testing and Research Department, and Kenya Institute of Highway and Building Department of Ministry of Roads and Public Works (MOR&PW) will be converted into Road Agency. The Mechanical and Transport Department will be privatised as a lease firm of construction equipment.

The Road Agency is to concentrate on road maintenance of the classified roads in order to effectively and promptly carry out the actual road maintenance works to meet national requirements that provide well developed basic infrastructural facilities in the whole of Kenya.

Taking advantage of this system, the following relationship between the Roads Board and Road Agency is proposed (see Fig. 5.4.2):

- The Roads Board requests the Road Agency to maintain the classified roads according to a road maintenance plan, which will be established by the Roads Board based on the necessary budgetary allocation.
- The Roads Agency implements the required road maintenance efficiently and effectively.

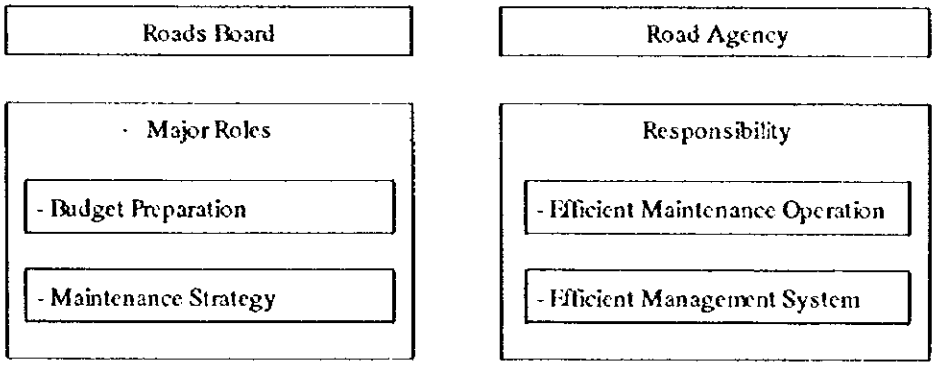


Fig 5.4.2 Relationship of the Roads Board and the Road Agency

2) Proposed New Relations between Roads Board and MOR&PW

The new relations between the Roads Board and MOR&PW under the new organisation of Road Agency are illustrated in Fig. 5.4.3. In these relations, the new planning division will function as a secretariat in the Roads Board in order to prepare the actual plan and programme for practical road maintenance. The plans will be transformed into the defined road service levels and

maintenance requirements for the Road Maintenance branches in the MOR&PW.

The Material Research and Testing Department will have more responsibility in road maintenance quality and introduction of cost saving pavement design and structure.

The Mechanical and Transport Department will be an independent commercialised organisation, financially autonomous of the Roads Department and provide equipment required for road maintenance on a cost compensating rental basis to MOR&PW and private contractors.

The Kenya Institute of Highway and Building Technology will be a more competent training centre in order to cover the areas of planning and programming, and computer training for Maintenance Management Information System (MMIS).

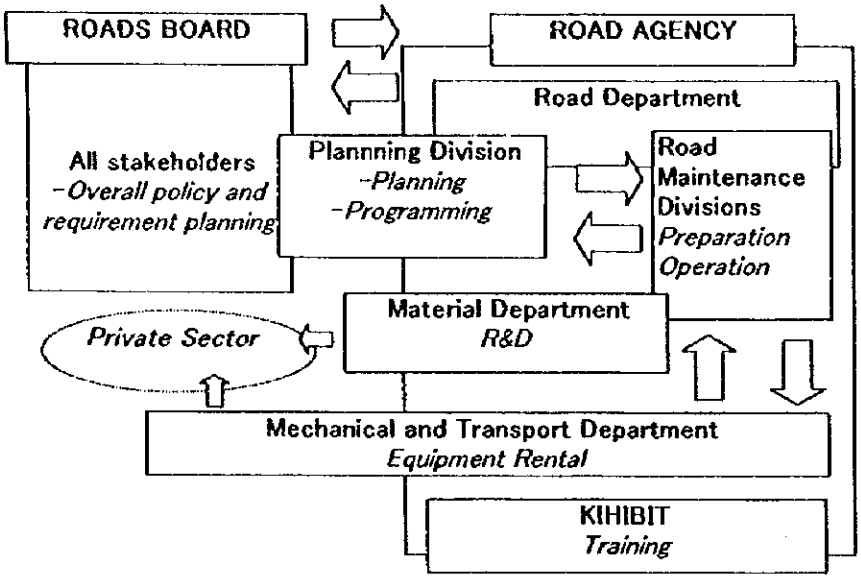


Fig. 5.4.3 New Relations of Roads Board and Roads Agency

5.4.2 Provincial and District Works Office Structure

(1) Provincial Works Office

At present, there is no clear goal of institutional improvement established for the Provincial Works Office (PWO). PWO has no planning and programming section so far. Maintenance work is expected to increase in future, and a quick response will be required to keep the level of service of the roads for users. In addition, prioritisation of maintenance works will be required as well.

It is proposed that PWO add the function of planning and programming in order to cope with road maintenance and upgrading requirements. Bituminous road maintenance is under the responsibility of PWO according to the current demarcation. However, the current maintenance process is not able to completely meet effective maintenance works. District Works Offices (DWO) have much local information on the current conditions of roads including bitumen standard. They inform about the necessity for repairs of the bituminous roads to PWO but the response is often delayed and the timing is inadequate.

Table 5.4.1 shows an immediate proposal for the demarcation between PWO and DWO on bituminous road maintenance. The major points of the proposal are as follows:

- DWO has responsibility for patching work in routine maintenance works,
- PWO has responsibility for surfacing in periodic and special maintenance works, and
- Special work is done in co-operation by both PWO and DWO.

Table 5.4.1 Bituminous Road Maintenance

Present				*Proposed*			
	PWO	DWO			PWO		DWO
Routine	◎	X	⇒	Patching	X	←— <report>	◎
Periodic	◎	X		Sufacing	◎	← <request>	X
Special	◎	X		Special	◎	↔ <coordinate>	○

(2) District Works Office Structure

1) Structure by Roads 2000 Maintenance Programme

Fig. 5.4.4 and Fig. 5.4.5 show MOR&PW headquarters structure and District Works Office (DWO) structure, respectively.

District Works Offices (DWO) directly operate road maintenance. Improvement of organisational efficiency in DWO is one of the most important tasks. However, a concept of the proposed DWO organisation by the Roads 2000 Maintenance Programme emphasise preparation and operation functions of maintenance activities and the policy of commercialisation is still not clarified.

The proposal for District Works Offices in the Roads 2000 Maintenance Programme has no institutionally clear function for programming, planning, or preparation of maintenance system. In addition, there is no consideration for preparing emergency maintenance and the training function. These functions become more important in maintenance management system under the prospective Roads Board Act. Furthermore, there are not clear demarcation between contract management and in-house operations.

