

REPUBLIC OF KENYA



MINISTRY OF ROADS, PUBLIC WORKS AND HOUSING

**DESIGN REVIEW AND UPDATE**

**OF**

**EMBAKASI - MACHAKOS TURN OFF  
(A109/A104) DUAL CARRIAGEWAY**

**ENVIRONMENTAL IMPACT ASSESSMENT**

NOVEMBER 2003

**FILE COPY**

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## **EXECUTIVE SUMMARY**

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### **INTRODUCTION**

Poor road conditions have been a major obstacle for development in Kenya. In view of this, the Ministry of Roads, Public Works and Housing, Government of Kenya (GoK) with funding from the International Development Association (IDA), contracted Norconsult International A.S. to carry out the design review and update of the Embakasi to Machakos Turn-off to dual carriageway standard.

One of the objectives of the study is to identify and update the most appropriate economically justified design and construction methodology for the dual carriageway road. This preliminary environmental impact assessment (EIA) study, of the existing road and proposed works, is to be undertaken as part of the design and update review.

### **PROJECT SETTING**

The road traverses two administrative areas, Embakasi Division in Nairobi Province and Mavoko and Athi River Divisions in Machakos District in Eastern Province. The entire road is just under 34 Km long, with the majority of the project road lying in Machakos District. This road forms part of the Nairobi – Mombasa A109 international highway. The road from Embakasi to the Athi River Junction is part of the A104 road which is an integral section of the Trans-African Highway and as such functions as a major transit route for traffic to and from Tanzania. The road traverses an area of relatively high population density. Most of the formal sector activities take place at Mlolongo at Km 5.5 and Makutano (Kyumvi) at Km 33.5 at the Machakos Turn-off junction.

### **DESIGN COMPONENTS**

The project involves a review of the design of the Embakasi to Machakos Turn-off to dual carriageway standard initially undertaken by HP Gauff Consulting Engineers in 1992.

The design will incorporate bridges, box culverts, and gabion works necessary to improve drainage and control soil erosion along the project road. The width of both carriageways is 7 m and the widths of the shoulders are 2.5 m and 1.0 m respectively. The average width of the median is 17 m. Between Km 0 and Km 12.5 the new carriageway will be constructed parallel to the existing one with an offset of the centre line of 25 m. Beyond Km 15 up to the end of the project road the new dual carriageway will be accommodated within the existing road reserve.

### **EXISTING IMPACTS**

The project road has brought immense economic benefits to the country. The Embakasi – Machakos Turnoff (A104/A109) road is part of the Nairobi – Mombasa international trunk road, and carries a substantial amount of traffic including heavy goods vehicles. Two major centres are found along the road: Mlolongo and Kyumvi at the Machakos Turn-off. These centres emerged as a result of the project road, and are characterised by high population densities. The road will further stimulate the growth of trade along the road.

There is considerable traffic congestion just after the weighbridge at Mlolongo, and on the approach to Nairobi after the Athi River Turn-off.

Drainage problems are a factor featured along the project road. Drainage is poor especially in the flat sections along the road and at the centres, notably at Mlolongo and Makutano. At Km 7.52 the road descends, and there is no provision for drainage and control of road runoff along this section of the road. The drainage ditches are not clearly defined and have not been properly maintained, and as a result are blocked and covered with vegetation.

The junction at Makutano at Km 33.5 is heavily congested due to the parking of lorries and trucks on the road side. Mlolongo and the junction at Makutano have become established truck stops and pose a significant hazard to both vehicles and people. A number of land owners along the project road have been over the years subdividing their land and selling it to individuals who are not aware that that land encroaches onto the road reserve.

### ANTICIPATED IMPACTS

In general, the proposed improvement works to the project road will pose minor environmental problems because any changes to the hydrological regime, vegetation, etc., occurred when the alignments were originally cleared and the road constructed. The most significant impacts are social and socio-economic ones.

Positive impacts will result from better flow of traffic, and improved access to the trade centres and destinations beyond the terminal points of this project. This would further contribute to the national economy. During construction, opportunities for temporary employment will arise for the local people. The establishment of gravel sites and selling of material from the pits will be of benefit to the site owners.

Congestion will reduce along the road, especially along the section from Athi River to Mlolongo for traffic going towards Nairobi, and traffic from Namanga (A104) joining the A109 at the Athi River junction. Improved access to rural areas often leads to higher prices for land, as compared to the same sized plot in areas where access is difficult.

There are no protected or endangered plants or animal species found along the project road, hence the impact will be negative but minor and will revert to the present condition after construction. The impact will result from route deviations, clearance activities, and construction of the dual carriageway. Soil erosion due to earthworks (including deviations) will also create a negative impact.

Pollution due to air, dust and noise is already a problem more significantly around the trade centres. Air, dust and noise pollution will be exacerbated during construction activities, though this is expected to revert to the present situation, or even improve slightly, after construction. Blasting of rock outcrops will be necessary to create room for the dual carriageway. Given the nature of the rock and the fact that previous blasting of the rock has been done, the ecological impact is expected to be minimal.

The most significant impacts will arise from the acquisition of land and displacement of people necessary for the construction of the dual carriageway. New road reserves will have to be created for the proposed dual carriageway.

The workforce will exert pressure on water and fuel wood sources, and may contribute to the spread of sexually transmitted diseases (STDs) in the trading centres and settlements along the

road. Sanitation and solid waste disposal at the construction camp are issues that could also impact negatively on the environment.

## **MITIGATION**

Mitigation is possible for all adverse impacts that may result from the proposed construction works.

Hydrological impacts can be minimised by allowing unimpeded flow of water, i.e. through installing adequate box or pipe culverts in the road design.

Impacts due to earthworks can be reduced by exercising care, and if possible, carrying out these activities during the dry season. Replanting areas cleared for deviations, and vegetating slopes and embankments would help to prevent soil loss and reduce visual intrusion. In order to reduce the impact of runoff that leads to erosion; scour checks and gabion mattresses will be introduced in the side drains at specified intervals.

There is a need to consider the provision of proper parking bays for the long haul trucks and heavy goods vehicles in order to reduce congestion and increase safety.

The introduction of speed restrictions and occasional spraying with water can reduce dust emissions along deviations. Asphalt and crushing plants should be located downwind of settlements to lessen disturbance caused by noise and dust pollution to nearby residents. Sensitising motorists and providing special parking areas with provision for carrying out maintenance works for trucks to control oil and noise pollution at Mlolongo and Kyumvi.

The project road is to be designed for a maximum speed of 110 km/h on flat sections, which poses a danger to non-motorised traffic (including livestock). The provision of separate footpaths and cycle lanes, footbridges and livestock underpasses will help to mitigate this impact. Access and egress to the road should be carefully planned, for industries along the initial section of the road, as well as at Athi River Town and Makutano, where flyovers and slipways will be required. Road safety can be enhanced through installing clear and frequent road signs and markings, particularly where the road passes through urban centres or trading centres.

Land acquired for the construction of the dual carriageway and the extension of road reserves must be fair and transparent and the owners promptly compensated. The issue of displacement and resettlement will be handled in accordance with the World Bank's OP 4.12 on Involuntary Resettlement and Government of Kenya guidelines. These issues are not part of our terms of reference and will be dealt with in the socio-economic study and RAP to be carried out by Gibb East Africa.

Gravel pits must be landscaped and reinstated or back-filled with overburden, if the depth of the overburden is sufficient to allow for this. If excavation is properly planned, organised and executed, it would be possible to rehabilitate most of the gravel pits. It is therefore important to have separate stockpiles for topsoil, overburden, gravel, etc. A contract should be drawn up between the landowner and the Contractor, according to which the Contractor should plant trees to replace those that have been removed during excavation. Where requested by the landowner terracing and replacement of fencing should be part of the rehabilitation process.

Locating the workmen's camp at Nairobi, Kyumvi at the Machakos Turn-off or at the abandoned Crescent Construction Contractor camp will minimise some impacts. The camp should use gas or

kerosene to preclude the need to buy charcoal, and a central canteen for the workforce would reduce energy and water consumption and the amount of solid waste generated. STD awareness campaigns should be conducted in the camp as well as in the trading centres along the project roads.

Workmen should be provided with suitable protective working gear, and there should be a health safety and environment officer on site at all times. In addition, a fully equipped first aid kits should be kept on site and the Contractor must have workmen's compensation cover.

Indigenous trees and flowery shrubs should be planted along the road reserve especially on the section that leads to Nairobi. This will enhance the beautification of the road and the city as a whole. People who reside next to the road reserve should be encouraged to be involved in this exercise to prevent them from uprooting of the plants and planting them on their own farms or using the trees that were originally there for charcoal. The median of the dual carriageway should be grassed and planted with shrubs. This would add to beautifying of the road, and would help to reduce nocturnal glare. Drainage for road surface run-off along some sections of the road can also be improved if a drainage structure is provided along the median (Pers, Comm. Mr Kiruja, District Works Officer).

## **MONITORING**

Mitigation measures, design features, or actual impacts can be monitored to ensure environmental acceptability of the project during and after construction. In some cases, monitoring can be done as part of routine or periodic maintenance, while socio-economic or ecological parameters can only be effectively assessed in the longer term. Parameters that can be monitored include:-

- efficiency of drainage structures
- soil conservation interventions
- gravel pit rehabilitation
- sanitation at the workmen's camp
- impact on public health (due to STDs, clean drinking water)
- frequency of road traffic accidents
- air quality
- noise quality
- impact on road safety

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Conclusions**

As the road already forms part of the international trunk highway, the improvement will no doubt contribute to promoting economic development in the study area and the country as a whole.

The project road is an existing one, and thus the natural environment has already been considerably altered. Therefore any major impacts have already occurred and additional disturbances due to construction works will be relatively minor. The impacts in respect of

mitigation are described above. The design is expected to considerably improve drainage along the road, especially along the flat sections, notably at Mlolongo and Makutano.

### **Recommendations**

The recommendations made in this report are summarised as follows:-

- new gravel pits must be cordoned off or fenced during use, and rehabilitated after use as per the requirements of the landowners;
- special provision should be made for pedestrian, bicycle and livestock traffic. This includes separate footpaths, cycle lanes, footbridges and livestock underpasses;
- shrubs and grasses should be planted along road embankments to prevent erosion and in the median between the two lanes;
- unnecessary clearing of vegetation should be avoided to preclude additional erosion;
- trees should be planted, especially at the centres and on the approach to Nairobi, Athi River turn-off and Makutano, to improve visual aesthetics and act as filters for particulate matter;
- special parking areas should be provided for trucks and public transport vehicles at Makutano, Athi River and Mlolongo (near the weighbridge);
- the local people must be informed of the details and progress of the project, particularly those who will be affected by the proposed realignment and extension of the road reserve, so that they can plan for the future accordingly;
- compensation and resettlement of landowners that must relinquish their land for the project road must be fair and transparent, and the landowners paid promptly. It should cover crops, all structures (permanent and semi-permanent, fences, etc.) as well as land;
- the World Bank's OP 4.12 on Involuntary Resettlement and Government of Kenya guidelines will be followed and used complementarily where applicable to avoid conflict. Community participation in planning and implementing resettlement will be encouraged;
- a Compensation and Resettlement Action Plan will be developed addressing land, housing, crops, and other compensation to be provided to the adversely affected population. A monitoring and evaluation mechanism for resettlement activities will be carried out.

Diligence on the part of the Contractor and proper supervision by the Supervising Engineer during construction and the initial operation period is crucial for mitigating impacts. However all mitigation measures need to be specified in tender and contract documents, and must be included in the Engineering Drawings, Specifications and Bills of Quantities. During operation, maintenance of the road is a key factor in protecting the environment.



## **CHAPTER 1**

### **INTRODUCTION**

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#### **1.1 BACKGROUND**

The Embakasi to Machakos Turn-off road forms part of the Nairobi – Mombasa international trunk road. This road is important in terms of economic activity and it is vital that the road remains in sound condition.

The Ministry of Roads, Public Works and Housing contracted Norconsult International A.S. in March 2003 to carry out the design review and update of the Embakasi to Machakos Turn-off to dual carriageway standard. The International Development Association (IDA) provides funding for the project road.

A preliminary environmental impact assessment (EIA) study, of the existing road and proposed works, has been undertaken as part of the requirements of the terms of reference. An environmental management, mitigation and monitoring plan has been prepared to provide details of mitigation measures necessary to reduce existing impacts and minimise any additional adverse environmental impacts during and following construction. Schedules for effecting proposed measures, monitoring of impacts after rehabilitation are included where possible. In addition, the environmental mitigation plan outlines institutional requirements and responsibilities necessary for the successful implementation of these mitigation measures.

