18.6 STRUCTURE DESIGN

18.6.1 General

Box typed culvert was selected in former Clause 18.2. Master Plan Route and Plan 4 Route needs to install the each location. There are three and two box culverts on Master Plan Route and Plan 4 route. These box culverts are possible to apply the Japanese Standard Design. Therefore the size of each box culvert should be considered and determined the overburden in this Clause.

18.6.2 Master Plan Route

1) Existing Condition

A box typed culvert is installed at Roundabout A on Av. Paara o Palmer(1426). The inner size of existing box culvert is 1.0 m width and 1.0 m height. The Boring No.2 was carried out just near the box culvert. The characteristics of ground are composed of sand and sandstone. The thickness of sand layer is approximately fourteen meters. The sand is classified into two layers, which are the fine to medium grained sand and the medium to coarse grained sand as show in Appendix 15.2.

At entrance of golf course, there is a box typed culvert on Rua 3867. The inner size of existing box culvert is 2.0 m width and 1.0 m height. The ground condition is almost same as Boring No.2.

2) Discharge Volume

The discharge volume of each box culvert is presented in Clause 18.7. Each volume is as below.

	Capacity (m^3/sec.)	Discharge Volume (m^3/sec.)
• Ravine 1	71	68
• Roundabout A	18	17
• Junction B	42	36

3) Size of Box Culvert

The size of each box culvert is shown in Table 18.6.1.

Table 18.6.1 Box Culvert Size

Location	Inner Section W(m)×H(m)	Overburden (m)	Top slab (mm)	Floor slab (mm)	Side wall (mm)	Haunch size (mm)
Ravine 1	5.0×5.0	0.5	400	500	500	200×200
Roundabout A	3.0×3.0	0.5	400	400	400	200×200
Junction B	3.5×2.0	0.5	400	400	400	200×200

18.6.3 Plan 4 Route

1) Existing Condition

The improved gabion typed drainage has been installed in Ravine 3 and Ravine 4. The length of gabion drainage is approximately 600 m in Ravine 4. And in Ravine 3, the length of gabion drainage is approximately 100 m. However in order to drain smoothly from Rua 3523, the pipe typed three culverts have been installed toward the existing Av. J. Nyerere. In Ravine 2, there is no culvert cross the existing road.

The Boring No.1 was carried out at Ravine 3. The characteristics of ground are composed of sand, clayey sand and sandstone. The thickness of sand layer is approximately eighteen meters. The sand is classified into three layers, which are the fine to medium grained silty sand and clayey sand and the coarse grained sand as shown in Appendix 15.2.

2) Discharge Volume

The discharge volume of each box culvert is presented in Clause 18.7. Each volume is as below.

	Capacity (m^3/sec.)	Discharge Volume (m^3/sec.)
• Ravine 4	18	17
• Ravine 3	36	32
• Ravine 2	18	17
• Ravine 1	71	68

3) Size of Box Culvert

The size of each box culvert is shown in Table 18.6.2.

Table 18.6.2 Box Culvert Size

Location	Inner Section W(m)×H(m)	Overburden (m)	Top slab (mm)	Floor slab (mm)	Side wall (mm)	Haunch size (mm)
Ravine 4	3.5×3.5	0.5	400	400	400	200×200
Ravine 3	4.0×4.0	0.5	400	400	400	200×200
Ravine 2	2.5×2.5	0.5	400	400	400	200×200
Ravine 1	5.0×5.0	0.5	400	500	500	200×200

18.7 DRINAGE DESIGN

18.7.1 Background

Present condition of the drainage system in Maputo has been described in Chapter 4.4.
Existing plan of the drainage and storm water in Maputo has been established in study of the Maputo Drainage Master Plan conducted by a Dutch consultants of DHV in 1980 - 1981.

18.7.2 Present Drainage System of Maputo City

The existing drainage system in Maputo is shown in Figure 18.7.1 that storm water is collected by drainage tertiary lines (open ditch or pipes), and then led to outlet through secondary and primary lines.

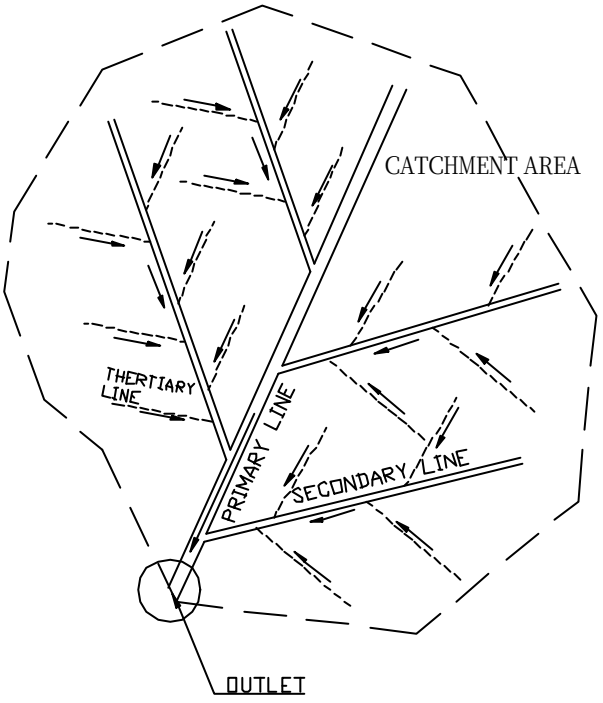


Figure 18.7.1 Present Drainage System

Maputo City has two type of drainage system. In the urban area, most of streets were already installed pipe drain system located under sidewalk or carriageway. In the semi urban area, the open drainage system has been constructed consisting with concrete - lined drainage and earth drainage led to the outlet.