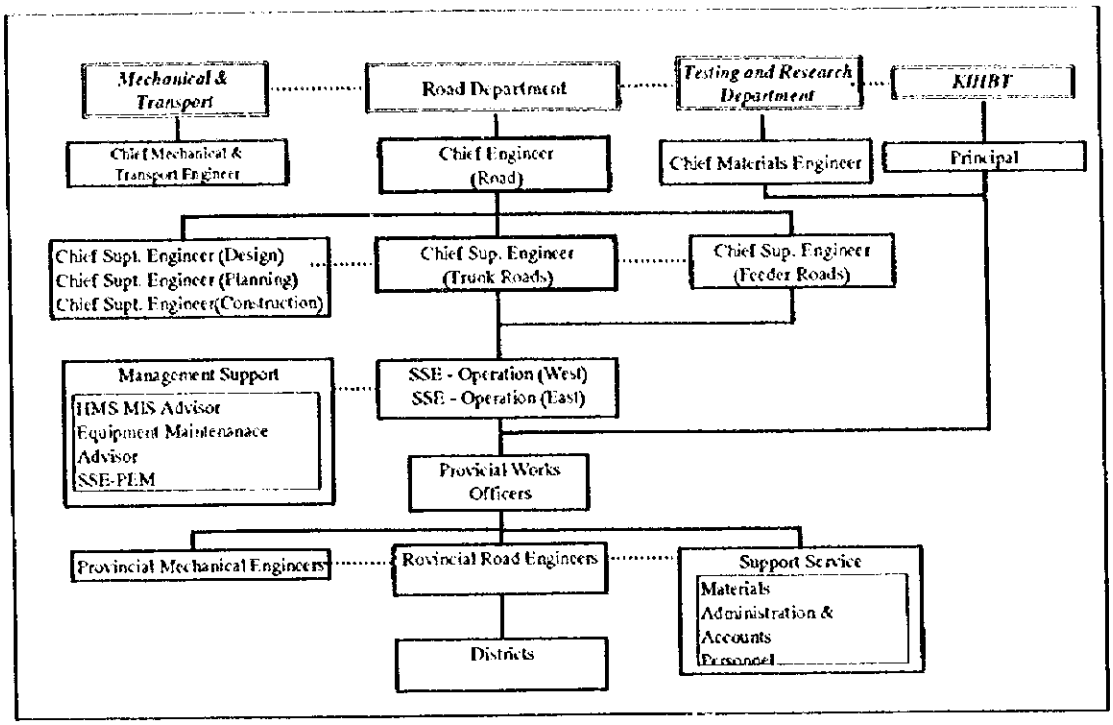


Fig. 5.4.4 Headquarters Structure Proposed for Roads 2000 Programme

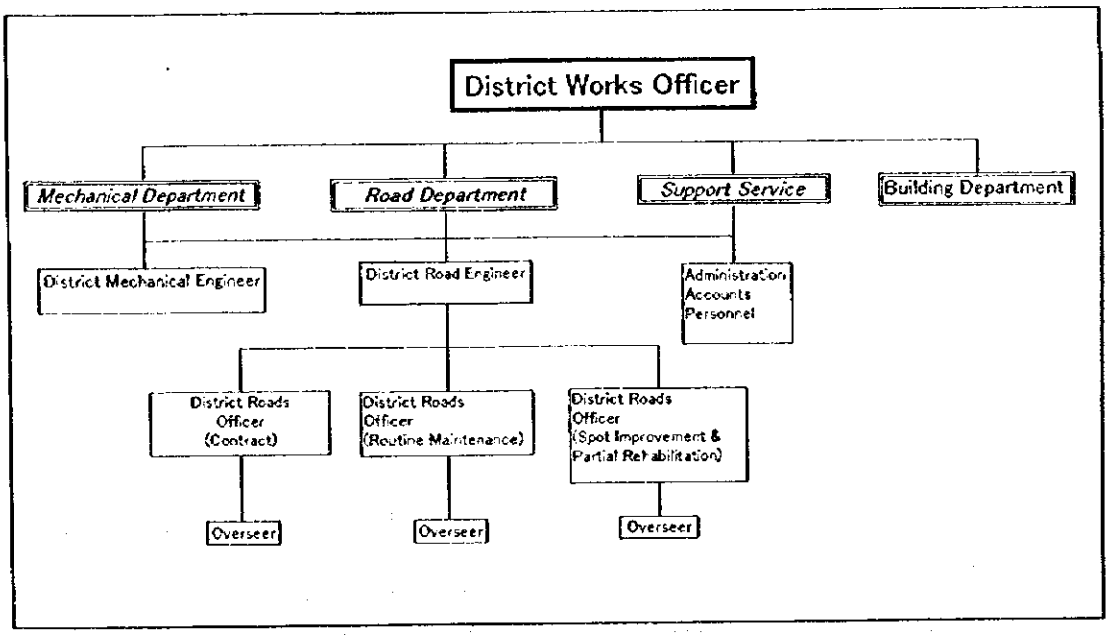


Fig. 5.4.5 District Structure Proposed for Roads 2000 Programme

2) Proposed District Works Office Structure

a) District Works Office

A new concept of District Works Office proposed by the Study, which is shown in Fig. 5.4.6. This organisation has three clear functions: planning and programming departments, tender preparation department and operation department.

In addition, the proposed DWO has sections of contracting-out management and in-house management that the Provincial Road Office will assist and co-ordinate. The contracting-out management system and in-house operation will be applied in each department.

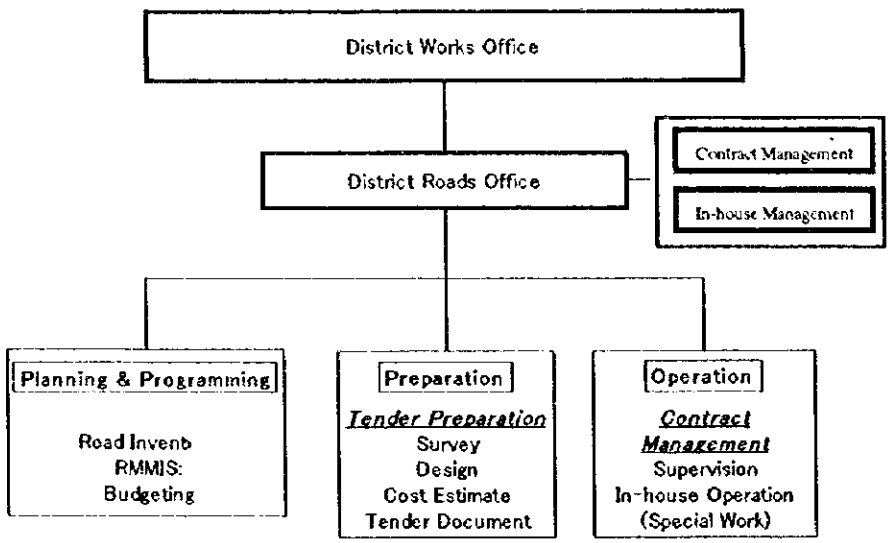


Fig. 5.4.6 Proposed DWO Structure for Rural Road Maintenance

b) Planning and Programming Department

Periodic road conditions survey will be contracted to local survey consultant. On the other hand, the in-house engineer will carry out routine patrol for emergency maintenance.

The results will be collected in the Road Maintenance Management Information System in Nairobi through well-established Wide LAN Network of MOR&PW

in order to proceed to budget preparation using Highway Design and Maintenance Manual (HDM-IV) and other information treatment.

c) District Tender Preparation Department

Periodic maintenance will be contracted out to the large and medium size contractors. For the contract preparation, local consultants will be employed for survey, design, cost estimate, and tender documents preparation. However, the District Engineer will prepare engineering's cost estimate for the tender.

For routine maintenance by the small contractors using Labour Based Method, the in-house engineer will carry out survey, design, cost estimate and tender preparation applying the authorised standard contract.

d) District Operation Department

Under the contract management of the District Engineer, local consultants will supervise the contractors who carry out the periodic and routine maintenance works. On the other hand, the in-house engineers using force account, which should have sufficient equipment, materials, and labours, will carry out Special Works. This will usually contribute to job training for the staff. In the case of maintenance works in emergency and the rainy season, the force account will be shifted for emergency operation.

5.5 Construction Industry Development

5.5.1 Supporting Institutional Arrangement

As mentioned in Chapter 3, the construction industry has shrunk under the current circumstances. In addition, supporting institutional arrangement for the industry is not favourable to overcome the adverse environment.

Since there are no credit system and no equipment rental and leasing system, the construction firms are forced to borrow expensive operating fund at high interest rates and possess equipment that is sometimes idle. This has weakened the market competitiveness and working efficiency of the contractor.