#### **1.2 OBJECTIVES OF THE STUDY**

The objectives of the study are:

To document the present condition of the environment and identify the positive and negative impacts that may result from the design of the Embakasi to Machakos Turn-off to dual carriageway standard. In doing so, to address the necessary environmental mitigation and monitoring measures.

The requirements of the Environmental Impact Assessment Study are indicated in the Terms of Reference.

#### **1.3 APPROACH AND METHODOLOGY**

The approach and methodology for conducting this study is based on World Bank environmental guidelines, and the Kenyan Environmental Impact Assessment and Audit Regulations, 2003 as provided for in the Environmental Management and Co-ordination Act, 1999.

At the time the original terms of reference (ToR) were written the Environmental Impact Assessment and Audit Regulations, 2003, and the Environmental

Management and Co-ordination Act, 1999 were not in place hence a project report and scoping study have not been carried out for the project road. According to the Environmental Impact Assessment and Audit Regulations, a ToR is to be drawn up during the scoping study. Therefore this study is being handled as a preliminary environmental impact assessment (EIA) study. A letter explaining this from the Ministry of Roads, Public Works and Housing (MoRPW&H) is to be sent to NEMA and a copy to be included as an appendage in the final EIA report (Pers, Comm. Mr Mbegera, Director of Compliance and Enforcement Department, NEMA).

The project road falls under a section of the Northern Corridor, and in order to provide a holistic assessment of the corridor, the MoRPW&H proposed that the study be handled by a separate consulting firm. Gibb East Africa, who is currently responsible for the social study, drew up a separate ToR for that study, which includes a compensation and resettlement action plan. The social study and RAP are being carried out in accordance with the World Bank's OP 4.12 on Involuntary Resettlement and Government of Kenya guidelines.

The Involuntary Resettlement Policy stresses that where displacement of people, loss of crops, semi-permanent and permanent structures is unavoidable, a resettlement plan should be developed. It further goes on to add that these displaced persons should be: -

- (i) compensated for their losses at full replacement cost prior to the actual move;
- (ii) assisted with the move and supported during the transition period in the resettlement site; and
- (iii) assisted in their efforts to improve their former living standards, income earning capacity, and production levels, or at least to restore them.

These issues will be addressed comprehensively by Gibb East Africa.

It is assumed that this project will be categorised as a World Bank Category "A" project, on the basis that it will necessitate the acquisition of land and the displacement of people. A Category "A" project requires a full EIA to be carried out. At this stage, we have carried out a preliminary environmental impact assessment study.

The methodology used for this assessment was based on the standard World Bank method and involved four basic tasks:

- A review of the existing environmental conditions;
- Identification of the anticipated impacts;
- Identification of appropriate mitigation measures and/or design changes to eliminate or reduce the identified impacts, and;
- The formulation of an environmental management, mitigation and monitoring plan.

Field work for the environmental impact assessment study was conducted in April, September and October 2003. Preliminary data on topographical surveys, hydrology and drainage, soils and materials investigations, and condition surveys of the existing project road were collected in the field during the following weeks. Baseline measurements on air and noise quality will also be taken, and the results incorporated into the Final Report.

#### 1.4 PRESENTATION OF THIS REPORT

This report presents the findings of the scoping study for the project road, and recommends mitigation measures that should be incorporated in order to minimise adverse impacts that may arise from the construction works.

**Chapter 1** gives background information relevant to the study, describing the objectives and requirements of the study.

**Chapter 2** outlines the legislative and regulatory framework of the study.

**Chapter 3** describes the administrative, physical, natural and social environments of the project area.

**Chapter 4** briefly outlines the key project components that are relevant to the environmental study.

**Chapter 5** describes the impacts and observations due to the existing road.

**Chapter 6** addresses impacts anticipated during and after road construction.

**Chapter 7** describes the proposed mitigation measures.

**Chapter 8** provides an environmental management and monitoring plan for the road.

**Chapter 9** presents conclusions and recommendations.

## CHAPTER 2

### ENVIRONMENTAL LEGISLATION

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#### 2.1 ENVIRONMENTAL PROTECTION AND MANAGEMENT AT THE NATIONAL LEVEL

The Environmental Management and Co-ordination Act 1999, is the legislation that governs Environmental Impact Assessment (EIA) studies. This EIA falls under the Second Schedule, which lists the projects required to undergo EIA studies in accordance with section 58 (1-4) of the Act. These projects are considered to pose potentially negative environmental impacts. Part 3 of this Schedule, refers to transportation projects and these include *inter alia*, all major roads and all roads in scenic, wooded or mountainous areas and wetlands, therefore according to the above Act, this project requires an EIA study. The approach and methodology for conducting this study is based on World Bank environmental guidelines, and the Kenyan Environmental Impact Assessment and Audit Regulations 2003.

The law has made provisions for the establishment of the National Environment Management Authority (NEMA), which has the statutory mandate to supervise and co-ordinate all environmental activities. Upon the completion of this preliminary EIA study, it will be submitted to NEMA for review and comments.

Policies and legislation highlighting the legal and administrative requirements pertinent to this study and relating to land and natural resources, water management, forests and public health are briefly summarised below.

#### 2.2 ENVIRONMENTAL IMPACT ASSESSMENT

An EIA is a legal requirement in Kenya for all development projects. The objective of an EIA study is to document the present condition of the environment and assess the positive and negative impacts due to the rehabilitation of the access roads together with the necessary mitigation measures. The EIA study is part of the road upgrading works, and aims to highlight the environmental issues of concern that need to be considered during the planning, design, construction and operation phases of the study.

Policies and legislation highlighting the legal and administrative requirements pertinent to this study are presented below.

*The Local Government Act Chapter 265 Laws of Kenya:* provides for making by-laws and institutions by the Local County Councils. By-laws can be made on the governance of a project under the provisions of this Act.

*The Traffic Act Chapter 295 Laws of Kenya:* consolidates the law relating to traffic on all public roads. The Act also prohibits encroachment on and damage to roads including land reserved for roads. The project is under the provision of the Act.

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*The Land Acquisition Act Chapter 295 Laws of Kenya:* provides for the acquisition of land for public benefit. The project is under the provision of the Act.

*The Registered Land Act Chapter 300 Laws of Kenya:* provides for the absolute proprietorship over land (exclusive rights). Such land can be acquired by the state under the Land Acquisition Act in the project area.

*The Land Adjudication Act Chapter 95 Laws of Kenya:* provides for ascertainment of interests prior to land registrations under the Registered Land Act.

*The Wayleaves Act Chapter 292 Laws of Kenya:* provides for certain undertakings to be constructed e.g. pipelines, canals, pathways etc., through or under any lands. The project is under the provision of the Act.

*The Water Act Chapter 372 Laws of Kenya:* The Act vests the water in the State and gives the provisions for the water management, including irrigation water, pollution, drainage, flood control and abstraction. It is the main legislation governing the use of water especially through water permit system.

*The Lakes and River Act Chapter 409 Laws of Kenya:* This Act provides for protection of river, lakes and associated flora and fauna. The provisions of this Act may be applied in the management of the project.

*The Wildlife Conservation and Management Act, Cap 376:* This Act provides for the protection, conservation and management of wildlife in Kenya. The provisions of this Act should be applied in the management of the project.

### 2.3 PUBLIC HEALTH

The MoRPW&H has guidelines on environmental protection and mitigation. In the Ministry's Standard Specification for Road and Bridge Construction a number of clauses address protection of water sources, health safety and accidents, water supply, maintenance of the engineers staff houses, offices, laboratories, and attendance upon the engineer and his staff (refer Standard Specification Clauses 116, 117, 125, 135, 136, 137).

*The Public Health Act Laws of Kenya:* Provides for the securing of public health and recognises the important role of water. It provides for prevention of water pollution by stakeholders, among them Local Authorities (county councils).

### 2.4 INTERNATIONAL LEGISLATION

This EIA study is also based on internationally respected procedures recommended by the World Bank in the World Bank Operational Directives 4.01 and Environmental Assessment Source Book Volume II, which provides the relevant sectoral guidelines. As such, this EIA study is intended to meet the expectations of international financiers and Kenyan adjudicators.

## CHAPTER 3

### ENVIRONMENTAL AND SOCIO-ECONOMIC PROFILE

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This chapter presents a brief description of the environmental and socio-economic setting of the project area. A more detailed socio-economic baseline will be provided by the social study to be carried out by Gibb East Africa.

#### 3.1 ADMINISTRATIVE LOCATION OF THE PROJECT ROAD

The study area for the Embakasi – Machakos Turnoff road (A104/A109) lies mostly in Machakos District in Eastern Province. The start of the project road lies at the boundary of Nairobi Province. The road traverses two areas, Embakasi Division in Nairobi Province and Mavoko and Athi River Divisions in Machakos District in Eastern Province. Administratively, the district is divided into twelve divisions, sixty-two locations, and two hundred and twenty five sub-locations (*Machakos District Development Plan, 2002 – 2008*).

The majority of the project road lies in Machakos District, and the entire road is just under 34 Km long. The road starts at latitude 01° 20' 59" south and longitude 36° 54' 19" east just before the Caltex Depot, and ends approximately 1 Km after the Machakos Turn-off at latitude 1° 31' 49" south and longitude 37° 07' 52" east. The road lies at elevations between 1635 and 1712 m above sea level from the start to the end of the project road respectively.

#### 3.2 SERVICES

This road forms part of the Nairobi – Mombasa A109 international highway. The road from Embakasi to the Athi River Junction is part of the A104 road which is an integral section of the Trans-African Highway and as such functions as a major transit route for traffic to and from Tanzania. Most of the informal sector activities take place at Mlolongo at Km 5.5 and Makutano at Km 33.5 at the Machakos Turn-off junction.

Generally, Machakos District has no or inadequate access to a reliable water supply for domestic, livestock, crop and industrial use.

Both Athi River and Central Division are served with electricity from the National Grid, though the demand for electricity is high. The major sources of energy in the district are wood fuel, petroleum fuels and hydro-electric power (*Machakos District Development Plan, 1997 – 2001*).

#### 3.3 POPULATION STRUCTURE AND DISTRIBUTION

According to the 1999 Kenya Population Census report Machakos District has a population of 906,644 people consisting of 442,891 males and 463,753 females

representing 48.8 and 51.2 percent of the population respectively. The population is expected to increase to 1,056,535 by 2008 (*Machakos District Development Plan, 2002 – 2008*).

Soil fertility and rainfall influence the population density, where the high-density settlements are located along the hill masses of Kangundo, Kathiani, Central and Mwala Divisions. These areas receive moderately high rainfall and have great agricultural potential. Spatial settlements are found in the low plains where ranching and dairy farming is carried out (*Machakos District Development Plan, 2002 – 2008*). 70% of the population work in the agricultural sector. Table 3.1 tabulates the projected population densities in selected divisions.

**Table 3.1 Projected Population densities in selected divisions along the A104/A109 project road over the plan period.**

Division	Projected Population Density in 2002 (persons/sq km)	Projected Population Density in 2004 (persons/sq km)	Projected Population Density in 2006 (persons/sq km)	Projected Population Density in 2008 (persons/sq km)
Athi River	54	56	57	59
Central	307	318	329	340
Kalama	130	135	140	145

*Source: District Statistics Office, Machakos, 2001.*

A more comprehensive study on the population distribution and projections in the project area are dealt with in more detail in the socio-economic study report to be prepared by Gibb East Africa

### 3.4

#### HEALTH

The biggest challenge facing the district is the increasing cases of HIV/AIDS in spite of the awareness level of over 85% of the population. The district faces a challenge of providing medical care and support for the infected. For those already infected, the district intends to provide subsidised treatment for opportunistic infections (*Machakos District Development Plan, 2002 – 2008*). Table 3.2 provides information on the prevalence of HIV/AIDS cases in Machakos District in 2001.

Table 3.2 HIV/AIDS cases in Machakos District in 2001.

Month	Patients	Blood Donors	Total	HIV Positive Blood		
				Patients	Donors	Total
Jan	34	226	260	21	10	32
Feb	11	63	74	9	2	11
Mar	25	258	283	9	3	12
Apr	23	20	43	8	2	10
May	24	149	173	9	8	17
Jun	25	4	29	14	1	15
Jul	35	148	183	18	3	21
Aug	41	349	390	15	8	23
Sep	18	85	103	4	4	8
Total	236	1302	1538	107	41	148

Source: Ministry of Health, Machakos, 2001

Out of 236 patients who were screened, 107 were found to be HIV/AIDS positive representing a 45.3% prevalence rate, and out of 1302 cases of blood donors screened, 41 donors (or 3.1%) were HIV/AIDS positive (*Machakos District Development Plan, 2002 – 2008*). Since 1989, when the first case was diagnosed in the district and at the time 9 people were HIV positive, the numbers have continued to increase.