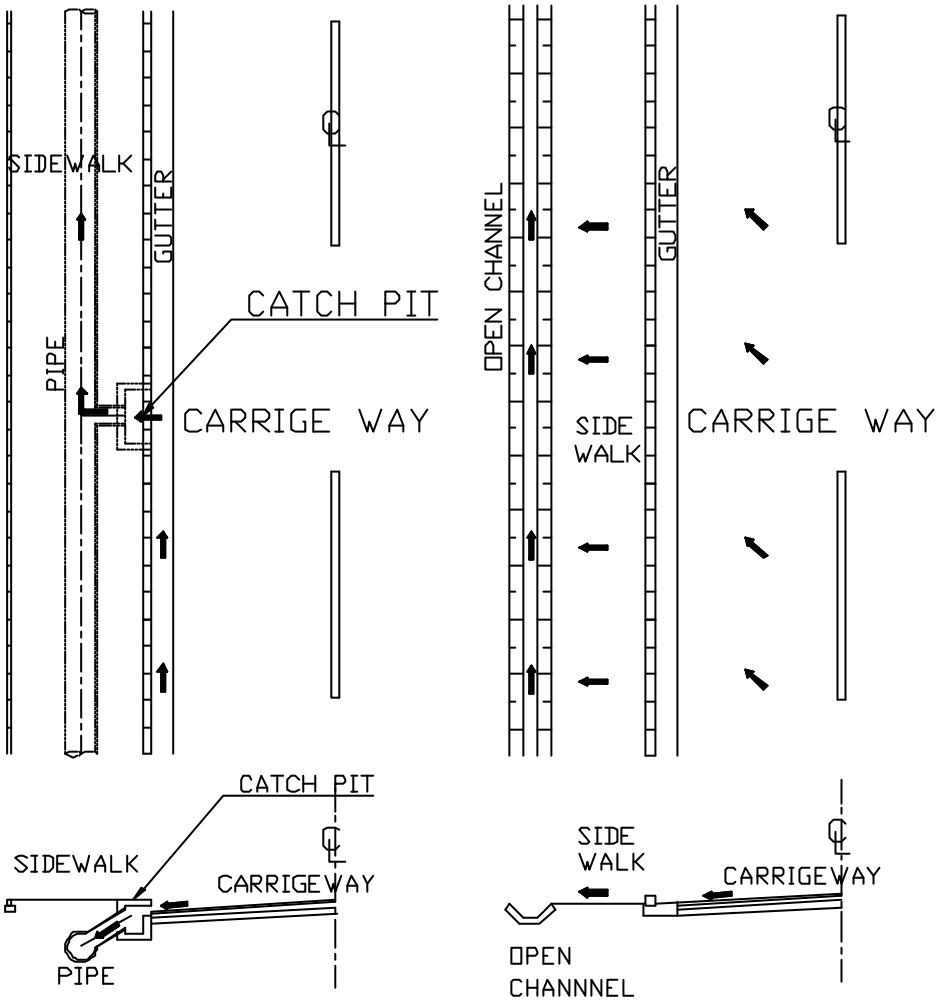


Figure 18.7.2 Present Drainage System

18.7.3 Problem of Existing Drainage System

(1) Urban area

A flood in 2000 heavy rain suffered some street of Maputo city. In according to rainfall record in January 28,2000,the maximum 1-h rainfall was 70mm,corresponding to return period of less than 10 years. Volume of discharges was more than the capacity of existing drainage system. In addition, most of drainage systems seemed not to functions due to poor maintenance. Therefore damage became more serious.

In urban area, most of drainage catchpit are blocked by soil/garbage due to lack of cleaning and flushing so that the drainage capacity are reduced. It can be also considered that a location of catchpit without considering gradient of land is the other reason of a flood.

Solutions of the problem are follows:

- Cleaning and flushing to drainage structure.(Strengthening to maintenance)
- Protection for soil and garbage
- Improvement of location of catchpit
- Strengthening the drainage capacity of outlets leading to the port

(2) Semi urban area

In most of semi urban area, there is no proper drainage system. In those areas, there are many squatters who have been occupied within the right of way; therefore, width of road has been reduced, so that there has not been enough space to construct proper drainage system. .
Other area where has the drainage system are also blocked by soil/garbage same as the urban area.

Solutions of the problems are follows:

- Construction of new drainage systems
- Cleaning and flushing to drainage structure.(Strengthening of maintenance)
- Activity of enlightenment of resident not to put garbage into open ditch.
- Removal of squatters

18.7.4 Proposed Drainage Network

Proposed drainage network for the study area has been determined based on the concept and catchments basins mentioned in the Maputo Drainage Master Plan and a Preliminary Design Study of Repair of Avenida Julius Nyerere prepared in 2000.
Proposed drainage network for the study area shows Figure 18.7.3,4,5.