The large contractors are faced with stiff competition from international competitors who have an easy access to more concessive credit facilities. This is a hidden handicap for Kenyan contractors. The middle contractors have difficulty finding credit facilities for tender and performance bonds in the

present credit system and specific equipment in the market. The small contractors have no opportunities to pay wages to the labourers when there are delays in payment from MOR&PW.

It is recommended to introduce supporting institution arrangement in order to ease financial constraints and to enhance maintenance capacity as follows:

1) Level-up of Small and Medium-scale Contractor

Under introducing the privatisation and contract-out maintenance, the contractor's capability becomes more critical matters for road maintenance in terms of the progress and quality of operations. In particular, for rural road maintenance, the small and medium scale contractors carry out actual field operations of periodic and routine maintenance activities. Therefore, they should increase the financial and equipment capacity to complete the maintenance contract together with technical and engineering skills to fulfil instructions of the supervising staff of District Works Office (DWO). The following areas are required to level up.

a. Corporate management skills including human resource management for Labour Based Methods (LBM)

b. Knowledge of road maintenance specification and techniques.

c. Project management knowledge and implementation.

d. Skills of specific areas for construction work such carpenter, iron work, etc.

2) Equipment Rental and Lease Market

The contractors have difficulties in finding equipment for maintenance operations, because there is no equipment rental and lease market in Kenya. This low availability of equipment results in the contractors delay and incomplete contracts. Three alternatives are considered to solve this constraint. The first alternative is enhancement of the force account by MOR&PW. The second alternative is to provide funding system for contractors to purchase necessary equipment. The third alternative is to provide a lease market with equipment. As mentioned before, enhancement of force account is against the prevailing privatisation climate. Although to provide funding system or lease market is considered, attention has to be paid to the privatisation of the Mechanical and Transport Department (MTD), which is one of the department of MOR&PW. Creation of a rental and lease market for road construction and

maintenance equipment is, thus, to meet the solution of the current constraints. The present MTD equipment should be one of the resources for the rental market.

3) Credit facility for Working Capital Fund and Guarantees

Most of the local contractors need easy access to credit facilities such as banks and insurance companies. Generally, they need tender bonds, performance bonds, advance bonds and operating capital in implementation of the contracts. However, the private banks and insurance companies request very high interest rates of over 18% in some case. Many contractors missed opportunities to enter new tenders and sometimes they went bankrupt because of a shortage of operational funds, when their cash flows deteriorated due to the delay of government payments.

Creation of credit corporations and facilities for local small and medium contractors will solve these problems and it will assist to develop the local contractors. This will also create employment opportunities in the rural areas by locally established contractors.

4) Training Needs

Private contractors have currently no training opportunities except for on-the-job construction and maintenance work. For increasing capacity of private sectors in accordance with progress of privatisation, training by KIHBT is helpful as well as the governmental officers. In Kisumu, KIHBT has trained small-scale contractors in co-operation with the Swiss International Development Agency in order to promote the Labour Based Methods. This experience will be expected to medium-scale contractors, where are local key enterprises in the rural areas. They need basic education and training in the fields of total corporate management, quality control and maintenance engineering.

5) Market Demarcation and Tender Policy

In the construction industry development, market demarcation is required in accordance of the size of the contractors as follows.

a. Large Contractor: regional general contractor and export-oriented firms

b. Medium Contractor: district general contractor and specialised contractor

c. Small Contractor: specialised artisan

d. Community Group: LBM contractors based in the rural community.

Currently, the large contractors occupy periodic and rehabilitation of bituminous standard roads in the regional markets, and become suppliers to provide asphalt materials for routine maintenance. Their roles are important. Therefore, regional preference in the maintenance tender is needed.

The middle contractors are district-based firms that carry out mostly regravelling maintenance. However, the contractors from the other districts and provinces come to the district market, which provide a few benefits in the local economy. They need district's tender preference.

All contractors need to improve both corporate management and road maintenance techniques for enhancing their competition. It is recommended creating sub-lets to the higher level of the contractor or joint ventures among the same-scaled firms. This policy should be introduced in the tender conditions of road maintenance with consideration for regional and local preference.

6) Market Information System

Market information has to be released to contractors for creating transparency and more competitions and increasing tender opportunities to contractors. Such system is expected to be developed in future, as a computer system for efficient and effective procurement management to be integrated into the Highway Management Information System (HMIS) of MOR&PW.

5.5.2 Mechanical and Transport Department

(1) Privatisation

Under the current road strategic plan, the Mechanical and Transport Department (MTD) of MOR&PW will be privatised for a commercial equipment rental enterprise. This organisation should assure the operation productivity of rented equipment to the customers and expected to encourage medium and small contractors, which currently have not enough construction equipment. Privatisation of MTD will, without doubt, contribute to creation of lease and rental markets, which have not be recognised in Kenya.

(2) Maintenance of Equipment

1) Unification of Equipment for Easy Maintenance

Various donors provide construction equipment without consideration of standardisation for maintenance equipment. This makes availability of spare parts for the machines worsen as well. Most of the temporal local dealers have no capacity of stocking corresponding to various kinds of spare parts. MOR&PW capacity is also limited to maintain and repair the various kinds of machines, of which makers are different. For efficient use of it, it is recommended that the equipment and machines, of which dealers should full ability for back-up services. In addition, unification of kinds of equipment is desirable for easy maintenance.

2) Importance of Back-up Service

It has become virtually impossible to repair equipment at MOR&PW and local workshops properly because of technological advances. Modern equipment has adapted computerised engines, hydraulic systems, and transmissions. Machine makers train their mechanics at the dealers when equipment modification is introduced. This progress is now too fast for MOR&PW mechanics to catch up with. The role of local dealers has become more important. A credible back-up service system through dealers in the local market must be guaranteed, when new machines are provided.

The most efficient way is to categorise the technical complexity into a number of levels that are suitable for undertaking between MOR&PW and the dealer's workshop. Table 5.5.1 proposes organisation of equipment maintenance and repair.

Table 5.5.1 Equipment Maintenance and Repair

Operation	Level	Operation	Activities	Location
maintenance	Level 1	daily check	visual inspection, control of lubricant, cooling fluid, pressures in tyres etc.	road work sites by operator
	Level 2	periodic maintenance minor repair	replacement of oil filters, hoses, and accessories.	local site facilities of MOPWH
repair	Level 3	unit exchange repair	replacement of components, engine, transmission etc.	authorized dealers
	Level 4	major component repair	repair of major component by replacement of piston and cases and tuning of injector pomps etc.	-ditto-
	Level 5	major refurbishment	repair of major component by refurbishment of straightening cylinders and reboring	-ditto-

5.6 Human Resource Development

(1) Training Improvement Plan

1) Review of Present Training Scheme and Training Needs

The Kenya Institute of Highways & Building Technology (KIHBT) carries out the training function of the road sectors. The institute provides various training services in (1) road construction, (2) road maintenance, (3) equipment operation, and (4) equipment maintenance. Particularly they have developed a training programme for the Labour Based Methods with the initiative of the International Labour Organisation and various donors.

Swiss International Development Aid introduced a training scheme for private contractors of LBM in terms of contracting management, supervision of construction, and technical development for foremen and inspectors. Without a government policy for developing the construction industry, the acquired skills of the contractors may easily disappear. Co-ordination of the training programme with construction industry development is important.

2) Present Training Objectives

The training objectives are limited to the Roads 2000 Maintenance Programme project and are as follows.

a. Training for the Roads 2000 Maintenance Programme: District Works Offices where this programme is to be implemented,

b. Training of the Road Department staff in the development, administration, and quality management of routine maintenance contract, and

c. Training of Labour Based contractors.