It is not possible to know the exact number of HIV/AIDS cases since most of the infected go for checking only when they are seriously sick. It is estimated that there are over 15,000 children who are in the need for special care. Most of the HIV/AIDS patients within the project road districts are found in Machakos Town and in all the towns along the Mombasa highway, and most of the latter cases are attributed to the long distance truck drivers/touts and commercial sex workers (*Machakos District Development Plan, 2002 – 2008*).

### 3.5 CLIMATE AND RAINFALL

Machakos District is generally hot and dry, with two rainy seasons: the long and short rains. The long rains start at the end of March and continue to the end of May, and the short rains start at the end of October and continue to the end of December. The average rainfall in the project area varies from 500 to 1300 mm with high altitude areas receiving more rain. The project road falls under agro-climatic zones IV and V classified as semi-humid to semi-arid (Appendix B). Towards the end of the project road the environment is semi-arid.

Temperature slightly varies along the project road, getting progressively warmer towards the end of the road. The mean average maximum temperature is 25°C and the average minimum temperature is 12.3°C (Engineering Report, 1992). The coldest months being July to August, while October and March are the hottest (*Machakos District Development Plan 2002 – 2008* and *Agro-climatic Zone Map of Kenya, 1980*).



### 3.6 TOPOGRAPHY, HYDROLOGY, GEOLOGY AND SOILS

The Embakasi – Machakos Turn-off road is characterised by rolling terrain, with one notable hill at Km 25.4, Lukenya Hill. The project road traverses the Athi Plains, and all catchments drain in a south-easterly direction towards the Indian Ocean on the Kenyan coast. The terrain can be described as generally flat to rolling.

The road traverses a variety of soil types of which there are five soil types evident: Vertisols and Rendzinas – poorly drained black cotton soils evident at the start of the project road.

Luvisols, rhodic Ferrasols and luvic Arsenosols – well drained sandy clay loam soils  
From approximately Km 13 to Km 15 the soils are well-drained slightly to moderately calcareous gravelly clay soils. From approximately Km 20 to Km 25 the soils are well-drained loose, loamy coarse sand to friable sandy clay loam. Towards the end of the project road at the Machakos Turn-off, the soils are imperfectly drained moderately deep, dark greyish brown to black, very firm, gravelly, cracking clay (Exploratory Soil Map and Agro-climatic Zone Map of Kenya, 1980).

These soils are developed on quartz–feldspar gneisses. The area is occupied by rocks of basement system which are generally of Tertiary and Achaean age.

Rainfall is inadequate and unreliable, water from the permanent rivers and dams is not fully harnessed. Ground water resources are low and saline because of the basement rock systems (Machakos District Development Plan, 2002 – 2008).

There are a few surface water bodies along the A104/A109 project road. These include the swamp crossing at Km 13.4, and the Athi River crossings at Km 17.1 and Km 26.0. A bridge provides access over both river crossings. In the major towns such as Athi River, and market centres, there is competition for water use among the domestic, livestock and industrial sectors. Due to the increase in population and growing economic activity, water resources is becoming increasingly scarce (Machakos District Development Plan, 1997 – 2001). Indeed, an inefficient water supply is the one major drawbacks to further investment opportunities in the area (Machakos District Development Plan, 1997 – 2001). To address this situation, programmes aimed at protecting the water catchment areas and harnessing water from Athi and Tana rivers are proposed to be undertaken under the 'Effective Management for Sustainable Economic Growth and Poverty Reduction' (Machakos District Development Plan, 2002 – 2008).

### 3.7 VEGETATION, FORESTS AND FOREST RESOURCES

The vegetation along the project road consists mainly of scrub and grass. The type of vegetation cover along the project road is predominantly of the Mimosoideae family of Acacia trees. Acacia species are dominant where man, fire or animals have destroyed tree cover. Common Acacia species found along the project road include the Yellow fever tree and the Whistling Thorn. There is also extensive grass cover along the road. Grasses include the *Tetrapogon bidentatus* and *Chrysopogon ancheri* species.

Forests are only found on the hilly masses in the high potential parts of the district. Gazetted forests cover an area of 706.6 ha, while ungazetted forests cover an area of 1,619 ha (Machakos District Development Plan, 2002 – 2008). There are no forest reserves within the immediate area of influence of the Embakasi – Machakos Turn-off road.

### **3.8 AGRO-ECOLOGICAL ZONES**

The Agro-Ecological Zones (AEZs) give an indication of the land potential, which is dependent on sound farming practices, improved seed and regimented planting programmes and on the rainfall probabilities. The AEZ map (Appendix B) shows the AEZs for the project road (Machakos District Development Plan, 1997 – 2001).

The project road lies in Upper Midland (UM) zone VI, which is exclusively a ranching zone, though with irrigation run-off catchment techniques farming can be practised (Machakos District Development Plan, 1997 – 2001). But as a district, 70% of the population work in the agricultural sector (Machakos District Development Plan, 2002 – 2008).

### **3.9 WILDLIFE**

Wildlife can be found along the ranches on the project road. These are established game ranches for commercial purposes. Wildlife spills over from the protected Tsavo National Park and Nairobi National Park into the Athi-Kapiti Plains (*Machakos District Development Plan, 1997 – 2001*).

### **3.10 MINERALS AND MATERIALS**

There are deposits of limestone found in Athi River Division. Limestone is a raw material for cement production. Pozzolana deposits are found along the project road. Pozzolana is mined and used as a binding agent in cement production. Granite deposits have also been found in Athi River Division. Sand, which is harvested along rivers and streams in the district, is sold to the major towns including Nairobi, Thika, Machakos and Athi River for use in the building and construction industries (*Machakos District Development Plan, 1997 – 2001*).

### **3.11 CURRENT LAND USE ACTIVITIES**

Crop farming in the project area is mainly for subsistence purposes. The main food crops grown include maize, beans, pigeon peas, cowpeas, sorghum and cassava. There are two flower farms along the project road, one of which is next to the existing road at Km 20. In Mavoko Division flowers (predominantly roses) are the main cash crop grown.

Land use activities are very limited and vary along the project road, these being governed by factors such as climate (rainfall and temperature), soil conditions, altitude, and limited use of farm inputs such as pesticides and fertilisers. Between Embakasi and Athi River the land adjacent to the project road is used for commercial and industrial purposes.

Most of the remaining land along the road is used for large scale commercial ranches (beef and dairy cattle) and wild game animals. Dairy and beef cattle populations have increased steadily over the years due to increased local demand. Other livestock reared in the district include sheep, goats, rabbits, pigs and bees. Livestock is a major economic activity in the district. Almost every household owns cattle and/or sheep and goats (*Machakos District Development Plan, 1997 – 2001*). As a district, close to 80% of the population work in the livestock sectors (*Machakos District Development Plan, 2002 – 2008*).

### 3.12 INDUSTRIAL ACTIVITIES

The start of the project road is characterised by a number of industries including Nation Printers and KAPA Oil Refineries (the latter produces cooking oils and margarine).

Athi River is considered by many as the industrial centre of Machakos District (Pers, Comm. Julius Inyingi, Machakos District Public Health Officer). The town is the hub of industrial activity and is the fastest growing town in the district. The cheap and sparsely settled land, its strategic location along the Nairobi-Mombasa highway, the railway, and proximity to Nairobi make Athi River Town attractive for industrial investment. The town is the base for a number of large industries such as Mabati Rolling Mills (MRM), and East African Portland Cement. In 1990, the Government of Kenya established the Export Processing Zone to provide an attractive investment opportunity for export-oriented business ventures within designated areas or zones.

Development of a dual carriageway will lead to improved access to and from these industries, and in-turn reduce transport times for goods and services. The project road is therefore likely to attract new industries.

## CHAPTER 4

### KEY COMPONENTS OF THE PROJECT ROAD

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The design of the project road and a description of the section by section defects is presented in detail in the preliminary engineering design report.

For the purposes of this environmental impact assessment study, it is necessary to understand features that are to be included in the road design in order to identify significant impacts that may arise from the project.

#### 4.1 CONSTRUCTION HISTORY

The 15 Km long section between Nairobi and Athi River was constructed on a new alignment in 1974/75 and received an overlay pavement in 1988. The section between Athi River and the Machakos Turn-off was constructed in 1956.

The most pertinent features of the existing road are listed below:

- It has severely damaged pavement edges along much of the section and the shoulders are virtually non-existent on the section from Athi River to the Machakos Turn-off;
- The carriageway is 7.0 m wide between Nairobi and Athi River and 6.0 m wide between Athi River and the Machakos Turn-off;
- The surface of the road is very rough due to extensive cracking, rutting and pot holing of some sections;
- Drainage is also major problem in some areas. Around Km 5.8 at Mlolongo and Makutano at Km 33.5 there are no drainage structures and as a result large pools of water have accumulated by the roadside. At Km 7.52 the road descends, and there is no provision for drainage or control of road runoff along this section of the road.
- Drainage structures require evaluation with regard to their structural strength and drainage capacity.

#### 4.2 PROPOSED STRUCTURAL AND DESIGN CHANGES

The road is constructed to bitumen standard. The new carriageway will be on the right-hand-side and generally 25 m from the centreline of the existing carriageway. A summary of the proposed structural changes is presented below:

- Two new bridges are to be constructed at a point 80 metres upstream of the existing bridge across the Athi River at Km 13.7. The new bridges will have spans of 3 x 30 m, with an overall deck width of 10.5 m with 7.5 m for the 2-lane carriageway and 1.5 m footpaths on either side;

- A new Stony Athi River bridge is to be constructed at a point 32 metres upstream of the existing bridge at Km 17.1. The existing bridge is too narrow for present day standards and no footpaths are provided. The new bridge will have spans of 15 – 20 – 15 metres with 1.5 m footpaths on each side;
- Structures for the grade-separated junctions;
  - At the Namanga junction, Km 11.7, two independent bridges have been proposed to be located just after the A104/A109 junction. The two bridges will carry the Nairobi-Mombasa dual carriageway, while slip roads beneath will be used for Namanga-bound traffic.
  - At Stony Athi a new bridge is proposed for the Nairobi bound lanes.
- Box culverts and gabion works will be necessary to improve drainage along the project road;
- Scour and erosion protection measures and channelling watercourses involving the installation of gabion boxes and mattresses will be required particularly at the steep sections of the road;
- The proposed design speed for the whole project road is 110 kph, which is the speed limit for dual carriageway traffic;
- Between Km 0 and Km 12.5 the new carriageway will be constructed parallel to the existing one with an offset of the centre line of 25 m. Beyond Km 15 up to the end of the project road the new dual carriageway will be accommodated within the existing road reserve; however, construction works do not cover and will not affect the Nol Turesh water pipeline.

While no alternative routes are being considered for the road alignment, various options are being considered for improving the carriageway, as follows:

- Single carriageway with climbing lanes on steep sections
- Dual carriageway for the section from Embakasi to Mlolongo
- Dual carriageway for the section from Embakasi to Namanga Road Junction
- Dual carriageway for the section from Embakasi to Machakos Turn Off.

Other considerations:

- The width of both carriageways is 7 m and the width of the shoulders is 2.5 m and 1.0 m, respectively.;
- The average width of the median is 17 m. One section, at Km 5 will have a median of 27 m;

- Deviations will be necessary over short sections to enable uninterrupted traffic flow during construction;
- Six material sites for the various improvement and rehabilitation works have been identified and material investigations are still on-going. All the material sites are located along the project road. The area investigated for each material site was no more than 40,000 m<sup>2</sup>. The smallest site investigated was 12,000 m<sup>2</sup>;
- Workmen's camps will have to be located along the road at Nairobi, Athi River and Machakos or at the abandoned Crescent Construction contractors camp located at Km 31.8 on the left side of the road.
- As part of the feasibility study, contract and tender documents are to be prepared to include environmental considerations.

## CHAPTER 5

### EXISTING IMPACTS AND OBSERVATIONS

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#### 5.1 GENERAL

A comprehensive study of existing environmental impacts due to the existing road was not carried out. However, from observations made in the field and discussions held with various people, a number of aspects affecting the natural, physical and social environment were noted. These observations are also intended as useful pointers during the design stage of this project.

#### 5.2 POSITIVE IMPACTS

##### 5.2.1 Economic Benefits

The Embakasi – Machakos Turnoff (A104/A109) road is part of the Nairobi – Mombasa international trunk road, and carries a substantial amount of traffic including heavy goods vehicles. The road has stimulated the growth of trade centres such as Mlolongo and Makutano, and will further stimulate the growth of trade along the road.