Figure 18.7.3 Proposed Drainage Network District 1

Figure 18.7.4 Proposed Drainage Network District 2

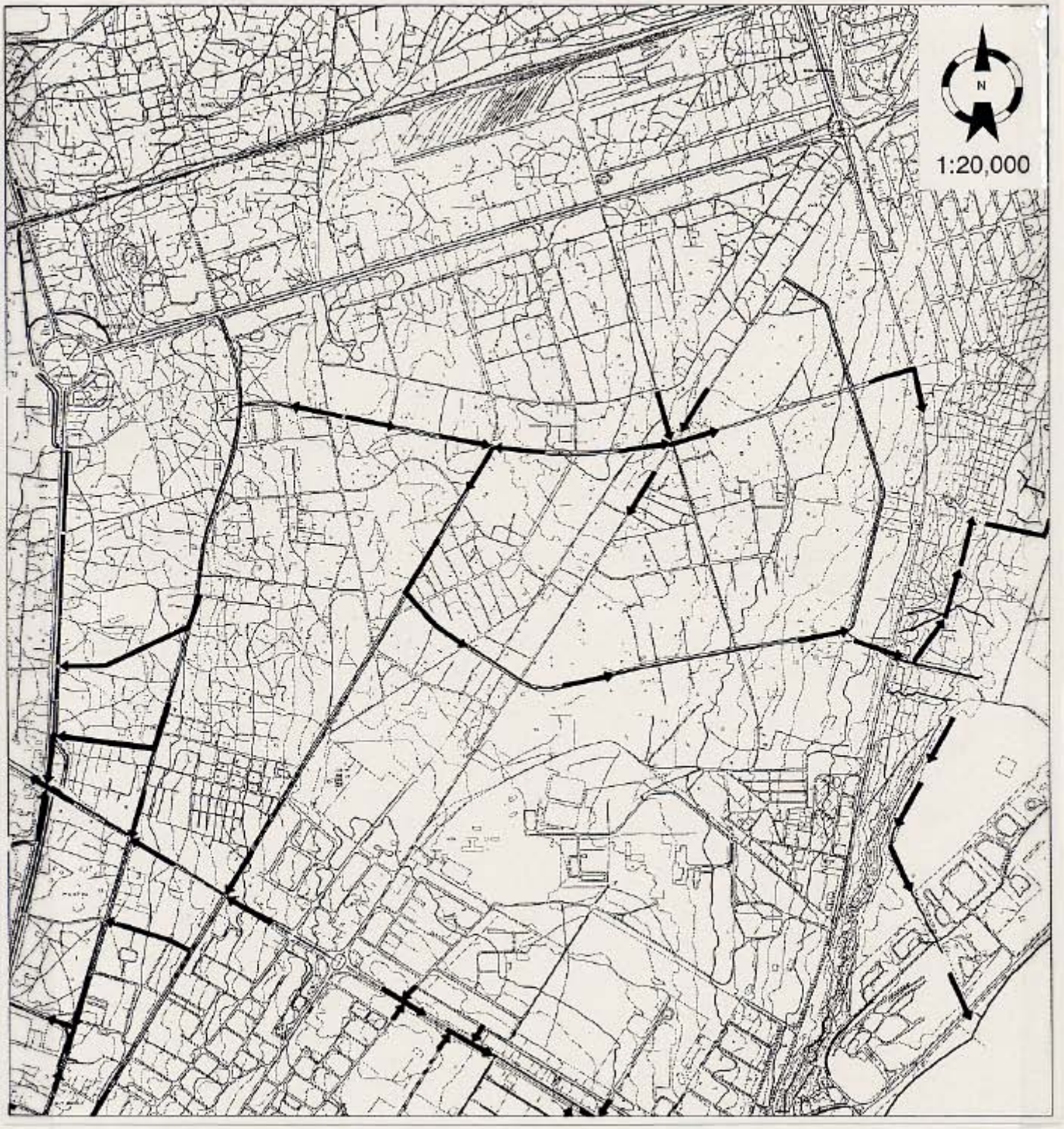


Figure 18.7.5 Proposed Drainage Network District 3

18.7.5 Design policy

Selection of drainage structure should be determined taking consideration into the evaluation of the Pilot project. In urban area L-side ditch and Lu-side ditch are selected as appropriable and in semi urban area, the open drain is selected with considering easy maintenance.
In some parts of semi urban area where level of underground water is high; it should be considered to construct soak pit and drain.

18.7.6 Proposed Drainage System for Study Area

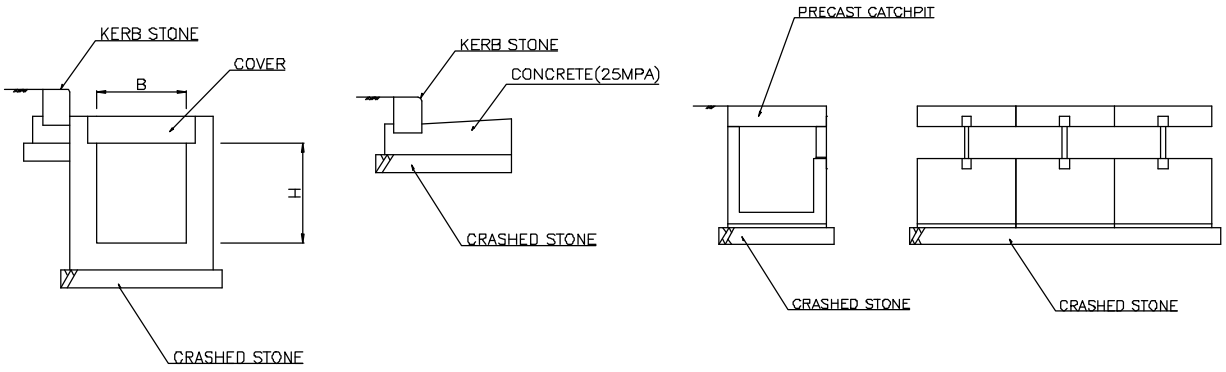
In order to solve existing problem of drainage system, JICA Study Team has prepared following drainage system for study area.