(2) Training Improvement Strategy

For privatisation of rural road maintenance and construction industry development, the following training improvement strategy must be added to the present training.

a. To strengthen management capability

b. To gain operation and technical experience on road maintenance works

c. To review LBM for combination with equipment and for community participation.

d. To promote small local contractors for employment opportunity generation in the rural area.

e. To promote regional contractors for meeting demands in the local construction market.

f. To promote national contractors in enhancing their capacity as international firms for exporting their services to the neighbouring countries.

g. To improve Research & Development through a MOR&PW-Universities-Private sector consortium that will introduce and apply new and cost-saving road improvement and maintenance technology.

h. To carry out Environment Impact Assessment training and adhere to Global Environment Issues for sustainable rural development.

i. To improve KIHBT capacity for an in-house human resource development centre.

(3) Proposed Trainees and Outline of Training Description

To meet the above objectives and strategy, the trainees and outline of training description are proposed as follows:

1) Road Sectors in MOR&PW.

a) Nairobi

Training candidates will be recruited from the Roads Department, Materials Testing and Research Department, Mechanical & Transport Department, and Kenya Institute of Highway & Building Technology. In the Roads Department, the relevant branches such as Planning, Maintenance (both trunk and feeder roads), and the special branch for environmental & gender issues will be the major targeted branches for trainee recruitment.

b) Province and Districts

Training candidates will be recruited from the Provincial Works Offices and District Works Offices in the Study Area. For senior staff, they require management training in planning, implementing, monitoring for rural road maintenance together with environmental issues, and public participation.

2) Private Sector

a) Community

Training candidates from the community will be recruited for community participation in routine road maintenance. NGOs and other community-based organisation will initiate and provide this training in co-operation with the relevant local administrations.

b) Candidates for Small Scale Contractors and Jua Kali*

A training scheme has been developed under the Roads 2000 Maintenance Programme. However, this training scheme may not be sufficient for some Districts and efforts must be made to fulfil their training needs. Recruitment of trainees will be considered from local Jua Kali base contractors. For these purposes, KIHBT and NGOs may co-operate in these training schemes.

Note: Jua Kali is a Swahili word meaning "hot sun" workers and is defined as small scale and minor enterprises and artisans.

c) Regional Contractor

Regional contractors are not only road maintenance agencies but also local economy promoters by introducing contract maintenance scheme under the privatisation policy. Both technical and management training will be provided to the regional contractors in order to ensure the quality of the maintenance work and contract performance.

d) National Contractor

National contractors are capable of working under international competitive bidding, if they become more competitive through proper management and technical training for their staff under the government's inducing policies for developing a construction industry. Through joint ventures or association with experienced foreign contractors, they will obtain effective on-the job training in addition to in-house seminars.

3) Specific Group

a) Research & Development Groups

Trainee candidates will be recruited not only from MOR&PW but also universities and private consultants. University related training and overseas training will be considered.

In particular, Research & Development (R&D) scheme is suggested for implementation of Second Tokyo International Conference for African

Development (TICAD II) policy for regional co-operation to solve common issues on rural road maintenance in the East Africa region.

b) Mechanical and Transport Department and local Mechanical Workshops

Special attention must be given to the Mechanical and Transport Department, provincial and districts' Mechanical Workshops, and their training requirements in order to proceed with the privatisation of this organisation.

4) Proposed Special Training Objectives

a) Contract Management and In-house Operation

i) Planning and programming

In the planning and programming phase, a periodic road inventory is proposed to contract out to the private survey consultants, while in-house staff will carry out routine patrol. Training for tender preparation and supervision of the consultants is required.

ii) Preparation

Major maintenance activities will be carried out through local competitive tender. The private consultants will carry out preparation of tender for the periodic maintenance in terms of survey, design, cost estimate, and preparation of tender documents and tender assistance. Training for contract management of the private consultants and the contractor is required.

On the other hand, in-house staff will administer tender for routine maintenance to small scale contractors (LBM) by using a standard tender and contract form. This training is proposed under Roads 2000 Maintenance Programme.

iii)Operation

For periodic and routine maintenance, local consultants will undertake the supervisory services. Contract management of the private consultant and the contractors will be provided, while for special work including operations of emergency, rainy season, and training, in-house staff will be trained.

b) Finance and Accounting Monitoring

After creating the Roads Board, special training is recommended in terms of financial planning and monitoring system for the Roads Board staff.

c) Training for KIHBT lecturers

The KIHBT should be the in-house human resource development centre. Upgrading the skills for KIHBT instructors and lecturers can be done through expatriate experts and overseas training.

d) Special Training for NGO and Community

Special training for NGOs and the Community is recommended for community participation. This area is quite new and a pilot base programme is recommended with participation of NGOs and technical volunteers.

(4) Improvement Plan of Kenya Institute of Highways & Building Technology

1) Past Tendency

At present the Kenya Institute for Highway and Building Technology (KIHBT) has a conventional training scheme which covers operator and mechanics training in operation of road maintenance. Due to budgetary constraints, KHIBT expanded their training scopes into the private vocational training markets to generate income. These training areas are provided by other training facilities such as polytechnics and other ministries. This policy neglects the role of the small private training facilities, and worsens the efficiency of vocational training due to unnecessary competitions among the training facilities. The KIHBT should prepare an improvement plan under the following strategy.

2) Strategy

As a MOR&PW training institute, establishment of the following areas in which the private and other ministerial training institutes are unable to provide services is recommended. The following training are needed for MOR&PW staff.

a. Administration Management

b. Highway and Maintenance Management System in MOR&PW

c. Practical Road Maintenance Technology

3) Administration Management

Under the privatisation policy for road maintenance, contract management has become more important. Training for total improvement of the efficiency and effectiveness of contract management under good governance should be considered also.

4) Highway and Maintenance Management System in MOR&PW

As MOR&PW has introduced computerisation in the highway and maintenance management system which covers the areas from planning to monitoring, computer training for MOR&PW staff is required. There is no systematic and efficient training course at the present. The private consultants already use Auto Cad road design. Update of the present engineering skills and practical application must be considered. This is important for checking and reviewing the results done by the consultants using the computer design.

5) Road Maintenance Technology

Most of the new engineers of MOR&PW have missed opportunities for practical maintenance skills under the privatisation, despite ministerial efforts in job-rotations between the headquarters and the local offices. In addition, universities and institutes provide lectures in the class only and have no training field for road improvement and maintenance both by mechanised and LBM. New recruits of MOR&PW need practical training on the construction site.

Training is required also for the areas of survey, planning, operation, maintenance, and monitoring. All targets areas of training will use computer systems and develop practical skills for road improvement and maintenance. These experiences will be applied to road maintenance programme, engineering cost estimate, budget preparation, and contract management both for the private consultants and contractors.

6) Combination of Labour Based Methods and Equipment

For rural road maintenance, training needs require combined optional courses for MOR&PW force account, labour based, and labour plus equipment methods. In addition, training for the community in rural road maintenance is important for promoting community participation and road ownership. This training should involve NGOs.

5.7 Implementation Programme

5.7.1 Road Maintenance Programme

(1) Proposed Rural Road Maintenance Programme

Proposed Rural Road Maintenance Programme in the Study area is given in Table 5.7.1.

Within five years, the strengthening of maintenance capacity by 13% is required to cover about 887km for paved roads, and to enhance maintenance capacity by 29% to cover 2,880km for gravel roads. Routine maintenance requires the capacity to carry out maintenance for 5,572km of roads, which includes off-carriageway.