Since 1990 when the Athi River Export Processing Zone (EPZ) was created to provide an attractive investment opportunity for export-oriented business ventures, the EPZ has continued to grow creating a number of jobs for hundreds of people in the area.

As part of the economic feasibility, detailed economic benefits derived from the upgrading of the project road to dual carriageway standard will be determined, and the internal rates of return for the proposed improvement works will be calculated.

#### 5.3 NEGATIVE IMPACTS

##### 5.3.1 Hydrology and Drainage

Drainage problems are a factor featured along the project road. Drainage is poor especially in the flat areas along road and in settlements, notably at Mlolongo at Km 5.8 and Makutano at Km 33.5. Run-off from the urban settlements contributes to the drainage problem.

Just after the weighbridge at Mlolongo the soils are black cotton, commonly associated with the Athi Kapiti Plains. Large pools of water have accumulated around this area.

At Km 7.52 the road descends, and there is no provision for drainage and the control of road runoff along this section of the road. After the turn-off to Athi at around Km 13.4 the road crosses a swamp.

Along the length of the road the drainage ditches are not clearly defined and have not been properly maintained, and as a result are blocked and covered with vegetation. The structural designs of the culverts will need to be reviewed as part of the investigations. The detailed hydrological survey study will determine any sensitive areas along the project road.

### **5.3.2 Erosion**

Generally erosion is not a serious problem along the road mainly due to the flat topography of the land (except for a few sections).

### **5.3.3 Impact on Town Centres**

The junction at Makutano at Km 33.5 is heavily congested due to the parking of lorries and trucks on the side of the road. Although there are bus stops at Mlolongo and Makutano, these are located on the main road, with no provision for vehicles to pull in and out of the bus stops. This kind of situation results in congestion and creates a safety hazard to the commuter vehicles and other road users.

Shops and kiosks are located adjacent to most of the bus stops. Consequently there is a substantial amount of solid and liquid waste, including human waste accumulating at the road junctions and the road side and no proper waste disposal measures are in place.

There is already considerable pressure on local natural resources including water and fuel wood attributed to the population growth and economic activities along the project road, especially at Mlolongo and Makutano.

At Mlolongo and Makutano the long haul truck drivers engage in illicit sex with the commercial sex workers. Most of these individuals are dying from the opportunistic diseases associated with HIV/AIDS, the most prevalent being tuberculosis<sup>1</sup> (Pers, Comm. Julius Inyngi, District Public Health Officer).

### **5.3.4 Pollution**

Minor servicing of the trucks is done on the road reserve, especially around Mlolongo and Makutano. As a result, oil is washed on to the roadside vegetation due to of lack of proper storm water drains. It is likely that this oil eventually seeps into watercourses in the area.

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<sup>1</sup> At the time of the interview Mr Inyngi was attending a seminar and did not have any statistics on him



### 5.3.5 Road Safety

Mlolongo and the junction at Makutano have become established truck stops and pose a significant hazard to both vehicles and people. Heavy goods vehicles, as well as commercial vehicles, are parked on the side of the road, impeding visibility for on coming traffic along the main road and traffic entering on to the main road. There is only one health facility, the Athi River Health Centre, between Athi River and the Machakos turn-off that handles accident victims along this section of the road. Currently it cannot cope with the road traffic accidents (RTAs).

There is some wildlife movement along the road, especially between Km 19 and Km 26. Livestock movement was also noticed along the road. There are no road signs to warn motorists of their presence, nor are there designated cattle crossings along the road.

### 5.3.6 Road Reserve

Encroachment onto the road reserve was noticed at most trading centres along the project road, but is particularly obvious at Mlolongo and Makutano. Structures found within the road reserve included shops, hotels/bars, and other businesses.

Encroachment of vegetation, and crops in particular, onto the road reserve was evident along the project road. Although the presence of such vegetation is beneficial for the road edges, in that it reduces the risk of erosion of soil on the road embankment, it is a danger to the traffic as it will increase the side friction and reduce the sight distances and thus affect the safety.

### 5.3.7 Design

The Machakos District Roads Engineer proposed that if the entire road cannot be upgraded to a dual carriageway, then at least the section from the Athi River turn-off to the Machakos turn-off should be reconstructed and the road widened. Presently carrying out routine maintenance is proving very costly for the MoRPW&H (Pers, Comm. Mr Shachile, District Roads Engineer).

### 5.3.8 Landowners

A number of landowners along the project road have, over the years, been subdividing their land and selling it to individuals who are not aware that the land they are buying encroaches onto the road reserve. The landowners carry out this activity without dealing with the Lands Office, and obtain fake title deeds which are passed on to the unsuspecting buyers (Pers, Comm. Mr J. O Kemoni, District Lands Officer).

The socio-economic study to be carried out by Gibb East Africa will assess land tenure and transfer systems. This will include common property and non-title based usufruct systems governed by local recognised land allocation mechanisms and any

issues raised by different tenure systems in the project area (squatting, temporary occupation license, rented etc). This will be done taking cognisance of World Bank and government of Kenya definition criteria.

## CHAPTER 6

### ANTICIPATED IMPACTS DUE TO THE PROJECT ROAD

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#### 6.1 GENERAL

This chapter focuses on the impacts likely to occur as a result of the proposed construction works on the project road. For ease of reference, the impacts due to or affecting certain elements during construction and operation are presented in tabular form below. Mitigation measures for the various impacts are described in Chapter 7, while monitoring of impacts is dealt with in Chapter 8.

- In general, environmental issues likely to be of concern during the construction phase of the project road include:
- Nuisance from noise and air (dust) pollution;
- Minor ecological damage from the clearance of areas for construction camp, and storage of materials (fuel, lubricants and machinery);
- Water and materials supply for the construction works; and
- Social disturbance caused by the teams undertaking the construction works.

Impacts can be positive or negative, direct or indirect. The magnitude of each impact is described in terms of being significant, minor or negligible, temporary or permanent, long-term or short-term, specific (localised) or widespread, reversible or irreversible.

These qualities are indicated in the assessment table below as follows:

Key	Type of Impact	Key	Type of Impact
++	major positive impact	+	minor positive impact
--	major negative impact	-	minor negative impact
0	negligible/ zero impact	NC	no change
sp	specific/localised	w	widespread
r	reversible	ir	irreversible
sh	short term	L	long term
t	temporary	p	permanent
Y	mitigation of negative impacts/ enhancement of positive ones IS possible	N	mitigation of negative impacts/ enhancement of positive ones is NOT possible

Generally, temporary impacts having no obvious long term consequences are regarded as being minor. But those with long term repercussions are classified as significant. Significant positive impacts are usually associated with improved access, which is the prime objective of the rehabilitation project.

## 6.2 ANALYSIS OF ANTICIPATED IMPACTS

Construction of the dual carriageway is likely to present several environmental and social impacts, which are described in Table 6.1 below:

**Table 6.1** Anticipated Environmental Impacts on the A104/A109.

Impacts on or due to	Construction Mit		Operation Mit		Remarks
	- ir t	Y			
Changes in hydrology/ drainage	- ir t	Y	+		The existing road has already altered the hydrology of the area because runoff is channelled through culverts. The flow of runoff will be altered temporarily during the construction process due to blocked drains and culverts. Provision of new bridges and culverts has been made in the design. A review of the design and positioning of existing culverts will be made to ensure no future blockage by siltation and plant overgrowth that will impede water flow. As a result drainage will be improved.
Soil erosion	- L sp	Y	-	Y	Earthworks (during road construction, and creation of gravel pits) and deviations will have an impact on soil erosion, which may continue after construction. Incorporating appropriate soil conservation measures and proper drainage facilities during construction would mitigate impacts during operation. During operation, maintenance of structures would also prevent soil erosion.
Pollution: air dust noise oil wastes sediment loads	-- t ir -- t ir -- t ir -- L ir - t ir	Y Y Y Y Y	-- p ir -- p ir -- p ir -- L ir	Y Y Y Y	During construction there will be air, dust and noise pollution, but this will be temporary in nature. Blasting of rock outcrops will be necessary. Oil wastes however will have a longer-term impact. Sediment loads (building debris) in water courses will increase due to the construction of the dual carriageway, culverts, and deviations.  During operation, air, noise, dust and oil waste pollution will affect market centres, settlements/households along the road. Pollution due to sediment loads (apart from soil) will not be a problem during operation. Mitigation is possible through consideration on the part of the Contractor and motorists, or legal enforcement.

Impacts on or due to	Construction Mit		Operation Mit		Remarks
Loss of land	-- p ir	Y	0		Land will have to be acquired for the proposed dual carriageway, and the extended road reserve. This will be a permanent, irreversible impact, and mitigation will be in the form of resettlement and compensation. Deviations would necessitate temporary loss of land in some places if it goes beyond the road reserve. The deviations can be used again for cultivation afterwards.
	-- t r	Y			
Loss of crops	- p sp	Y	0		Any crops on the road reserve will be cleared during road construction works. Loss of crops due to the dual carriageway, extension of the road reserve, and deviations, or provision of access roads to borrow pits will have to be compensated for provided they lie on private property.
Materials sites	-- p r	Y	-- p r	Y	Negative impacts such as soil erosion, loss of crop productivity, hazards to children and livestock, water accumulating in the pits providing a breeding ground for mosquitoes may result from pits and quarries that are not reinstated/landscaped or fenced.
Sand sources	-- ir p	Y	- ir	Y	Sand should be taken from authorised sand sources and not from small rivers as this may alter the hydrological regime of the river
Wetlands	0		0		No wetlands of significance will be affected by the road works or during the operation of the road.
Forests	0		0		There are no forests along the project road that will be affected during construction or the operation of the road.
Water resources	-- sh	Y	--	Y	The scarcity of water along the project road may put pressure on the local communities. During operation, the demand for water could continue to persist due to an increasing population and economic activities.
Wildlife	- r	Y	-	Y	Wildlife is found along the road and sometimes crosses it. Wildlife will be disturbed by on-going construction works. Mitigation includes the placement of warning signs and raising awareness among construction workers and all road users by use of signs.
Vegetation/Flora	- p ir	Y	0		Clearing of vegetation will be necessary for the dual carriageway, extending the road reserve, and deviations. The natural vegetation is not regarded as having any special conservation significance. However, clearing activities could encourage soil erosion.
Fauna	- p ir	Y	0		Clearing activities may disturb small animals and birds and their homes/nesting sites. Any

Impacts on or due to	Construction Mit		Operation Mit		Remarks
					clearing should be done with the utmost consideration for the animal species, and there should be no unnecessary clearing activities.
Livestock movement	- p sp	Y	- p sp	Y	Warning signs should be erected at intervals along strategic locations of the project road, and designated cattle crossings provided.
Settlements / Induced settlements	- t	Y	-- p	Y	During construction, there will be temporary disturbance due to noise and dust. These impacts will continue to occur during operation There could be upsurge in induced settlements along the road on approach to the trade centres and at the major junctions. Chiefs and local councillors should monitor the development of settlements along the road through awareness campaigns and proper planning.
Employment opportunities	++ t		0		The local people will benefit from temporary employment during road improvement activities. This will benefit their families and the local economy. The EPZ will continue to grow creating a number of jobs for hundreds of people in the area.
Workmen's camp	+ sh -- L r	Y	0		Some benefits are expected from increased business due to the workforce at centres such as Mlolongo and Makutano. However the presence of the camp is likely to lead to an increase in water usage and fuel wood putting a strain on the local communities. Solid waste disposal and sanitation problems will be an issue. Workmen's camp should preferably be located at urban centres such as Athi River or Mlolongo, or at the existing Crescent Construction Contractors camp at Km 31.8.
Public health	- t ir w -- p ir w	Y Y	- p w ir -- p ir w ++	Y Y	During construction and operation, increased dust, noise and air pollution (leaded exhaust fumes) levels will impact on public health. Workers on road projects, and truck drivers are associated with the spread of sexually transmitted diseases. Awareness campaigns in centres and at the workmen's camp would help to mitigate this problem. Better access to health facilities such as the Athi River Health Centre can be regarded as a major positive impact.
Road safety	t sp r	Y	-	Y	During construction there will be some danger to people along the existing and proposed new carriageway, but this can be mitigated with awareness campaigns and road signs, and by providing segregated footpaths

Impacts on or due to	Construction Mit		Operation Mit		Remarks
			++	Y	and cycleways that can be used by non-motorised traffic. The construction works will be designed to improve road safety during operation. Road safety can be further enhanced, by awareness and educational campaigns. The erection of warning and directional signs particularly when approaching densely populated areas, such as market centres and major junctions. There is a need to provide an additional health facility, and improve the Athi River Health Centre to a hospital standard with specialists.
Visual intrusion	- t/p	Y	--	Y	During construction visual intrusion will be due to road works and traffic. During operation there will be nocturnal glare. Mitigation will be achieved through controlling traffic, sensitising motorists and clearing of construction debris, and planting shrubs within the median.