Table 18.7.1 Proposed Drainage System for Study Area

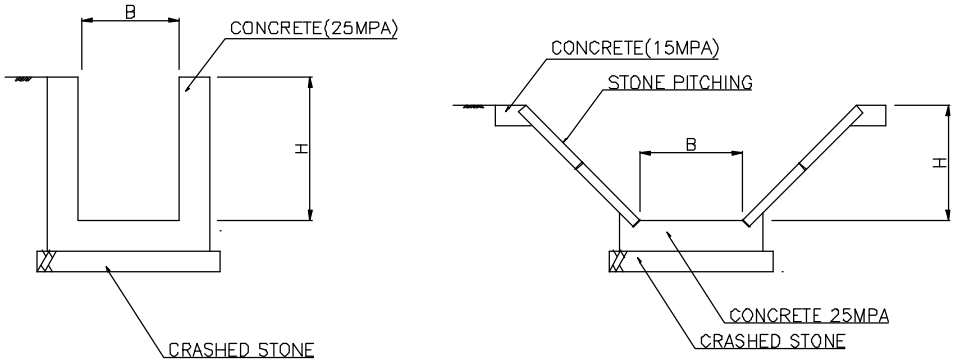
Project Name		Contents
Trunk Road	Construction of Missing Link on Av.Julius Nyerere	Construction of New Drainage System (Open ditch,Catch pit,Box culvert) Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation and Improvement of Av.Acordos Lusaka	Construction of New Drainage System (Lu-side ditch)
	Rehabilitation and Improvement of Av.Angola	Construction of New Drainage System (Lu-side ditch)
	Rehabilitation and Improvement of Av.Marien Ngouabi	Construction of New Drainage System (L-side ditch) Cleaning of Existing Pipe
Collector Road	Rehabilitation of Industrial and Comercial Area Roads	Cleaning of existing drainage system (Catch pit, Pipe)
	Rehabilitation of Port Area Roads	Construction of New Drainage System (Catch pit) Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation of District 1 Area Roads	Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation of District 2 Area Roads	Construction of New Drainage System (Open ditch,U-side ditch)
	Rehabilitation of District 3 Area Roads	Construction of New Drainage System (Open ditch,U-side ditch)

18.7.7 Proposed Drainage Structure Design

Proposed drainage structure are shown in Figure 18.7.6
All drawings are attached in the appendix.



Lu-side ditch L-side ditch Precast Catch pit



U-side ditch Open ditch

Figure 18.7.6 Proposed Drainage Structure

18.8 PAVEMENT DESIGN

18.8.1 Selection of Pavement Type

Pavement structures are broadly divided into two types: namely, flexible pavement (asphalt) and rigid pavement (concrete). Considering the construction economy and local conditions, Asphalt Concrete Pavements are recommended for the Trunk Roads and Collector Roads in District 1 and the Industrial & Commercial Area.
Concrete Block Pavement is recommended for the Collector Roads in District 2 & 3 due to easy maintenance.

Table 18.8.1 Proposed Pavement Type

	Carriageway	Sidewalk	Remarks
Trunk Road	AC	DBST	
Industrial and Commercial Area Roads	AC	DBST	
Port Area Roads	AC or Concrete Block	Concrete Block	
District 1 Area Roads	AC	Concrete Block	
District 2 Area Roads	Concrete Block	DBST	
District 3 Area Roads	Concrete Block	DBST	

18.8.2 Pavement Improvement Measures

Different stages of damaged roads demand different paving improvement measures. For this purpose, an appropriate improvement measure should be selected based on the survey results on the Present Serviceability Index (PSI) for each existing road as shown in Table 18.8.2.

Table 18.8.2 Required Rehabilitation Measures of Pavement

PSI	IRI	Improvement Measure
Very Bad	11<IRI	Reconstruction from Subbase Course
Bad	7<IRI<10	Reconstruction from Base Course
Fair	4<IRI<6	Overlay
Good	2<IRI<3	Pot-hole patching
Very Good	0<IRI<1	Ordinary maintenance work

Proposed pavement improvement measures are shown as Figure18.8.1.

LEGEND	Pavement Improvement Measures	PSI
	Maintenance / Pot Hole Patching	2.5<PSI<5.0
	Overlay	1.5<PSI<2.5
	Reconstruction from Base Course	0.5<PSI<1.5
	Reconstruction from Subbase Course	0.0<PSI<0.5

Figure 18.8.1 Pavement Improvement Measures

18.8.3 Pavement Thickness Design

The pavement thickness design was carried out in accordance with AASHTO, as applied for Mozambican Pavement Manual.

The thickness and the structure of individual layers of pavement were designed based on a comprehensive judgment of various factors including subgrade, estimated future traffic volume of heavy vehicles, climate conditions as well as economic aspects.

The in-situ soil/gravel stabilized material is useful for Base course & Subbase course.
The stabilized material strength of requiring for the base and subbase are already confirmed by the Pilot Project of this study.

The AASHOTO formula is used to calculate structural number [SN] in inches required pavement structure placed on the roadbed soil with Mr and able to carry the design traffic load [ESALd] providing a desired quality of service expressed as the difference between the initial and the final serviceability index [ΔPSI=ISI-FSI].

ESALd=10^{So*Zr+2.32*L10(Mr)+9.36*L10(SN+1)+L10[[ΔPSI/2.7]/[0.4+1094/(SN+1)5.19]-8.27]

$$SN=h1*a1*m1+h2*a2*m2+h3*a3*m3$$

Where

hi : layer thickness

ai : layer strength coefficients

mi : drainage coefficients (1 for bituminous & cement stabilized layers)

Table 18.8.3 Layer Coefficients

Pavement Materials	ai	mi
Asphalt concrete(existing AC)	0.35	1.0
Asphalt concrete(new pavement)	0.40	1.0
Base course (cement stabilized material)	0.20	1.0 *
Subbbase course (cement stabilized material)	0.12	1.0 *
* The improvement measures of the reduction of water level are necessary at the place where the existing water level is high before the pavement works. (For example : installation of soaking pit)		

-Design Traffic

The opening year of this project roads will be supposed year 2005. Target year of this project is 2010, however the design traffic in 2015 after 10 years from the opening year should be used for design traffic. After 10 years from the opening year, the overlay works shall be done by

periodic maintenance.

The cumulative numbers of axle loads on the project roads have been forecasted as shown in Table 18.8.4.