Table 5.7.1 Proposed Road Maintenance Implementation Programme

	Length (km)	Year 1	2	3	4	5
Paved Road						
Total length	**787.2**	**807.2**	**827.2**	**847.2**	**867.2**	**887.2**
	100%	*103%*	*105%*	*108%*	*110%*	*113%*
Class A	225.2	225.2	225.2	225.2	225.2	225.2
Class B	179.9	179.9	179.9	179.9	179.9	179.9
Class C	382.1	402.1	422.1	442.1	462.1	482.1
Class D	0	0	0	0	0	0
Class E	0	0	0	0	0	0
Gravel Road						
Total length	**2,238.0**	**2,368.0**	**2,498.0**	**2,628.0**	**2,758.0**	**2,888.0**
	100%	*106%*	*112%*	*117%*	*123%*	*129%*
Class A	0	0	0	0	0	0
Class B	0	0	0	0	0	0
Class C	657.8	637.8	617.8	597.8	577.8	557.8
Class D	337.4	487.4	637.4	787.4	937.4	1,087.4
Class E	1,243	1,243	1,243	1,243	1,243	1,243
Routine Maintenance (Off-Carriageway)						
Total length	**5,572.2**	**5,572.2**	**5,572.2**	**5,572.2**	**5,572.2**	**5,572.2**
	100%	*100%*	*100%*	*100%*	*100%*	*100%*
Class A	225.2	225.2	225.2	225.2	225.2	225.2
Class B	179.9	179.9	179.9	179.9	179.9	179.9
Class C	1,040	1,040	1,040	1,040	1,040	1,040
Class D	1,213.2	1,213.2	1,213.2	1,213.2	1,213.2	1,213.2
Class E	2,914.0	2,914.0	2,914.0	2,914.0	2,914.0	2,914.0

(2) Maintenance Activities Programme

Proposed major maintenance activities are shown in Table 5.7.2. These are categorised into bituminous standard roads, gravel roads, and spot improvement activities.

(3) Maintenance Schedule Programme

1) Budget Preparation

Fig. 5.7.1 shows proposed annual maintenance schedule, which is divided into two calendars; budget preparation calendars and maintenance activities calendars.

The budget preparation calendar starts in January and ends in June for preparation of the budget of the next year. At first, District Road Engineer (DRE) prepares a draft of maintenance works plan including periodic maintenance for the next year, which is to be planned through road inventory in the programme stage by the end December.

The Provincial Road Engineer (PRE) reviews the District maintenance works plans and summarises them in the Provincial Maintenance Works plan at the end of February. This includes bituminous standard roads maintenance. After final adjustment is made by headquarters in Nairobi, MOR&PW submits a draft budget to Ministry of Finance (MOF) by the end of March. During April and May, MOF and MOR&PW discuss together the final figures and MOF completes the printed estimate of proposed budget for the parliament in June. The next fiscal year generally starts in July.

Fig. 5.7.1 Annual Road Maintenance Calendar

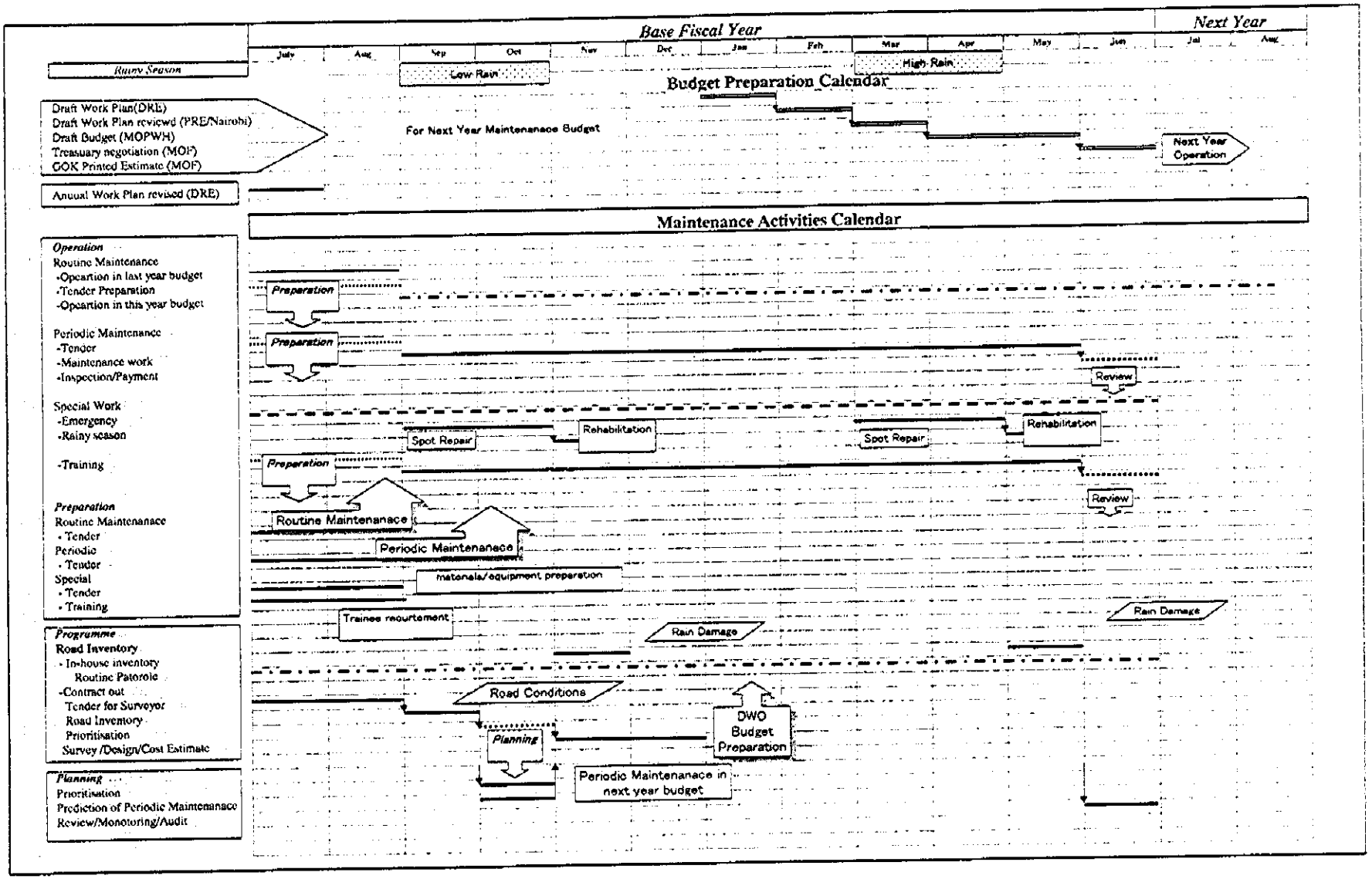


Table 5.7.2 Proposed Road Maintenance Activities

	Maintenance Categories			
	Routine	Periodic	Repair	Special
Paved Road				
(Surface Treatment Road)				
Activities	patching sealing	resurfacing	damages rehabilitation	emergency repair
Frequency	daily	5 years or IRI survey	occasion	
Contract	LBM	Large	Medium/ Large	In-house
Gravel Road				
(Subbase Treatment Road)				
Activities	pothole	regravelling	damages rehabilitation	emergency repair
Frequency	daily	2-3 years loss survey	occasion	
Contract	LBM	Medium	LBM	In-house
Spot Improvement				
(Subbase Treatment Road)				
Activities	by plan		damages rehabilitation	emergency repair
Frequency	on schedule		occasion	
Contract	LBM	Medium	LBM	In-house

2) Maintenance Activities

There are four management functions in the maintenance activities calendar.

a. Operation: routine maintenance, periodic maintenance, and special work

b. Preparation: tender for the above.

c. Programme: routine patrol, and tender for survey for road inventory.

d. Planning: prioritisation, review, and monitoring.

After authorising the budget in June, allocation for Provincial Works Office (PWO and District Works Offices (DWO) takes two months, July and August, actual spending will commence in September. In the operation, routine maintenance can not be suspended and has to be continued by using the pervious year's budget for the two months of July and August, until the new budget is effected.