### 6.3 SUMMARY OF MAIN ISSUES

#### Economic Benefits

Improvement of this road will greatly enhance traffic flow and further contribute to the national economy, as this road forms part of the major highway from the port of Mombasa to Uganda, the Democratic Republic of Congo, Rwanda, Burundi and southern Sudan.

The development of a dual carriageway will lead to improved access to and from the industries in EPZ. Such a development will reduce transport times for goods and services from and to the EPZ, and in turn encourage further development of the EPZ.

The road is designed such that road safety along it will considerably improve. This in itself has a considerable economic benefit: loss of life of one employed individual has a high economic cost in terms of loss of national productivity, loss of income to the family, and related livelihood factors.

There are numerous sociological and socio-economic benefits, resulting from improved access to schools, health facilities and trade centres associated with road projects. Though these institutions are few, the improved road will contribute to increased productivity and thus an ultimate improvement in standards of living. Improved access means these institutions can be better staffed and equipped. Better access will inevitably increase the price of land along the road. However, overall the impact on these institutions will be minimal, as they are still accessible at present, despite the condition of the road.

### **Soil Erosion**

Earthworks during construction and along steep sections will result in some soil erosion which is unavoidable. Improper drainage of runoff from the road to lower catchments can also cause erosion. Incorporating soil conservation measures during construction would help to mitigate damage caused by erosion.

Clearing of vegetation for the new dual carriageway, and excavating murrum from gravel pits with slopes exceeding 4% could result in an increase in runoff along the slopes and thus encourage erosion.

### **Pollution**

Exhaust and engine emissions from vehicles cause air pollution, which can have an impact on public health, as well as soils, crops and water supplies.

Where culverts, drains and retention ditches are required, sediment loads in the rivers and streams will increase as a result of construction debris and excavation works along the banks. The Resident Engineer should ensure that the Contractor disposes of all construction debris in a sensible manner, and does not throw it into any of the rivers/streams. Air, noise and dust pollution and disposal of oil wastes is already occurring to a certain extent (whether significant or not) along the project road. The situation will be exacerbated temporarily during construction, but it is expected that pollution from vehicle emissions may in fact reduce as congestion is reduced, and there will be less idling.

During construction and operation, oil wastes may become an issue if oil is carelessly stored, handled, or drained from construction vehicles and equipment.

### **Loss of Land**

Land lost as a result of the proposed dualling of the Embakasi to Machakos Turn-off will be inevitable and pose a significant impact to land and property owners along the project road. In addition, land will have to be acquired to accommodate an extended road reserve as required for a dual carriageway (- according to the MoRPW&H Road Design Manual, the width of the road reserve is 60 m for a Class A road). The creation of deviations in some parts will also result in the loss of land, although this is expected to be minimal.

Details on the amount of land that will need to be acquired and the number of households that will be affected will be determined during the detailed socio-economic study and RAP to be carried out by Gibb.

There are a number of commercial and industrial businesses between Embakasi at the start of the project road, Km 0.0, to Athi River at Km 16. Shops, kiosks and houses have been set up within the road reserve, these may have to be removed, but from a legal standpoint the owners are not eligible for compensation. But owners holding legitimate title deeds for their land will need to be properly compensated for the loss of their land.

One positive impact will be the increase in the value of land beside or near the road once the duelling of the A104/A109 is complete.



## **Deviations**

The need for deviations is considered to be minimal, as the existing road can be maintained on most sections while the new lane is being constructed. However, in the event that deviations are required, they should ideally remain within the road reserve. In some cases, this is not always practical or possible, so traffic may have to be diverted temporarily across private land. In such cases, landowners will have to be compensated for loss of crops/grazing land, nuisance, fencing, etc.

If deviations are made, then they should be demolished, scarified and re-vegetated after construction.

The Contractor will need to institute traffic control measures. This level of construction work requires deviations for safety reasons and to reduce construction costs but is subject to availability of space.

## **Materials Sites**

Major concerns relating to gravel sites and hardstone quarries include vegetation clearance, landscape scars, dust and general disturbance during excavation, and the need to reinstate or landscape the sites when the Contractor has completed quarrying.

Most of the gravel sites are on privately owned land with homesteads on them or located fairly close by. Dust and noise during excavation and quarrying will therefore affect most of these homesteads. The Resident Engineer will need to establish the general wind directions on project roads and advise the Contractor accordingly.

Hardstone will be sourced from existing bonafide commercial quarries.

Traffic to the materials sites will also pose a nuisance to people living around them.

Erodibility depends largely on soil type and to some extent on the gradient of the site (slope). Gravel pits are more susceptible to erosion than hardstone quarries. In general the soil types found at the gravel pit locations are fairly stable and on relatively flat ground reducing the chance of extensive erosion.

## **Induced Settlement**

The dual carriageway is likely to encourage further development at Mlolongo and Kyumvi, and possibly at other locations along the road. There are a number of environmental and social issues that emanate from induced settlements along roads, such as erection of unplanned structures, lack of provision for sanitation and water supply, road safety concerns due to vehicles stopping at these centres and pedestrians crossing or walking along the road.

## **Workmen's Camp**

During construction works, there will be some direct employment opportunities for both skilled and unskilled labour with the construction teams along the project road. Furthermore, indirect employment opportunities are bound to arise from the provision of services to the construction teams.

Construction teams have the potential to cause natural resource degradation in terms of accelerating tree felling, hunting and vegetation clearance at the location. In setting up the workmen's camp, consideration must be given to fuel supplies and water availability. It is likely that the workforce will put an additional demand on fuel wood for cooking. This demand may affect local fuel wood supplies and may also compromise its availability to the local people. Water sources are limited along the A109. The demand for water will put temporary pressure on local supplies. Water in the camp is important in terms of maintaining hygiene and sanitary conditions. The Contractor may need to sink a borehole, and for this he would require an environmental impact assessment study.

The camp would also generate solid and liquid waste, the disposal of which will need to be addressed, as the settlements/towns along the project road are not served by sewage systems or waste collection services.

The actual location of the camp will determine the extent of the impacts due to the camp. Along A104/A109, the ideal location for the camp is near centres such as Athi River and Mlolongo. Another possibility is the old Crescent Construction camp at Km 31.8, which was used by a Contractor between 1989 and 1993 during the works on the Machakos Turn-off to Ulu section of the A109.

### **Congestion**

Congestion will reduce along the road, especially along the section from Athi River to Mlolongo for traffic going towards Nairobi, and traffic from Namanga joining the A109 at the Athi River junction (Pers, Comm. Mr Shachile, District Roads Engineer). The link between the A109 and the A104 (Athi River Turn-off) is an important detail in terms of ensuring smooth traffic flow, reduced congestion and better safety for the road users (Pers, Comm. Mr Kiruja, District Works Officer).

### **Road Safety**

The road will be designed so as to improve road safety. Design features include separating directional traffic and the provision of separate footpaths and cycle lanes for NMTs. As mentioned above, the economic benefits resulting from reduced mortality and morbidity rates through enhanced road safety are considerable. However, road traffic accidents will still occur due to high traffic speeds and motorists' behaviour.

### **Access and Egress**

Access and egress to and from industries and other plots along the road will have to be considered. In this case service roads to industries on both sides of the carriageway will be retained and planned as appropriate.

Another issue of concern is accessing and exiting the dual carriageway at major junctions, particularly at Athi River Town and Makutano (for Machakos). The design makes provision for safe access and exit at these junctions, by providing flyovers. However, in both cases, land will have to be acquired for this purpose, and structures and buildings will have to be demolished.

## **Public Health**

Improvement works and traffic during operation will create dust, air and noise pollution, which can have an impact on public health. Oil wastes from vehicles can also impact on public health if they find their way into water sources.

Exhaust fumes from leaded fuel can in the long-term lead to renal complications for people whom residing along the road reserve. Equally the leaded compounds will accumulate on any roadside vegetation planted for consumption purposes. Vehicles moving along the road will cause vibrations that can affect road side buildings (Pers, Comm. Julius Inyingi, District Public Health Officer).

Sanitation and hygiene in the workmen's camp are also issues of concern, and if not properly addressed may lead to outbreaks of illnesses such as hepatitis, typhoid, intestinal worms, etc. The water line from Mlolongo to the Machakos turn-off should not be interfered with, as this is a critical water source for the area (Pers, Comm. Mr J. O Kemoni, District Land Officer and Julius Inyingi, District Public Health Officer).

Road projects are associated with an increase in sexually transmitted diseases such as STDs and, HIV/AIDS due to the influx of workmen interacting with the local people. Construction teams, as well as the greater number of drivers who are expected to pass through the trade centres and settlements, can also cause social upheaval among communities along the project road.

The dual carriageway is likely to encourage further developments at Mlolongo and Kyumvi. In this regard the local council (Mavoko) should look into providing services such as piped water, sewage works and garbage collection (Pers, Comm. Ms. Oceanic Sakwa, District Environmental Conservation Officer).

## CHAPTER 7

### MITIGATION OF IMPACTS

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#### 7.1 PROPOSED MITIGATION MEASURES

This chapter focuses on measures that can be incorporated into the design, and during construction and operation stages of the Embakasi – Machakos Turnoff road in order to mitigate the negative environmental impacts and enhance the positive ones described in Chapter 6.

##### 7.1.1 Hydrology and Drainage

Changes to the hydrological regime will be taken into account in the road design through the construction of box culverts and bridges so that flow in the rivers and streams is unimpeded, and improve drainage along the project road through side drains. These may be lined, and may require cascades to break the impact of water flowing in them, particularly in sections with gradients greater than 4%.

These features must be properly designed and regularly maintained to prevent runoff from accumulating by the side of the road, and to ensure that water that is drained off the road does not create gullies, and that siltation of the structures does not occur. Safe final disposal and self-cleaning are essential elements in designing drainage structures. In some cases, particularly in black cotton areas, the construction of lined drains may be necessary to facilitate the safe discharge of runoff to the final recipient body.

As a result of incorporating these drainage structures, drainage along the road will substantially improve, particularly at Mlolongo and Makutano.

##### 7.1.2 Soil Erosion Control

The speed of road runoff is one of the major contributing factors to erosion and scouring in the side drains along the slopes of a road. In order to reduce the impact of runoff, scour checks and gabion mattresses will be introduced in the side drains at specified intervals, depending on the gradient of the slope. Grouted stone pitching and rock fill gabion works will be necessary to protect culvert inlets and outlets and control soil erosion.

Earthworks should be controlled during construction, so that land that is not required for the dual carriageway or deviations is not disturbed.

The specified cut and fill gradients (1:1.5) must be adhered to, and the embankments should be planted with shrubs and grasses to reduce erosion of road embankments.

Areas that have been cleared of vegetation, e.g. gravel sites or deviations, must be planted after completion of works. Indigenous *Acacia* trees and shrubs should be planted along the project road. This has the advantage of controlling soil erosion, reducing soil stability problems and beautifying the road.

In order to ensure that environmental protection is taken into account during construction, these issues must be specified in the contract documents.

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### **7.1.3 Pollution**

Dust emissions can be reduced during construction by dampening the gravel pit area, and occasional spraying with water along the deviation routes or earth along the road section. In the case of deviations, slowing the speed of traffic by using bumps and/or clearly marked road signs may contribute to reducing dust levels.

Poorly maintained vehicles often emit noxious fumes (carbon dioxide, carbon monoxide, and nitrogen and sulphur oxides). There is also much documentation on lead concentrations in the blood of people residing beside roads. Such issues need to be addressed at a national level, through encouraging the use of lead free petrol, and introducing "road worthiness tests" which must be passed before road licenses are issued.

Noise abatement can be done through sensitising motorists/truck drivers, particularly at the market centres, by using signboards and conducting awareness campaigns. Regulations should be introduced that restrict the movement of heavy vehicles through settlements after certain hours.

Oil is often drained from trucks and lorries by the side of the road, usually in the settlements/centres. Such maintenance activities should be carried out in specially designated trucking stops or at petrol stations. This can only be assured through legal means. Contamination of soil and/or water sources resulting from oil in stormwater drains can be controlled through installing oil sumps at truck parking bays (e.g. at the weighbridge at Mlolongo and at Makutano), and at the point where stormwater drains meet rivers or streams.