Table 18.8.4 Design Traffic

Group No	Cumulative Number of Standard Axles ($ESAL x 10^6$) 2010	Traffic Class 2010	Cumulative Number of Standard Axles ($ESAL x 10^6$) 2015	Traffic Class 2015
1. Construction of Missing Link on Av. J. Nyrere	0.12	T0	0.20	T1
2. Rehabilitation & Improvement of Av. A. Lusaka 2.1 Av. A. dos Lusaka(3013,4057) 2.2 Av. G. Popular(1189)	0.22	T1	0.30	T2
3. Rehabilitation & Improvement of Av. Angola 3.1 Av. Angola(3077) 3.2 Rua S. Cabral(3081)/Largo de Deta(3079)	0.32	T2	0.46	T2
4. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)	0.13	T0	0.19	T1
5. Rehabilitation of Industrial & Commercial Area Roads 5.1 Av. J. Michel(1070) 5.2 Av. F. de Magalhaes(1038) 5.3 Av. Z. Magalhaela(1034) 5.4 Av. M. Siad Barre(1203) 5.5 Av. Romao Fernandes(1199) 5.6 Rue 1229 5.7 Av. As Estancias(1030)	0.29	T1	0.41	T2
6. Rehabilitation of Port Area Roads 6.1 Rue Consigglieri Pedroso(1022) 6.2 Rue Joaquim Lapa(1020) 6.3 Rue do Bagamayo(1016) 6.4 Rue de Timor Leste(1014) 6.5 Av. Martires de Inhaminga(1006) 6.6 Other 6 roads	0.21	T1	0.32	T2
7. Rehabilitation of District 1 Area Roads 7.1 Av. Milargre Mabote(1369) 7.2 Av. da Malhangalene(1357) 7.3 Av. Para O Parmar(1426) 7.4 Av. Kweme Nkrumah(1250) 7.5 Av. Paulo Samuel Kankhomba(1152) 7.6 Av. Emilia Dausse(1138) 7.7 Av. de Maguiguana(1130) 7.8 Av. Filipe Samuel Magaia(1183) 7.9 Av. Friendrich Engels(1009)	0.09	T0	0.12	T0
8. Rehabilitation of District 2 Area Roads 8.1 Rua 2282/2265 8.2 Rua 2275 8.3 Rua de Xipamanine(2291) 8.4 Rua dos Imaos Roby(2289) 8.5 Rua 2315/2313 8.6 Rua 2309/2324	0.12	T0	0.17	T1
8.7 Av. das Estancias(2000)	0.29	T1	0.41	T2
9. Rehabilitation of District 3 Area Roads 9.1 Rua da Goa(3027) 9.2 Rua da Lixera(3030) 9.3 Av. Milagre Mbote(3001) 9.4 Av. da Malhangalene(3259) 9.5 Rua 1 de Maio(3374) 9.6 Rua 3306 9.7 Rua 3523 9.8 Rua 3576	0.11	T0	0.15	T1

Table : Traffic classes for paved roads

Traffic Class	Design traffic load $ESAL_d x 10^6$
T0	$ESAL_d < 0.15$
T1	$0.15 \leqq ESAL_d < 0.3$
T2	$0.3 \leqq ESAL_d < 0.7$
T3	$0.7 \leqq ESAL_d < 1.3$
T4	$1.3 \leqq ESAL_d < 2.5$
T5	$2.5 \leqq ESAL_d < 4.0$
T6	$4.0 \leqq ESAL_d < 7.5$
T7	$7.5 \leqq ESAL_d < 12$
T8	$12 \leqq ESAL_d < 20$
T9	$20 \leqq ESAL_d < 30$

- Reliability level: R = 85% (corresponds to urban trunk roads)
- Reliability level: R = 80% (corresponds to collector roads)

- Reliability Coefficient: Zr = -1.037 (corresponds to R = 85%)
- Reliability Coefficient: Zr = -0.841 (corresponds to R = 80%)

- Standards Deviation of Focussed Axle Loads: So = 0.45 (in the case of flexible pavement)
- Standards Deviation of Focussed Axle Loads: So = 0.35 (in the case of rigid pavement)

- Design CBR for subgrade

CBR for subgrade are determined as shown in Table 18.8.5.

- Serviceability Index (PSI)

Δ PSI = ISI – FSI
ISI = 4.2
FSI = 2.2
Δ PSI = 2.0

The required structural capacity [SNreq or SN2 as shown in the figure below] is determined by abstracting the structural number of recovered and reworked layers [SNr] from the design structural number for a new pavement [SN].

SNreq=SN-SNr

For rehabilitation purpose the structural number required [SNo1] to re-establish the service level and provide additional structural strength, is determined as the structural number for a new pavement [SN] subtracted the existing structural strength [SNeff] :

SNo1=SN-SNEff

- Overlay Design

For the rehabilitation with an overlay the existing structural number is calculated for the total existing pavement structure [SNEff], i.e. surfacing + base + subbbase, as described under, "Determination of structural capacity of existing pavement layers. The required AC overlay [OVL] thickness in mm is then calculated by the following equation.

OVL=25.4*[SN- SNEff]/a1

The required thickness of pavement has been obtained applying the above condition to the formula prescribed in AASHTO.

Table18.8.6, Figure18.8.2 shows the optimum pavement structures recommended to be applied for the proposed roads.

18.8.4 Pavement Structure of carriageway at around intersections

Semi-flexible pavement will be adopted at around intersections, level crossings at railway lines, road hump sites and bus stops to prevent the deterioration of the paving due to oil leaking from poorly maintained vehicles.

18.8.5 Pavement Structure of Sidewalk

The pavement structure to be applied for the sidewalk will be the simple pavement with DBST and a 10cm thickness base course (stabilized material).