During the first two fiscal months, preparation in tenders and contracts of routine and periodic maintenance, provision of materials, labour, and equipment for special works will be completed. From September, all maintenance works will start under the new budget.

For programming, the private consultant will start the road inventory survey in September after two months of tender procedure of DWO, while an in-house team is undertaking routine patrol. In October, all data and information will be processed for the prioritisation of the periodic maintenance. This will be planned in the budget of the following year.

(4) Maintenance Cost Estimate and Budgeting

1) General

It is more difficult to estimate the road maintenance cost rather than the project cost of road improvement. Road and pavement deterioration has lot of factors such as climate, topographic, traffic character and volumes etc. When unexpected rains like last recent El Nino occur, emergency maintenance work becomes necessary. Therefore, these maintenance works are divided into planned work and contingency work. The former will be contracted out and the latter is undertaken by in-house capacity.

The planned work is divided into routine maintenance and periodic maintenance. The routine maintenance on paved carriageway (bituminous standard) is patching of potholes and sealing of cracking. The prediction of deterioration of pavement is difficult despite of a lot of efforts in particular by HDM. The fixed budget of routine maintenance is used based on the past experiences. Cost of routine maintenance for off-carriageway is estimated based on review of the present LBM expenditures.

The periodic maintenance activities of carriageway are resealing for bituminous standard roads, and regravelling and grading for gravel and earth roads. Cost estimate of periodic maintenance is based on planning and scheduling frequency and size of each maintenance activities.

Table 5.7.3 shows estimate of unit rate of major maintenance activities.

Table 5.7.3 Annual Cost of Maintenance Activities

	Gravell Road		(ksh/km/year)		
Present Expenditure	*Routine*		*Periodic*		
	Grading	*LBM*	*Gravelling*		
Nyanza	*8,000*	*4,477*	*525,000*		
Western	*6,500*	*2,100*	*947,368*		
Average	*7,250*	*3,288*	*736,184*		
Note: Present actual costs in the study area					
Estimate by the Study					(ksh/km/year)
Activities	**Unit Rate**	**Months**	**Frequency**	**Value**	**Finacial Cost**
Grading	6,797	12	0	81,563	81,563
Routine (LBM)	9,155	1	9,155	0	9,155
Gravelling	631,015	Gravelling Loss Calculation			631,015
Note: For LBM maintenanace, operation must be the same as Paved Road.					
	Paved Road		(ksh/km/year)		
	Routine		*Periodic*		
Present Expenditure	*Pothole*	*LBM*	*Resealing*	60%	:labour percentage
Nyanza	*121,250*	*15,260*	*1,587,029*		of LBM
Western	*43,598*	*15,256*	*1,200,000*		15,258x60%=9,15.
Average	*82,424*	*15,258*	*1,393,515*		
Note: Present actual costs in the study area					
Estimate by the Study					(ksh/km/year)
Activities	**Unit Rate**	**Months**	**Frequency**	**Value**	**Finacial Cost**
Pothole	70,324	1	70,324	0	70,324
Routine (LBM)	9,155	1	9,155	0	9,155
Resealing	1,206,884	@ 5year	1,206,884	0	1,206,884

2) Periodic Maintenance Programme

a) Grading for unpaved road

Grading will be carried out once a month. Timing of grading is decided by routine patrol. This operation is recommended to carry out just before and after rainy season.

b) Regravelling

Regravelling will be decided by degree of loss of gravel by the traffic. The loss of gravel can be predicted by applying the formula in MOR&PW standard and specification. A routine field investigation patrol is required to compare the prediction with the actual loss.

c) Resurfacing for Bituminous Standard Road

Resurfacing will be programmed in five year's intervals. Because of difficulty of predicting pavement deterioration, a routine patrol and a road inventory decide the timing of resurfacing.

d) Drainage, slope, and shoulder reshaping for off-carriageway

These activities are carried out once a year either before or after the rainy season depending on the site conditions.

3) Routine Maintenance

The following activities are programmed on a daily basis.

a. Patching and sealing of paved road.

b. Pothole filling for unpaved road.

c. Cutting vegetation and cleaning drainage for off-carriageway.

(5) Maintenance Budget Preparation in the Study Area

Budget estimation for road maintenance in the study area for five years is given Table 5.7.4. The cost estimate is based on the present level of road pavement conditions and the request budgets by Provincial Works Offices (PWO) and District Works Offices (DWO) for 1999/2000. Review of cost estimate is required annually according to the progress of the pavement improvement programme and results of the road inventory.

(6) Proposed Road Inventory Programme

The road inventory activities are programmed for the following categorised.

a. Pavement conditions survey for paved roads,

b. Surface conditions inspection for unpaved roads, and

c. Routine inspection for off-carriageway.

For Class A and B, the pavement conditions survey is programmed to be undertaken with measurement equipment by private consultants. This survey will be carried out nation-wide with the present traffic census survey once every two years. In addition, Class C roads having heavy traffic will be measured by the same way upon request.

However, for Class C, generally, the local survey consultants undertake the pavement survey under DWOs. They will use the proposed road inventory

forms for visual inspection. Table 5.7.5 shows proposed road inventory programme.

Table 5.7.4 Budget Estimation for Road Maintenance

Unit : 1000 Ksh

Infration= 5.0%

	Budget Request 1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Western Province						
Unpaved Road		Routine Maintenance/Spot Improvement				
Teso	10,097	10,601	11,131	11,688	12,272	12,886
Busia	13,197	13,857	14,550	15,277	16,041	16,843
Sub-total	23,294	24,458	25,681	26,965	28,313	29,729
Paved Road						
Routine	2,266	2,379	2,498	2,623	2,754	2,892
Spot sealing	4,628	4,859	5,102	5,357	5,625	5,907
Resealing	18,120	0	0	0	0	23,126
Sub-total	25,014	7,239	7,601	7,981	8,380	31,925
Total	48,308	31,697	33,282	34,946	36,693	61,654
Nyanza Province						
Unpaved Road		Routine Maintenance/Spot Improvement				
Homa Bay	11,061	11,614	12,195	12,804	13,445	14,117
Suba	8,966	9,414	9,885	10,379	10,898	11,443
Siaya	10,593	11,123	11,679	12,263	12,876	13,520
Gucha	11,267	11,830	12,422	13,043	13,695	14,380
Kuria	8,731	9,168	9,626	10,107	10,613	11,143
Rachounyo	17,098	17,953	18,851	19,793	20,783	21,822
Migori	14,829	15,570	16,349	17,166	18,025	18,926
Bond	7,062	7,415	7,786	8,175	8,584	9,013
Kisii	14,972	15,721	16,507	17,332	18,199	19,108
Kisumu	8,361	8,779	9,218	9,679	10,163	10,671
Nyamira	5,853	6,146	6,453	6,776	7,114	7,470
Nyando	9,457	9,930	10,427	10,948	11,496	12,070
Sub-total	128,250	134,663	141,396	148,466	155,889	163,683
Paved Road						
Routine	52,927	55,573	58,352	61,270	64,333	67,550
Spot sealing	84,258	88,471	92,894	97,539	102,416	107,537
Resealing	231,065	0	0	0	0	294,904
Sub-total	368,249	144,044	151,246	158,809	166,749	469,990
Total	496,500	278,707	292,642	307,274	322,638	633,673
Study Total	544,807	310,404	325,924	342,220	359,331	695,327

Note: Based on 1999/2000 budget request by PWOs and DWOs.
Routine and spot improvement of unpaved road includes spot regravelling.
Most of the unpaved roads have less than 200 V/D.
So only inflation of 5% per year is considered for cost increses.
But cost factor of traffic volume increase in routine maintenance is neglected.
Resealing of paved road is applied in a 5 year interval by the specification.