Installing culverts during the dry season, wherever possible can reduce sediment loads in the rivers and streams. In addition, the Resident Engineer should ensure that the Contractor disposes of all construction debris, including oil and oil wastes, in a sensible manner. Disposal of waste into any water bodies (rivers/streams) should be prohibited.

In the sections having black cotton soil, construction works will require the excavation and removal of all the soil, and replacing it with gravel. A site, to be approved by the local authorities and NEMA, will have to be identified in order to dump this spoil. The Contractor will be responsible for the identification of the dump site.

### **7.1.4 Deviations**

Deviations may be necessary for only a few small sections of the project road. They should, wherever practical, adhere to the road reserve. All deviations must be planned and their routes specified in the contract documents.

As a condition of contract, any trees removed for the purposes of the deviation, must be replanted when the road works are complete and the deviation ceases to be of use. After construction the deviations should be demolished, scarified and re-vegetated.

### 7.1.5 Compensation

Loss of land, crops and housing is mitigated through compensation. The Commissioner for Lands in the Ministry of Lands and Settlement determines the amount of compensation to be paid for private land. When the road design is finished, the MoRPW&H must instruct or notify the Commissioner for Lands of its intention to construct the road. All technical details of the road design and gravel pits (including drawings and plans, details of location, volume of materials required, etc.) must be submitted along with the letter of notification.

The Consultant will indicate the amount of land required for the construction of the dual carriageway, extended road reserves and deviations, and the number of households and or businesses that will have to be compensated. The Commissioner for Lands then verifies the amount of land required for the proposed works, the market value of the land itself, value of crops lost, value of buildings on the land that may be affected, environmental and social implications, etc. The Ministry of Lands and Settlement then acquires the land for the MoRPW&H.

Compensation has to be fair and transparent. A new survey will need to be carried out to reflect the area and value of the remaining land (assuming land has been taken for the construction works), the owner would then surrender the title deed and a new title will be issued by the Land Offices reflecting the new acreage (Pers, Comm. Mr J. O Kemoni, District Lands Officer). Until all the alignments have been finalised, it will not be possible to determine the extent of compensation required.

Only people with genuine title deeds should be compensated. Persons living on the road reserve are not eligible for compensation, but IDA requirements state that all persons, even those without legal rights to the land in question, should receive compensation for structures, property and crops. People residing alongside the project roads, must be made aware, through Chiefs and local councillors, that by law they are not allowed to build structures or grow crops in the road reserves, and if they do so, they are not entitled to compensation of any sort. Both parties should be dealt with at an early stage.

There will also be people who legally own land to be acquired for the purposes of the road will need to be relocated as well. In addition, the relocation of a few businesses is also expected.

A detailed compensation and resettlement plan will be required to address the above-mentioned issues satisfactorily. One of the objectives of the baseline socio-economic study and resettlement action plan to be undertaken by Gibb East Africa is to provide a better understanding of the needs of the project affected people (PAPs) in accordance with World Bank and Government of Kenya guidelines. Gibb East Africa will ensure community participation in the resettlement process with a view to creating local ownership and sustainability of the process. In addition Gibb East Africa is required to specify locations for resettlement and undertake environmental impact assessment of the proposed resettlement to mitigate any externalities foreseen.

## 7.1.6 Gravel Pits and Quarries

At this stage of the study, investigations on gravel pits are still going on. None of the sites have been finalised. Hardstone will be obtained from existing and bonafide commercial sources. In this section, therefore, general means of mitigation are discussed.

### Excavation of Gravel Pits

Normally before excavation begins, landowners sign contracts with the MoRPW&H which include terms and conditions for payment, the amount of land to be excavated and rehabilitation measures to be carried out.

The area to be excavated should be cordoned off, which tend to be very deep and pose a danger to livestock and children. The contract documents should instruct the Contractor to maintain fences and "make good" afterwards.

Ideally the side of the road should not be the place to carry out excavation activities. All access routes to gravel pits and crossings over pipelines should be planned ahead of construction and described in the contract documents.

Haulage routes will need to be identified and maintained by watering to minimise the impact of dust.

### Rehabilitation

When gravel pits are being excavated the owner cannot use the land. Excavation also sometimes leaves an uneven land surface, which makes it difficult to cultivate.

Gravel pits must be landscaped and reinstated or back-filled with overburden, if the depth of the overburden is sufficient to allow for this. If excavation is properly planned, organised and executed, it would be possible to rehabilitate most gravel pits. It is therefore important to have separate stockpiles for topsoil, overburden, gravel, etc.

Terracing and replacement of fencing is part of the rehabilitation process. Contract documents should instruct Contractor to plant trees to replace those that have been removed during excavation.

Sometimes landowners wish to leave the gravel pits as they are so that they can be used as temporary water sources (pans) for livestock. Apart from encouraging the breeding of mosquitoes (the vectors for malaria), the pans will encourage localised erosion caused by trampling. On the other hand, some landowners wish to continue excavation as a source of income. This should generally be discouraged, due to the possible hazards discussed here.

Landowners must be informed of the environmental implications of the excavation works at the time of identification of the gravel sites. They should be told at the earliest whether testing has revealed that material from their plot was acceptable or not for use on the project road. They must also be told of the options available to them after excavation, i.e. rehabilitation/landscaping, or construction of water pans. It is very important that they understand the conditions on the contract form before they sign it, and must ensure that these

conditions include their requirements such as back filling, fencing, landscaping, terracing, or alternatively payment in kind such as grading murrum roads etc.

#### **7.1.7 Blasting of Rocks**

Blasting of rock outcrops should be done only once a stability analysis has been conducted. It should be done during the day, and residents in the vicinity of the quarry should be suitably warned of blasting activities, including the time and date that the blasting is to take place. Blasting should not be carried out at night as has been the case in the past (Pers, Comm. Ms. Oceanic Sakwa, District Environmental Conservation Officer). This must be specified in the conditions of contract.

#### **7.1.8 Trade Centres, Settlements and Industries**

Activities at Mlolongo, Kyumvi (Makutano), settlements and industries along the project road should, as far as is possible, not be disturbed. People should be informed of intended roadwork activities, including likely dates for commencement and completion of works. Warning signs should also be introduced on the approach to market/settlement areas.

At Mlolongo and Makutano, shops and kiosks are located within the road reserve. These will have to be removed during construction works, but the owners are not legally eligible for compensation. Nevertheless, they should be informed in advance by the Mavoko Council, if their structures are to be removed so that they can make arrangements to relocate their premises if necessary, and for future planning prevent the construction of the same on the road reserve. Further the Mavoko Council should stop any illegal structures coming up (Pers, Comm. Ms. Oceanic Sakwa, District Environmental Conservation Officer).

Ideally, a dual carriageway that is designed for speeds of 110 kph should bypass all trading centres, settlements and towns, so that an efficient speed can be maintained throughout. Link roads may then be constructed to connect the centres/towns to the dual carriageway. This is also highly desirable in terms of safety for pedestrians, NMTs and motorised vehicles. The design has given consideration to bypassing Mlolongo, Athi River and Makutano. While this has implications in terms of acquisition of land, as well as loss of livelihoods/businesses (for those shops and kiosks located directly along the project road), the bypasses pose plausible alternatives for the alignment. It can be argued that even if a bypass is constructed, people will move to the road and settle along it. This, no doubt, is true, but the onus lies on the local authorities to ensure that it does not happen.

#### **7.1.9 Vegetation**

Vegetation should not be cleared unnecessarily during the construction works, whether for the dual carriageway, or for the excavation of gravel pits. This should be specified in the Contractor's contract.

At Mlolongo and Kyumvi through which the project roads pass, trees should be planted along the edge of the road reserve after completion of the roadwork (see Section 7.1.14). The Contractor should be instructed to do this by the Resident Engineer, but the town councils or chiefs should care for the trees. This would augment the aesthetics of the settlements/towns, and would also help to prevent soil erosion along the roadside. The District Works Officer further added that if



trees are planted they should not be planted too close to the road such that when they grow the branches hang over the road. The problem with hanging branches is that they drip water onto the road ruining the bitumen, and the leaves and small branches tend to block drains and culverts leading to flooding in the rainy seasons.

The median of the dual carriageway should be grassed and planted. This would add to beautifying of the road, and if shrubs were planted in the median it would help reduce nocturnal glare. Drainage for road surface run-off along some sections of the road can also be improved if a drainage structure is provided along the median (Pers. Comm. Mr Kiruja, District Works Officer).

Planting of trees, shrubs, and grassing must be specified in the Standard Specification, and as an item in the Bills of Quantities.

#### **7.1.10 Livestock**

Livestock movement is not extensive along the project road, but it does occur. The design should give consideration to locating underpasses at strategic livestock crossing points along the road. Mitigation could also include the installation of warning signs erected at intervals along the road. The provision of separate footpaths/cycle lanes would allow livestock to use these instead of the road.

#### **7.1.11 Workmen's Camp**

##### **Local Resources**

The impact on water sources will be influenced by the location of the workmen's camp. Care should be taken not to stress the local supply at the expense of the local population. The Contractor should consult with the local authorities on where water can be sourced from, and then assess which options are viable. The District Water Officer, Mr Muriga, felt it important that the Nolturesh Pipeline on the left side of the road should not be disturbed during the construction works. If the Contractor needs water, he should dig a borehole rather than rely on the Nolturesh Pipeline, and given the dry climate in Machakos District, perennial rivers should not be used as a source of water for construction works or otherwise. If a borehole is to be sunk the Contractor would need an EIA carried out to address the impacts of the borehole.

The workforce should be discouraged from buying fuel wood including charcoal. The camp should have a central canteen to serve the entire workforce, and gas, kerosene or electric cookers should be used.

##### **Location of the Camp**

The workmen's camp should preferably be located at or near centres such as Mlolongo or Athi River. The old Crescent Construction Contractor camp at Km 31.8 towards the end of the project road may also be a suitable location. Mlolongo and Athi River would be able to temporarily absorb the workforce in terms of provision of food, water, fuel, etc., without greatly impacting on local demand. The camp should not be located at isolated points along the road where they will attract periphery businesses, and provide a nucleus for the growth of unplanned settlements.

### **7.1.12 Public Health and Occupational Safety**

A central canteen for the workforce at the construction camp, as recommended in Section 7.1.11, would contribute towards the general health in the camp as kitchen wastes can be disposed of in an organised manner, while hygiene can be monitored.

Workmen should be provided with suitable protective gear (such as nose masks, ear muffs, helmets, overalls, industrial boots, etc.), particularly during blasting, drilling, while working on the asphalt and crushing plant, and handling tar. There must be a fully equipped first aid kit on site and a Health, Safety and Environment Officer who has first aid training and knowledge of safety regulations. In addition, the Contractor must have workmen's compensation cover.

The location of pit latrines in the camp should preferably be downhill of potable water sources, or 50 m to 100 m from any water body. Communal bathrooms/lavatories with soakaway pits are a less polluting option, but would be slightly more expensive.

Sexually transmitted diseases (STD) awareness campaigns should be conducted in the camp as well as in the settlements/trading centres. The control of unplanned structures along the project road should be discouraged, as this will also curb the spread of STDs (Pers, Comm. Julius Inyingi, District Public Health Officer).

At present, there is a substantial amount of littering of solid and liquid waste, including human waste, accumulating at the major road junctions and by the road side. Long distance buses should be discouraged from stopping by the road side to allow passengers to relieve themselves. Special parking areas (similar to a small bus terminal) should be provided for public transport at the major centres, at which waste disposal and toilet facilities should be provided. While the design for this project can include the parking area, provision of waste disposal and toilet facilities will be the responsibility of the local authorities.

These issues should be included in the conditions of contract (Standard Specification).

### **7.1.13 Road Safety**

The danger posed to pedestrians, cyclists and livestock due to increased traffic volumes can be mitigated by installing clear and frequent road signs and markings (both directional and warning). While speed bumps are often introduced to effectively reduce speed at major centres, these would be dangerous on the project road, given the high speed with which vehicles will be travelling. The provision footpaths and cycle lanes, separated from the dual carriageway, are better means for enhancing road safety. Overhead footbridges should also be constructed at the major centres along the road, specifically at Mlolongo, Athi River and Makutano. Pedestrian and NMT counts will indicate where exactly such footbridges can be constructed. In order to ensure that the footbridges are used, a 2.5 to 3 m high steel fence can be constructed along the road to separate the settled areas from the road. This should be considered particularly at Mlolongo, Athi River Town and Makutano.

Footpaths or cycle lanes can also be used for livestock. As mentioned in Section 7.1.10, livestock underpasses at strategic locations would also enhance road safety. However, this is an expensive option.