Table 18.8.5 Design CBR

Group No	Length (km)	Subgrade Strength(CBR): Subgrade Soaked CBR (%)	Average Soked CBR(%)	Design CBR (%)	*Subgrade Classification	Existing Pavement Thickness(cm): Existing As Surface (cm)	Existing Base (cm)	Result of CBR test(%)							Ave.CBR	Ave. Soked CBR within each road link
1. Construction of Missing Link on Av. J. Nyrere		39	39	30	S6			44	34	30	48				39	39
		24	24	20	S6	***None***	***None***					23	23	27	24	24
2. Rehabilitation & Improvement of Av. A. Lusaka		-													-	
2.1 Av. A. dos Lusaka(3013,4057)		22						22							22	
2.2 Av. G. Popular(1189)		32	26	20	S6			32							32	26
3. Rehabilitation & Improvement of Av. Angola		-													-	
3.1 Av. Angola(3077)		34				***5***	***15***	34							34	
3.2 Rua S. Cabral(3081)/Largo de Deta(3079)		17				7	0	17							17	
4. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)		22	22	20	S6	***8***	***14***	22	21	24					22	22
5. Rehabilitation of Industrial & Commercial Area Roads		-													-	
5.1 Av. J. Michel(1070)		-													-	
5.2 Av. F. de Magalhaes(1038)		-				3	16								-	
5.3 Av. Z. Magalhaela(1034)		18				3	20	18							18	
5.4 Av. M. Siad Barre(1203)		23	22	20	S6	4	22	23							23	22
5.5 Av. Romao Fernandes(1199)		-				***3***	***15***								-	
5.6 Rue 1229		24						24							24	
5.7 Av. As Estancias(1030)		-				***3***	***14***								-	
6. Rehabilitation of Port Area Roads		-													-	
6.1 Rue Consigglieri Pedroso(1022)		-													-	
6.2 Rue Joaquim Lapa(1020)		-													-	
6.3 Rue do Bagamayo(1016)		-	37	30	S6	***2***	***20***								-	37
6.4 Rue de Timor Leste(1014)		-													-	
6.5 Av. Martires de Inhaminga(1006)		37						32	41						37	
6.6 Other 6 roads		-													-	
7. Rehabilitation of District 1 Area Roads		-													-	
7.1 Av. Milargre Mabote(1369)		-				4	12								-	
7.2 Av. da Malhangalene(1357)		-				6	0								-	
7.3 Av. Para O Parmar(1426)		-													-	
7.4 Av. Kweme Nkrumah(1250)		27				4	12	27							27	
7.5 Av. Paulo Samuel Kankhomba(1152)		-	25	20	S6	2	16								-	25
7.6 Av. Emilia Dausse(1138)		-				3	15								-	
7.7 Av. de Maguiguana(1130)		22				***2***	***12***	22							22	
7.8 Av. Filipe Samuel Magaia(1183)		-				3	15								-	
7.9 Av. Friendrich Engels(1009)		41						41							41	
8. Rehabilitation of District 2 Area Roads		-													-	
8.1 Rua 2282/2265		23				***1***	***18***	21	24						23	
8.2 Rua 2275		38				***None***	***None***	38							38	
8.3 Rua de Xipamanine(2291)		32				***None***	***None***	32							32	
8.4 Rua dos Imaos Roby(2289)		19	26	20	S6	4	0	19							19	26
8.5 Rua 2315/2313		16				***None***	***None***	16							16	
8.6 Rua 2309/2324		-				***None***	***None***								-	
8.7 Av. das Estancias(2000)		-				***3***	***14***								-	
9. Rehabilitation of District 3 Area Roads		-													-	
9.1 Rua da Goa(3027)		-				***1***	***2***								-	
9.2 Rua da Lixera(3030)		16				1	5	16							16	
9.3 Av. Milagre Mbote(3001)		24				***None***	***None***	18	29						24	
9.4 Av. da Malhangalene(3259)		-	21	20	S6	***None***	***None***								-	21
9.5 Rua 1 de Maio(3374)		22				5	15	22							22	
9.6 Rua 3306		-				***None***	***None***								-	
9.7 Rua 3523		-				***None***	***None***								-	
9.8 Rua 3576		-				***None***	***None***								-	

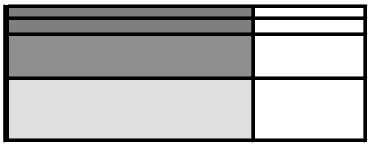
* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

Table : Subgrade Classification

Class	CBR Limits %
S1	CBR<3
S2	3≦CBR<5
S3	5≦CBR<8
S4	8≦CBR<12
S5	12≦CBR<20
S6	20≦CBR<30

Proposed Pavement Structure

1. New construction of Missing Link on Av. J. Nyerere



30 : As surfase course
40 : As binder course
100 : Base course (Graded Crushed Stone)
150 : Subbase course (Crushed Stone)

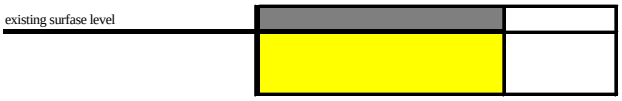
CBR=20%

2. Rehabilitation & Imprpvement of Av. A. Lusaka / G. Popular
2.1 Overlay

40 : Overlay
(50 : Existing AC)
(150 : Existing Base)

CBR=20%

2.2 Reconstruction from Base course



50 : As Surfase course
(150 : Stabilised Existing Base Material)

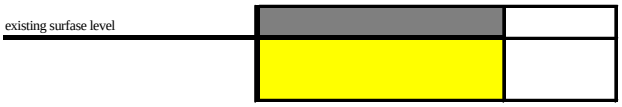
CBR=20%

3. Rehabilitation & Improvement of Av. Angola / Rua S. Cabral/Largo de Deta
3.1 Overlay

50 : Overlav
(50 : Existing AC)
(150 : Existing Base)