Table 5.7.5 Proposed Paved Road Inventory Programme

	Class	Office	Target (km)	Field Survey (month)	Data Analysis (month)	Total
Mechanical Pavement Inventory	A/B	MOPWH	3,957	4	4	8
	C	Nairobi	1,000	1	1	2
Visual Pavement Inspection	C (paved)	PWO	372	2	2	4
	C (gravel)	DWO	643	3	3	6

Note: 1. MOPWH provide two measurement vehicles to the consultants.
2. Monthly progress of mechanical pavement inventory
10km/hourx5hours/dayx20days/month=1,000km/month
3. Monthly progress of visual pavement inspection
2km/hourx5hours/dayx20days=200km/month

Surface conditions of unpaved roads and off-carriageway are inspected by routine patrol of DWO. Table 5.7.6 gives the Proposed Road Inventory Equipment and Staff for in-house routine patrol.

Table 5.7.6 Proposed Road Inventory Equipment and Staff for in-house Routine Patrol

	Province	District	Study Area
1 Equipment and Tools			
1) Inspection Vehicles	2	2	**30**
2) Handy GPS	2	2	**30**
3) Survey Tools (tape, pole etc..)	1	1	**15**
4) Computer and Accessories	1	1	**15**
5) Digital Camera	1	1	**15**
2 Materials			
1) Road Inventory Form	1	1	**15**
2) Road Conditions Maps	1	1	**15**
3) Stationary	1	1	**15**
3 Staff			
1) Road Inspector	1	1	**5**
2) Assistant staff	2	2	**5**

5.7.2 Maintenance Training Programme

(1) Preparation and Programming Improvement

Training is required for strengthening the contract management and in-house operation of MOR&PW and private contractors as well. These training will be carried out by KIHBT.

(2) Main Fields

Contract management training is required for the followings:

a. Procurement of the private consultants for survey, design, and cost estimate for the next year budget preparation for periodic maintenance and rehabilitation.

b. Procurement of the private consultants for supervising the contractors who carry out periodic maintenance.

c. Procurement of LBM contractors and length persons for routine maintenance.

(3) Operation Improvement

The following training programme is required.

a. Contract Management and actual operation for the periodic and routine maintenance works

b. Monitoring of the consultants' supervision for the above operation that is carried out by the Contractors.

5.7.3 Training Programme under Special Work

(1) Overall Training Programme

The annual training programme of recruiters of MR&PW under Special work is given in Fig. 5.7.2.

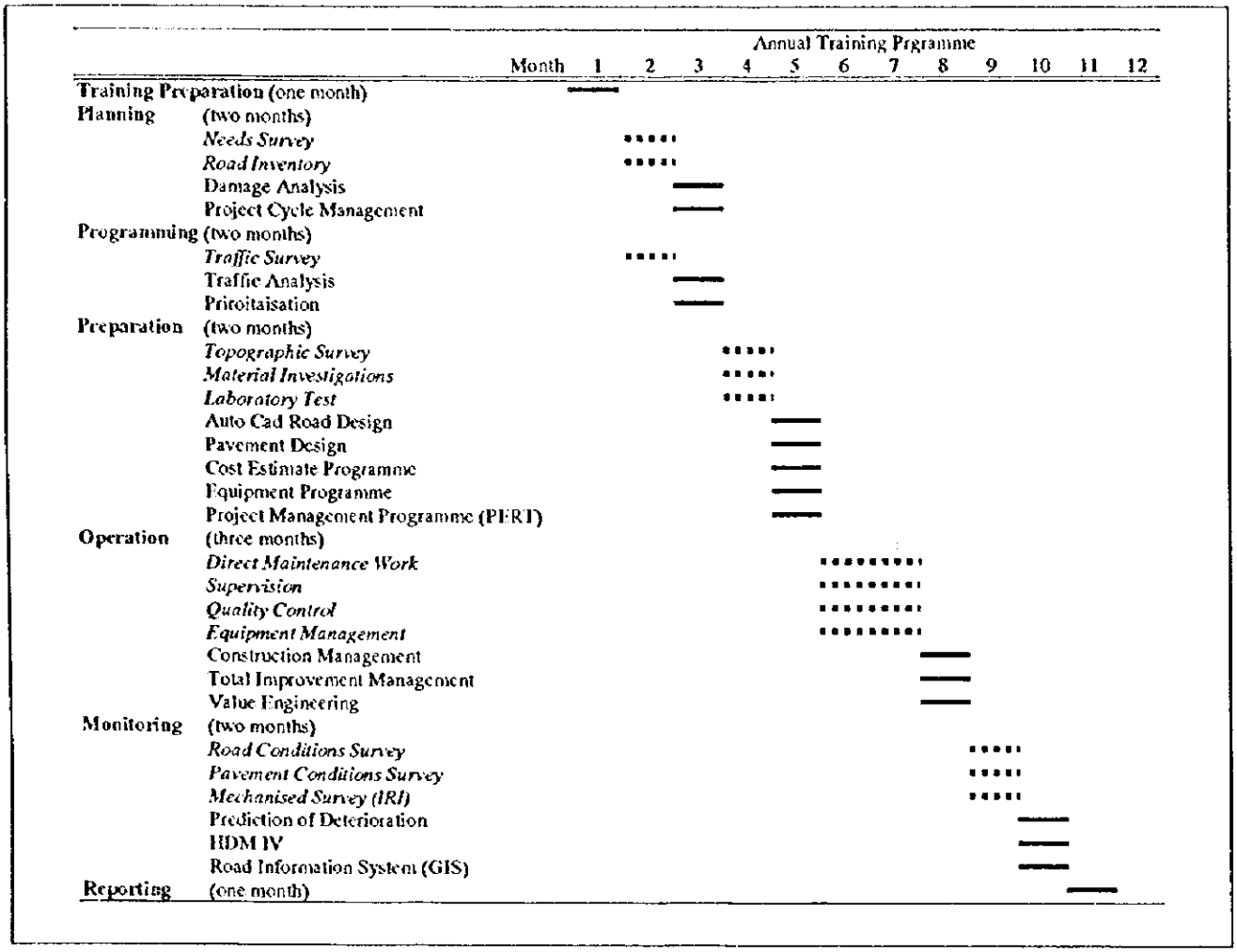


Fig. 5.7.2 Annual Training Programme

(2) Training Subject

1) Planning (two months)

a. Field training : needs survey and road inventory (one month)

b. In-house training: damage analysis and Project Cycle Management (one month)

2) Programming (two months)

a. Field training : traffic survey (one month)

b. In-house training : traffic analysis and prioritisation methods (one month)

3) Preparation (two months)

a. Field training : topographic survey and material investigations (one month)

b. Laboratory training : laboratory test (one month)

c. In-house training : Auto Cad Road Design and pavement design
Cost estimate and equipment management plan
Project Management Programme (PERT)
Procurement of contractors and consultants
(one month)

4) Operation (three months)

a. Field training : direct maintenance operation and Supervision
(two months)

b. Field and laboratory training : quality control (two months)

c. Field and workshop training : equipment management (two month)

d. In-house training : Total Improvement Management
Administration management
Legal problems
Financial matters
(one month)

5) Monitoring (two months)

a. Field training : Road Conditions Survey and Pavement Conditions Survey (one month)

b. Field training : Mechanised Survey (IRI) (one month)

c. In-house training : Prediction of Pavement Deterioration and HDM IV Road Information system (one month)

6) Reporting

a. In-house training : Computer Network System and Reporting System (one month)

(3) Maintenance Field Training

a) Maintenance Training Section

Fig. 5.7.3 shows a proposed concept of maintenance field training section.