Heavy goods vehicles (HGVs) parked by the side of the road, especially around the weighbridge at Mlolongo, and Kyumvi at Makutano, present a hazard to both pedestrians and road traffic. Parking bays for the HGVs as well as public transport vehicles, should be provided at these places, but should be located well off the road. They should include facilities for repair work for these vehicles (for example, bays should have storm water drains with suitable sumps to filter out oil residues). Local councils should make it illegal to park vehicles by the side of the road, especially if parking bays are provided. The parking bays would reduce congestion and increase safety.

The socio-economic study to be carried out by Gibb East Africa will address the provision of roadside amenities primarily to meet the needs of the long distance travellers and are aimed at reducing fatigue-related accidents. They include rest areas for heavy vehicles, service centres, and truck stops.

Provision should be made in the design to allow for U-turns at certain places. One such area is Mlolongo. The design should incorporate acceleration and deceleration lanes of suitable length. This would discourage drivers from making illegal u-turns and from driving across the median to reach the other lane (Pers, Comm. Mr Kiruja, District Works Officer).

#### **7.1.14 Visual Enhancement**

A well-designed road fits in well with its surrounding landscape because its design reflects the principles of regional landscape design. These principles can and should be applied whether or not the area being considered is one of special physical beauty (refer *Roads & the Environment: A Handbook*). Indigenous trees and flowery shrubs should be planted along the road reserve especially on the section that leads into Nairobi. This will enhance the beautification of the road and the city.

People who reside next to the road reserve should be encouraged to be involved in this exercise to prevent them from uprooting of the plants and planting them on their own farms or using the trees that were originally their for charcoal. The low density population along most of the project road (apart from Mlolongo and Kyumvi) means the likelihood of it happening is very slim. Because of the nature of the soils these trees and shrubs would need extensive watering.

A small fence could also be put around the trees to stop goats from destroying them (Pers, Comm. Mr S. N Njehia, District Forest Officer). Such an initiative would be costly, but an alternative is to get a corporate firm such as East African Portland Cement to sponsor the planting and protection of trees and general beautify of the roadside. Trees also help to filter dust and particulate matter from the air and in doing so help to lessen the impact on public health.

Once road works are complete, the Contractor must ensure that the landscape is restored as much as possible to its original form. Landscaping/reinstating and replanting gravel pits and deviations would reduce the visual intrusion caused by the excavation and clearing works.

Creating awareness among drivers to dim their lights for on-coming traffic, as well as planting shrubs and trees along the median, would reduce nocturnal glare.

#### **7.1.15 Public Awareness**

It is important that people along the project road and its area of influence are aware of the proposed road improvements. This is particularly important if land is to be requisitioned for the dual carriageway and extension of the road reserve. People must be told well in advance that they may need to relinquish their land so that they can prepare and plan for any changes to their lifestyles. The mental and social impact of the project on the communities is consequently diminished. This issue will be handled through a Resettlement Action Plan, the details of which will be made available in the socio-economic study to be conducted by Gibb East Africa.

The District Works Officer (DWO) represents the MoRPW&H on the ground. The DWO follows progress of the project from planning through construction, implementation and operation. Through the District Development Committee he must inform the district administration (i.e. District Commissioner, District or Divisional Officers, Chiefs, etc.) of progress on the project. The district administration, in turn, should keep the local population posted on the progress of the project, and of any relevant developments relating to the road project. Other effective channels for dissemination of information are churches, women's groups and self-help groups. The local administration and other channels mentioned here will be essential in ensuring that the RAP and compensation plan is properly and fairly implemented.

Furthermore, assistance should be sought from the local administration to sensitise the public not to allow livestock onto the median.

#### **7.1.16 MoRPW&H Environmental Requirements**

The Ministry of Roads, Public Works and Housing has recently set up an environmental unit under its Planning Branch whose responsibility is to oversee environmental compliance in all road related activities. Many MoRPW&H documents give guidelines on environmental protection and mitigation. For example, the Road Design Manual acknowledges that all road projects will have both positive and negative effects on the environment. It also states that the "location and design of a road should aim at maximising the favourable effects of the project, such as providing or removing undesirable traffic from environmentally vulnerable areas, while at the same time minimising the adverse effects of the project as much as possible".

Construction activities, protection from water, removal of the camp, safety and public health requirements, site clearance and removal of topsoil and overburden, and maintenance of deviations are addressed in the Ministry's Standard Specification for Road and Bridge Construction.

Road safety, security and protection of the environment with regard to quarries and borrow pits, soil erosion, diversions, haulage routes, workmen's camp, asphalt plant and machinery units, rock blasting, spillage of oil/fuel etc, and liaison with authorities in charge of wildlife and natural resources are stipulated in the general conditions of the contract.

It is essential that all remedial measures are stipulated in detail in the contract documents. This would then obviate reliance on the Contractor's and supervising engineer's willingness and ability to incorporate the recommended mitigation measures. In addition, the Contractor must cost all remedial measures in his tender documents.

### 7.1.17 Project Alternatives

As mentioned in Chapter 4, various options are being considered for improving the carriageway, as follows:

- Single carriageway with climbing lanes on steep sections
- Dual carriageway for the section from Embakasi to Mlolongo
- Dual carriageway for the section from Embakasi to Namanga Road Junction
- Dual carriageway for the section from Embakasi to Machakos Turn Off.

In general the impacts for all the above options will be similar in nature. However the main difference will be in the amount of land to be acquired for the dual carriageway and for the extended road reserve. This is directly proportional to the length of the dual carriageway. Thus in terms of impacts due to land acquisition, compensation and relocation, the least impacting option would be the single carriageway with climbing lanes on steep sections. However, this option would provide few of the anticipated economic returns.

The socio-economic study to be conducted by Gibb East Africa will determine exactly how many project affected people there would be for each of the above options, and will also provide an indication of the cost associated with these impacts for each option.

## 7.2 MITIGATION COSTS

The table below indicates costs for the various mitigation measures proposed in this chapter. It will be noted that many of the costs (for example those for drainage structures) will have been included in the BoQ for the design. Other issues such as sensitisation of the workforce or the public, management issues (including conduct and diligence) can be done at negligible cost.

**Table 7.2: Mitigation Costs**

Mitigation measure/intervention	Cost (US \$)	Remarks
Drainage structures		include in design
Erosion control measures - scour checks - gabions - stone pitching - cascades		include in design
Landscaping of embankments: - earthworks - planting of trees and shrubs		include in design

Gravel sites: - planned access routes - rehabilitation, landscaping and planting		
Use of personal protective equipment		
Road Safety - installation of signs - livestock underpasses - footpaths/cycle lanes - steel fencing at centres - footbridges		include in design
Workman's camp: - Use of kerosene/gas stoves in camp - Solid waste disposal - Sanitation facilities - HIV/AIDS sensitisation		
Tree planting at major centres along road		
Compensation for land to be acquired, structures, crops, other buildings and property	?	to be determined by Gibb East Africa
Resettlement and relocation activities, including income restoration	?	to be determined by Gibb East Africa
Monitoring studies: - air pollution - noise pollution - socio-economic impact studies		Cost for follow up studies

## CHAPTER 8

### ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

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#### 8.1 GENERAL

Monitoring is a long-term process, which should begin at the start of construction and should continue throughout the life of the road project. Its purpose is to establish benchmarks so that the nature and magnitude of anticipated environmental and social impacts can be continually assessed. So monitoring involves the continuous or periodic review of construction and maintenance activities to determine the effectiveness of recommended mitigation measures. Consequently, trends in environmental degradation or improvement can be established, and previously unforeseen impacts can be identified or pre-empted.

Environmental audits are carried out one year after completion of the project. These audits assess the relevance, efficiency and impact of any mitigation measures that have been employed.

#### 8.2 ENVIRONMENTAL MONITORING AND MANAGEMENT

The responsibility for the incorporation of mitigation measures for the rehabilitation of the roads lies with the Supervising Engineer, who must ensure that the Contractor implements all specified mitigation measures. In order for the Contractor to carry out environmental management activities during construction the Contractor should draw up an environmental management plan of his own to show how he will address the mitigation measures during the construction period. The Supervising Engineer is responsible for assessing the Contractor's environmental management plan.

The MoRPW&H Maintenance Unit will have to oversee the Supervising Engineer to confirm that mitigation is being implemented in the correct manner.

Environmental monitoring allows measures to be implemented in order to prevent or avert negative impacts. Simple monitoring systems should be set up during construction by the Supervising Engineer and Contractor, and during operation by the MORPW&H Maintenance Unit, so that potentially environmentally problematic areas can be detected well in advance and the appropriate remedial action taken. This could simply be a checklist of items that need to be inspected as a matter of routine, or periodically, depending on the nature of the aspect. An example of such a checklist can be found in Appendix E.

The types of parameters that can be monitored may include mitigation measures or design features, or actual impacts. In some cases, such as drainage structures and soil conservation interventions, monitoring is fairly straightforward and can be done as part of routine or periodic maintenance. However, other parameters, particularly those related to socio-economic and ecological issues can only be effectively assessed over a more prolonged period of say 3 to 5 years.

Table 8.1 below summarises the environmental management plan for the project road. It describes parameters that can be monitored, and suggests how monitoring should be done, how frequently, and who should be responsible for

monitoring and action. Measures that can be incorporated into the tender documents and Bill of Quantities are *italicised*.



**ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN FOR THE EMBAKASI TO MACHAKOS TURN-OFF (A104/A109)**

**Table 8.1 Monitoring and Management of Impacts and Mitigation Measures on the A104/A109**

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
Changes in hydrology /impeded drainage	<ul style="list-style-type: none"> <li>- <i>Install drainage structures properly</i></li> <li>- Efficiency of drainage structures</li> </ul>	<p>Design Engineer Supervising Engineer and Contractor</p> <p>Supervising Engineer</p>	MoRPW&H Maintenance Unit	<p>(c) inspection</p> <p>(o) routine maintenance and road condition survey</p>	<p>(c) during construction and completion of e: structure</p> <p>(o) once a year</p>
Soil erosion	<ul style="list-style-type: none"> <li>- <i>Control earthworks</i></li> <li>- <i>Install drainage structures properly</i></li> <li>- <i>Install erosion control measures</i></li> <li>- <i>grouted stone pitching and rock fill gabion works will be necessary to protect culvert inlets and outlets</i></li> <li>- <i>Landscape embankments and re-vegetate gravel sites with grass (e.g. Tetrapogon bidentatus or Chrysopogon ancheri) and indigenous shrubs.</i></li> <li>- <i>Scour checks will be necessary in steep sections for</i></li> </ul>	Supervising Engineer and Contractor		<p>(c) inspection</p> <p>(o) routine maintenance and road condition survey</p>	<p>(c) daily; erosion control measures: durin construction and completion of e: measure</p> <p>(o) once a year</p>

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<p><i>drainage ditches along the road.</i></p> <ul style="list-style-type: none"> <li>- <i>Ensure management of excavation activities</i></li> <li>- <i>On sections with high filling and deep cutting, slopes should be covered by stone walls and planted with grass and shrubs. Damaged existing drainage systems should be rebuilt or rehabilitated by suitable methods.</i></li> <li>- <i>Impact on erosion (on road, off road, embankments, riverbanks, etc.)</i></li> <li>- <i>Efficiency of erosion control measures</i></li> </ul>	Supervising Engineer	MoRPW&H Maintenance Unit	(c) inspection (o) routine maintenance and road condition survey	(c) once a month (o) once in 6 months to account for seasonal variations over 3-5 years
Air pollution	<ul style="list-style-type: none"> <li>- <i>Control speed of construction vehicles</i></li> <li>- <i>Prohibit idling of vehicles</i></li> <li>- <i>Sensitise workforce</i></li> <li>- <i>Residences should be 500 m from downward wind of asphalt mixing sites.</i></li> </ul>	Design Engineer, Supervising Engineer and Contractor		(c) inspection / observation	(c) daily/random

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<ul style="list-style-type: none"> <li>- <i>Water should be sprayed during the construction phase on excavated areas for the dual carriageway, deviations, and temporary roads leading to borrow pits, and asphalt mixing sites.</i></li> <li>- <i>In filling sub-grade water spraying is needed to solidify the material and to assist in compaction. After compaction, water spraying should be regular to prevent dust.</i></li> <li>- <i>Plant trees along road and around settlements (e.g. Acacia sp. and Commiphora sp.).</i></li> <li>- <i>Regular maintenance of plant and equipment.</i></li> <li>- <i>Impose speed limits for all vehicles, especially at market centres and busy junctions.</i></li> <li>- <i>Sensitise motorists/road users.</i></li> </ul>		Traffic Police	(o) observation	(o) random
Noise pollution	- <i>Sensitise workforce</i>	Supervising Engineer	Contractor	(c) inspection /	(c) daily/random