CBR=20%

3.2 Reconstruction from Base course



60 : As Surfase course
(150 : Stabilised Existing Base Material)

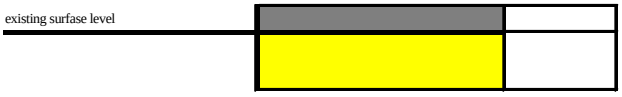
CBR=20%

4. Rehabilitation & Improvement of Marien Ngouabi
4.1 Overlay

40 : Overlay
(80 : Existing AC)
(140 : Existing Base)

CBR=20%

4.2 Reconstruction from Base course



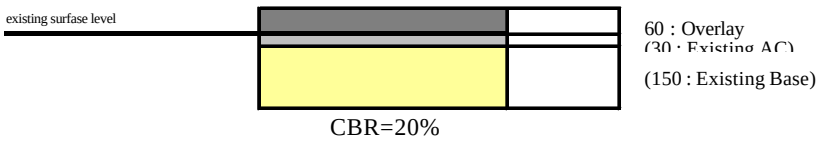
50 : As Surfase course
(140 : Stabilised Existing Base Material)

CBR=20%

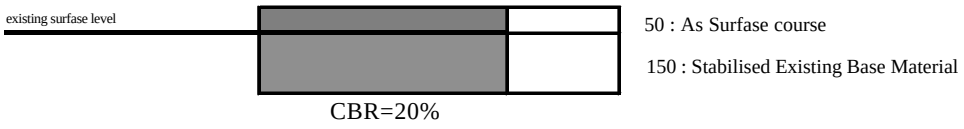
Figure 18.8.2 Proposed Pavement Structures(1)

5. Rehabilitation of Industrial & Commercial Area Roads

5.1 Overlay

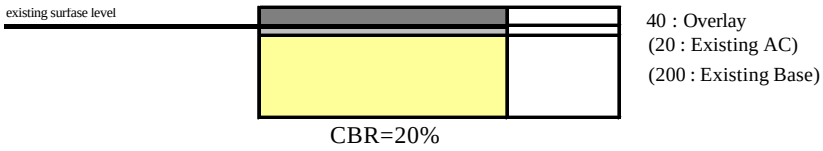


5.2 Reconstruction from Base course

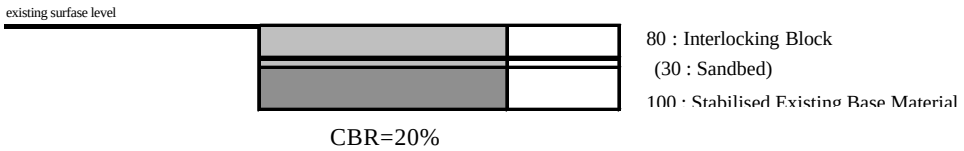


6. Rehabilitation of Port Area Roads

6.1 Overlay

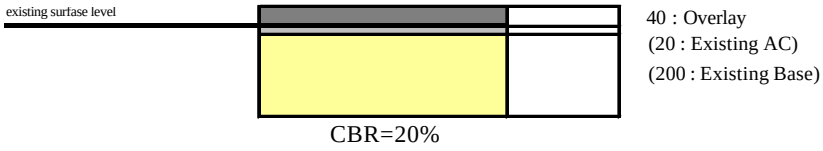


6.2 Reconstruction from Base course

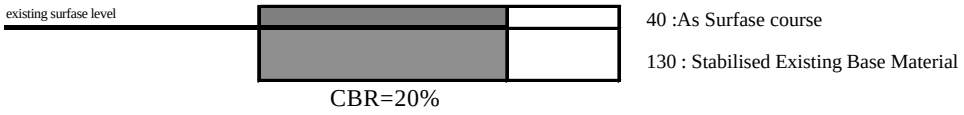


7. Rehabilitation of District 1 Area Roads

7.1 Overlay



7.2 Reconstruction from Base course



8. Rehabilitation of District 2&3 Area Roads

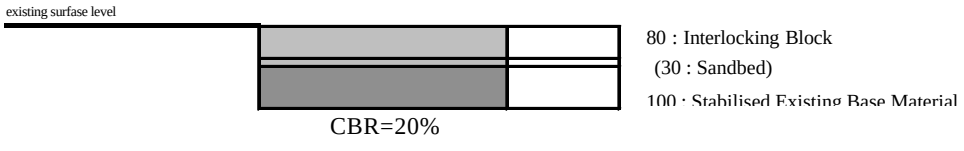


Figure 18.8.2 Proposed Pavement Structures(2)