For field training, maintenance training is programmed to target a 20-km road for four years by improving a 5-km stretch every year. In the first year, maintenance needs and traffic surveys for programming and planning will be carried out for all the 10km section. For preparation, topographic survey and site investigation will be done in the first 5km out of the 10km section. Actual operation of improvement will be carried out on the surveyed section of the 5km, while a remaining of 5km section will be carried with routine and emergency maintenance work. After completion of improvement, monitoring and reporting will cover the whole 10-km section.

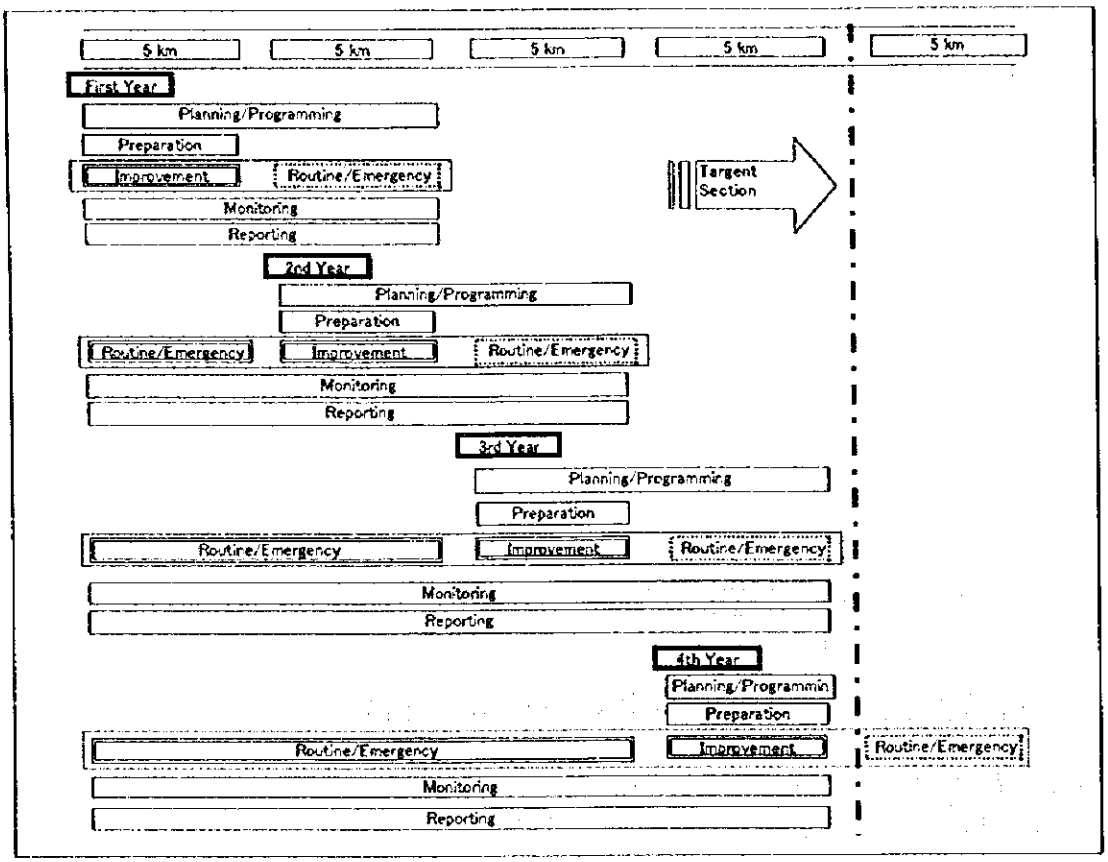


Fig. 5.7.3 Maintenance Training Section

For the second and the following years, this training concept will be extended to a total 20-km road stretch. It is important to monitor pavement and road conditions improved from the previous year.

b) Proposed Training Equipment and Facilities

Proposed list of equipment and tools for field training are listed in Table 5.7.7. A Regional equipment centre (REC) manages this equipment. In-house training will use KIHBT facility after its minor improvement.

Table 5.7.7 Proposed Training Equipment

Proposed List of Equipment for Training	Team A	Team B	Total
1 Construction Equipment			
1) Bull Dozer	1	1	2
2) Motor Grader	1	1	2
3) Wheel Dozer	1	1	2
4) Hydraulic Excavator	2	2	4
2 Compaction Equipment			
1) Vibrating Roller	1	1	2
2) Sheep Foot Roller	1	1	2
3) Road Roller	1	1	2
4) Pedestrian Roller	2	2	4
5) Tamper	2	2	4
3 Construction Vehicle			
1) Tipper	5	5	10
2) Flat Truck	5	5	10
3) Water Tanker	5	5	10
4) Fuel Tanker	1	1	2
4 Pavement Machine			
1) Bituminous Sprayer	1	1	2
2) Tips Spreader (truck mounted)	1	1	2
3) Hand Sprayer	2	2	4
5 Concrete Machine			
1) Concrete Mixer	1	1	2
2) Vibrator	2	2	4
6 Logistic Vehicle			
1) Small 4WD (<900cc)	10	10	20
2) Small Dump Truck (2ton)	10	10	20
3) Small Flat Truck (<900cc)	10	10	20
4) Camp house and facilities	1	1	2
7 Management Tools			
1) Computer	5	5	10
2) Printer	2	2	4
3) Accessories (Software)	5	5	10
8 Survey and QC			
1) Topographic instruments	1	1	2
2) Laboratory instruments	1	1	2
9 Training Tools			
1) Projector	1	1	2
2) Screen	1	1	2

5.7.4 Necessary Equipment and Facility in Regional Equipment Centre

Provision of equipment and facility improvement should be reviewed under the progress of privatisation. Table 5.7.8 shows equipment for road maintenance in the regional equipment centre.

Table 5.7.8 Proposed Maintenance Equipment for Regional Equipment Centres

	Regional Equipment Centre						
Regional Equipment Centre	*Western* Busia	Siaya	Kisumu	*Nyanza* Homa Bay	Kisii Nyamira	Migori	Total
including Districts	Teso	Bond	Nyando	Rachuony o	/Gucha	Kuria	
Paved Road (km)	42	144	299	110	123	90	807
Unpaved Road (km)	531	973	547	915	1,028	770	4,765
Maintenance Equipment							
Bull Dozer	1	1	1	1	1	1	6
Motor Grader	2	3	2	3	3	2	15
Wheel Dozer	1	1	1	1	1	1	6
Hydraulic Excavator	1	1	1	1	1	1	6
Compaction Equipment							0
Vibrating Roller	1	1	1	1	1	1	6
Sheep Foot Roller	1	1	1	1	1	1	6
Road Roller	1	1	1	1	1	1	6
Pedestrian Roller	2	2	2	2	2	2	12
Tamper	2	2	2	2	2	2	12
Construction Vehicle							0
Tipper	5	5	5	5	5	5	30
Flat Truck	5	5	5	5	5	5	30
Water Tanker	5	5	5	5	5	5	30
Fuel Tanker	1	1	1	1	1	1	6
Pavement Machine							0
Bituminous Sprayer	1	1	1	1	1	1	6
Tips Spreader (truck mounted)	1	1	1	1	1	1	6
Hand Sprayer	2	2	2	2	2	2	12
Concrete Machine							0
Concrete Mixer	1	1	1	1	1	1	6
Vibrator	2	2	2	2	2	2	12
Logistic Vehicle							0
Small 4WD (<900cc)	10	10	10	10	10	10	60
Small Dump Truck (2ton)	10	10	10	10	10	10	60
Small Flat Truck (<900cc)	10	10	10	10	10	10	60
Management Tools							0
Computer	1	1	1	1	1	1	6
Printer	1	1	1	1	1	1	6
Accessories (Software)	1	1	1	1	1	1	6

Note: Numbers of Motor Grader is calculated by one machine for 300km.