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<ul style="list-style-type: none"> <li>- <i>Supervise construction traffic</i></li> <li>- <i>Sensitise drivers of construction vehicles</i></li> <li>- <i>Maintain plant and equipment</i></li> <li>- <i>Workers in the vicinity of high level noise to wear safety &amp; protective gear.</i></li> <li>- <i>Impose speed limits for all vehicles, especially at market centres and busy junctions</i></li> <li>- <i>Sensitise motorists/road users</i></li> </ul>	and Contractor	Traffic Police	<p>observation</p> <p>(o) observation</p>	(o) random
Oil pollution	<ul style="list-style-type: none"> <li>- <i>Construct parking bays at Makutano for heavy vehicles, with oil interceptors in drains</i></li> <li>- <i>Proper storage, handling and disposal of oil and oil wastes</i></li> <li>- <i>Maintain plant and equipment</i></li> <li>- <i>Maintenance of construction vehicles should</i></li> </ul>	<p>Design Engineer Supervising Engineer and Contractor</p> <p>Supervising Engineer and Contractor</p>	District Engineer	<p>(c) inspection</p> <p>(o) routine maintenance</p>	<p>(c) during construction and completion</p> <p>(o) once in 6 mo</p> <p>(c) daily</p>

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	be carried out in the Contractor's camp.				
Material sites	<ul style="list-style-type: none"> <li>- Inform people living at/near the sites that the pits have been selected for exploitation.</li> <li>- Arable lands should not be used as borrow pits whenever possible. For new borrow pits the topsoil (30cm) should be kept and refilled after construction is over to minimise the impact on ecosystem and agriculture</li> <li>- Prior to blasting, a thorough inspection of the rock stability should be conducted and all nearby residents given ample warning</li> <li>- <i>Plan access to gravel sites</i></li> <li>- <i>Control and restrict access to gravel sites (e.g. by fencing)</i></li> <li>- <i>Control earthworks</i></li> <li>- <i>Proper management of excavation activities</i></li> </ul>	<p>Supervising Engineer and Contractor</p> <p>Supervising Engineer and Contractor</p> <p>Design Engineer and</p>	<p></p> <p></p> <p>MoRPW&amp;H</p>	<p>(c) meeting</p> <p>(c) inspection</p> <p>(c) payment records</p>	<p>(c) once, immed after selection o</p> <p>(c) daily</p> <p>(c) once, before</p>

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<ul style="list-style-type: none"> <li>- <i>Landscape, terrace and if necessary grass sites. Replace trees that were removed during excavation</i></li> <li>- Discourage pits being made into water pans after construction</li> <li>- Compensate owners as required</li> <li>- Progress of rehabilitated gravel sites (use of site, established vegetation)</li> </ul>	<p>Min. Lands and Settlement</p> <p>Supervising Engineer</p>	Maintenance Unit	(o) inspection	<p>excavation begin</p> <p>(c) once in 2 months (o) once in 6 months</p>
Water Sources	<ul style="list-style-type: none"> <li>- <i>Management of water usage</i></li> <li>- <i>Plan for harvesting and storage of water during rains for use later</i></li> <li>- <i>Plan works schedule according to water availability</i></li> <li>- Avoid abstraction of water</li> <li>- <i>Abstraction not to be done during low flow.</i></li> </ul>	Supervising Engineer and Contractor	n/a	(c) meetings, inspection check plans and schedule,	(c) during rains, during abstraction sources, and at random
Fuel	- Energy sources should be identified so as not	Contractor	Contractor	(c) inspection	(c) daily

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<p>to put a strain on the local resources</p> <ul style="list-style-type: none"> <li>- Discourage use of firewood/charcoal by providing alternatives such as kerosene and gas.</li> </ul>				
Construction Camp	<ul style="list-style-type: none"> <li>- <i>Sufficient measures should be taken at the construction camps i.e., provision of garbage bins and sanitation facilities. If septic tanks are installed, waste will be cleared periodically.</i></li> <li>- <i>Special attention should be paid to the sanitary condition of camps.</i></li> <li>- <i>Garbage should be disposed of periodically</i></li> <li>- <i>Sensitisation campaign on STDs will be mandatory at the camps and in the community</i></li> </ul>	Contractor, Supervising Engineer		(c) Inspection	(c) daily
Deviations	<ul style="list-style-type: none"> <li>- <i>Plan deviations</i></li> <li>- <i>Adhere to road reserve if possible</i></li> <li>- <i>Obtain permission from inhabitants if deviation goes beyond the Right of Way</i></li> <li>- <i>Reinstate deviations</i></li> </ul>	Supervising Engineer and Contractor		(c) check plans; inspections	(o) daily when deviations are ir

Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<p><i>(and old tracks) to original condition</i></p> <ul style="list-style-type: none"> <li>- Management of traffic along deviation</li> <li>- Pay compensation for crops/property removed/destroyed by deviations on inhabited land</li> <li>- Monitor rehabilitation of deviations</li> </ul>	Design Engineer and Min. Lands and Settlement	MoRPW&H Maintenance Unit	(o) payment records	(c) once before constructing deviations  (o) once in 6 months
Road Safety	<ul style="list-style-type: none"> <li>- <i>Install warning signs on approach to trade centres and busy junctions</i></li> <li>- Provide parking bays for heavy goods vehicles and public transport vehicles</li> <li>- Provide separated footpaths and cycle lanes</li> <li>- Provide overhead footbridges and livestock underpasses</li> <li>- Install fencing along carriageway at major urban centres</li> </ul>	Supervising Engineer and Contractor Design Engineer, Supervising Engineer and Contractor	District Roads Engineer       Traffic Police	(c) inspection (o) routine maintenance       (o) observation/reports	(c) when erecting       (o) once a month



Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<ul style="list-style-type: none"> <li>- <i>Enforce speed limits</i></li> <li>- <i>Monitor road accidents</i></li> </ul>				
Social condition of people who lost land or land was acquired for the dual carriageway	<ul style="list-style-type: none"> <li>- Social conditions of PAP</li> <li>- Compensation payments</li> </ul>		Socio-economic Consultant and Environmental Unit in the MoRPW&H	(c) observation/reports (o) observation/reports (c,o) social survey	(o) twice in the year, thereafter a year
Impact on trade centres (growth and development)	<ul style="list-style-type: none"> <li>- Planning</li> </ul>		Environmental Unit in the MoRPW&H	(c) observation (o) observation/reports (c,o) social survey	(o) once a year at completion of p
Public health and occupational safety	<ul style="list-style-type: none"> <li>- <i>Sensitisation campaign on STDs in the communities along the project road</i></li> <li>- <i>Monitoring solid waste disposal and collection facilities</i></li> <li>- <i>Monitor waste water management</i></li> </ul>	Contractor, Supervising Engineer	Environmental Unit in the MoRPW&H	(c) observation (o) observation/reports	(o) once a year



Environmental/ Social Impact	Proposed Mitigation and Aspects for Monitoring	Responsibility for intervention and monitoring during design, construction and defects liability period	Responsibility for mitigation, monitoring and/or maintenance after defects liability period	Monitoring means (c) = construction (o) = operation	Recommended frequency of monitoring
	<p>areas where livestock is to be kept off the road reserve.</p> <ul style="list-style-type: none"> <li>- <i>Install warning signs</i></li> <li>- <i>Enforce speed limits</i></li> <li>- Monitor livestock kills</li> </ul>	<p>Supervising Engineer and Contractor</p> <p>Contractor</p>	<p>District Roads Engineer</p> <p>Traffic Police</p> <p>District Livestock Production Officer</p>	<p>(o) observation/reports</p>	<p>(o) once in 6 months</p> <p>(c) daily</p> <p>(o) random</p> <p>(o) once a year</p>

### 8.3 INSTITUTIONAL RESPONSIBILITIES

Institutional responsibilities for incorporating mitigation measures and for monitoring various environmental/socio-economic aspects have been indicated in Table 8.1 above.

During the defects liability period the contractor must make sure that the road is completely serviceable, which entails ensuring optimal performance of all structures.

During construction, the Supervising Engineer and Contractor will be responsible for implementing all the proposed mitigation measures. However, the overall task of ensuring that mitigation is in fact implemented lies with the MoRPW&H Maintenance Unit.

After the defects liability period, responsibility for the maintenance of the project road will lie with the Maintenance Units of the Roads Department in the MoRPW&H Maintenance Unit. Therefore the District Roads Engineer, during routine or periodic maintenance can monitor certain parameters such as efficiency of drainage structures, or when carrying out annual maintenance needs assessments.

The Environmental Unit in the Roads Department of the MoRPW&H will be responsible for ensuring that monitoring does take place. It will also be responsible for analysis of data collected during monitoring, so that overall performance in terms of environmental degradation or improvement can be assessed and, if need be, the performance targets changed in order to achieve the objectives of mitigation interventions. The Environmental Unit can then instruct the relevant divisions within the Roads Department as to what (further) measures should be implemented, or whether changes or modifications are necessary to interventions or monitoring methodologies.

## CHAPTER 9

### CONCLUSIONS AND RECOMMENDATIONS

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#### 9.1 CONCLUSIONS

The primary objective of the study on the Embakasi to Machakos Turnoff (A104/A109) project road is to review the dual carriageway design and identify and update the most appropriate economically justified construction methodology for the road. It is anticipated that in the long term there will be considerable economic benefit accruing to the areas of influence of the project road due to more efficient and improved traffic flow.

The project road is an existing one; thus the environment along the road has been considerably altered and any major impacts will have already occurred. Additional disturbances due to construction of the dual carriageway will therefore be relatively minor.

At this preliminary stage, no adverse environmental impacts of significant magnitude are foreseen that would hinder the proposed rehabilitation of the project road. The project road will not harm any sites that are historically or environmentally sensitive. The road design will improve drainage along the project road, especially along the flat sections, notably at Mlolongo and Makutano. Soil erosion is also likely to occur, particularly as a result of excavation of gravel pits; but this can be mitigated. Pollution due to air, dust, noise, and sediments will be exacerbated during construction.

Workmen's camp should preferably be located at centres such as Mlolongo and Athi River. In addition, the camps must not stress local fuel wood and water supplies at the expense of the local population.

The project road is to be designed for a speed of 110 km/h, which poses a danger to non-motorised traffic. The provision of separate footpaths and cycle lanes, footbridges and livestock underpasses, as well as the installation of road signs will help to mitigate this impact.

#### 9.2 RECOMMENDATIONS

Recommendations for the prevention and mitigation of adverse impacts are as follows:

- new gravel pits must be cordoned off or fenced during use, and rehabilitated after use as per the requirements of the landowners;
- special provision should be made for pedestrian, bicycle and livestock traffic;
- shrubs and grasses should be planted along road embankments to prevent erosion and in the median of the dual carriageway;

- unnecessary clearing of vegetation should be avoided to preclude additional erosion;
- trees should be planted, especially at the centres and on the approach to Nairobi, Athi River turn-off and Makutano, to improve visual aesthetics and act as filters for particulate matter;
- special parking areas should be provided for trucks and public transport vehicles at Makutano, Athi River and Mlolongo (near the weighbridge);
- the local people must be informed of the details and progress of the project, particularly those who will be affected by the proposed realignment and extension of the road reserve, so that they can plan for the future accordingly;
- compensation and resettlement of landowners that must relinquish their land for the project road must be fair and transparent, and the landowners paid promptly. It should cover crops, all structures (permanent and semi-permanent, fences, etc.) as well as land;
- the World Bank's OP 4.12 on Involuntary Resettlement and Government of Kenya guidelines will be followed and used complementarily where applicable to avoid conflict. Community participation in planning and implementing resettlement will be encouraged;
- a Compensation and Resettlement Action Plan will be developed addressing land, housing, crops, and other compensation to be provided to the adversely affected population. A monitoring and evaluation mechanism for resettlement activities will be carried out.

Diligence on the part of the contractor and proper supervision by the Supervising Engineer during construction and the initial operation period is crucial for mitigating impacts. However all mitigation measures will be specified in tender and contract documents, and also be included in the Engineering Drawings, Specifications and Bills of Quantities.

During operation, maintenance of the road is a key factor in protecting the environment. For example, if the project road is always in motorable condition, vehicles would not have to drive off-road or on the wrong side of the road, thereby destroying vegetation, road structures, and posing a danger to pedestrians, cyclists and livestock.

Environmental monitoring allows measures to be implemented in order to prevent or avert negative impacts.