Table 18.8.6(1) Pavement Design for Overlay

Pavement Design for Overlay

Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification	Existing Pavement Thickness: Existing As Surface (cm)	Existing Pavement Thickness: Existing Base (cm)	SN_{exist} (Structure Number of existing pavement): surfacing 0.35	base 0.12	SN_{exist}	$SN_{required}$	SN_{exist}	Overlay	
															0.4	Proposed
3. Rehabilitation & Improvement of Av. A. Lusaka	0.00															
3.1 Av. A. dos Lusaka(3013,4057)	3.60		3.50	0.10				50	150	17.50	18.00	1.40	1.96	0.56	35.46	40
3.2 Av. G. Popular(1189)	0.65		0.65				S6	50	150	17.50	18.00	1.40	1.96	0.56	35.46	40
4. Rehabilitation & Improvement of Av. Angola	0.00															
4.1 Av. Angola(3077)	3.05		3.05					***50***	***150***	17.50	18.00	1.40	2.10	0.70	44.41	50
4.2 Rua S. Cabral(3081)/Largo de Deta(3079)	0.65		0.65					50	150	17.50	18.00	1.40	2.10	0.70	44.41	50
5. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)	1.80		1.30	0.50			S6	***80***	***140***	28.00	16.80	1.76	1.81	0.04	2.745	40
6. Rehabilitation of Industrial & Commercial Area Roads	0.00															
6.1 Av. J. Michel(1070)	1.70		1.70					30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.2 Av. F. de Magalhaes(1038)	1.30			1.30				30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.3 Av. Z. Magalhaela(1034)	1.77			1.77				30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.4 Av. M. Siad Barre(1203)	1.39		0.89	0.50			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.5 Av. Romao Fernandes(1199)	1.55			1.55				***30***	***150***	10.50	18.00	1.12	1.97	0.85	53.91	60
6.6 Rue 1229	0.24			0.24				30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.7 Av. As Estancias(1030)	0.58			0.58				***30***	***150***	10.50	18.00	1.12	1.97	0.85	53.91	60
7. Rehabilitation of Port Area Roads	0.00															
7.1 Rue Consigglieri Pedroso(1022)	0.45			0.45				20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.2 Rue Joaquim Lapa(1020)	0.25		0.25					20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.3 Rue do Bagamayo(1016)	0.45		0.45				S6	***20***	***200***	7.00	24.00	1.22	1.72	0.49	31.4	40
7.4 Rue de Timor Leste(1014)	0.25		0.25					20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.5 Av. Martires de Inhaminga(1006)	0.45		0.45					20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.6 Other 6 roads	1.68		0.25	1.43				20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
8. Rehabilitation of District 1 Area Roads	0.00															
8.1 Av. Milargre Mabote(1369)	1.03			0.50	0.53			30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.2 Av. da Malhangalene(1357)	0.99			0.49	0.50			30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.3 Av. Para O Parmar(1426)	1.29			1.29				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.4 Av. Kweme Nkrumah(1250)	1.60		1.00	0.60				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.5 Av. Paulo Samuel Kankhomba(1152)	2.35			2.35			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.6 Av. Emilia Dausse(1138)	2.27			2.27				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.7 Av. de Maguiguana(1130)	2.40			2.40				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.8 Av. Filipe Samuel Magaia(1183)	1.76			1.76				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.9 Av. Friendrich Engels(1009)	1.58		1.08	0.50				30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
9. Rehabilitation of District 2 Area Roads	0.00															
9.1 Rua 2282/2265	2.36				2.36			***1***	***18***				1.65			
9.2 Rua 2275	2.01				2.01			***None***	***None***				1.65			
9.3 Rua de Xipamanine(2291)	1.13				1.13			***None***	***None***				1.65			
9.4 Rua dos Imaos Roby(2289)	1.30				1.30		S6	4	0				1.65			
9.5 Rua 2315/2313	1.11				1.11			***None***	***None***				1.65			
9.6 Rua 2309/2324	0.68				0.68			***None***	***None***				1.65			
9.7 Av. das Estancias(2000)	1.07				1.07			***3***	***14***				1.65			
10. Rehabilitation of District 3 Area Roads	0.00															
10.1 Rua da Goa(3027)	0.76				0.76			***1***	***2***				1.61			
10.2 Rua da Lixera(3030)	0.79				0.79			1	5				1.61			
10.3 Av. Milagre Mbote(3001)	1.98				1.98			***None***	***None***				1.61			
10.4 Av. da Malhangalene(3259)	1.86				1.86		S6	***None***	***None***				1.61			
10.5 Rua 1 de Maio(3374)	1.50				1.50			5	15				1.61			
10.6 Rua 3306	0.52				0.52			***None***	***None***				1.61			
10.7 Rua 3523	0.95				0.95			***None***	***None***				1.61			
10.8 Rua 3576	1.10				1.10			***None***	***None***				1.61			
	56.18	0.00	15.46	20.59	20.13	0.00										

* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

Table 18.8.6(2) Pavement Design for Reconstruction

Pavement Design for Reconstruction from Base course

SN_{exist} (Structure Number of existing pavement)

Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification	Existing Pavement Thickness		surfacing	base	SN_{exist}	$SN_{required}$	SN_{eff}	Proposed Pavement Thickness			Surface	Base (Stabilised)	Base (Stabilised existing base)	SN
								Existing As Surface (mm)	Existing Base (mm)	0.35	0.12				As Surface (mm)	Stabilised Base (mm)	Stabilised Existing Base (mm)	0.4	0.2	0.08	
3. Rehabilitation & Improvement of Av. A. Lusaka	0.00																				
3.1 Av. A. dos Lusaka(3013,4057)	3.60		3.50	0.10			S6	50	150		18.00	0.71	1.96	1.25	50.00	0.00	150.00	20.00	0.00	12.00	1.26
3.2 Av. G. Popular(1189)	0.65		0.65					50	150		18.00	0.71	1.96	1.25	50.00	0.00	150.00	20.00	0.00	12.00	1.26
4. Rehabilitation & Improvement of Av. Angola	0.00																				
4.1 Av. Angola(3077)	3.05		3.05					***50***	***150***		18.00	0.71	2.10	1.39	60.00	0.00	150.00	24.00	0.00	12.00	1.42
4.2 Rua S. Cabral(3081)/Largo de Deta(3079)	0.65		0.65					50	150		18.00	0.71	2.10	1.39	60.00	0.00	150.00	24.00	0.00	12.00	1.42
5. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)	1.80		1.30	0.50			S6	***80***	***140***		16.80	0.66	1.81	1.15	50.00	0.00	140.00	20.00	0.00	11.20	1.23
6. Rehabilitation of Industrial & Commercial Area Roads	0.00																				
6.1 Av. J. Michel(1070)	1.70		1.70					30	150		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.2 Av. F. de Magalhaes(1038)	1.30			1.30				30	150		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.3 Av. Z. Magalhaela(1034)	1.77			1.77				30	150		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.4 Av. M. Siad Barre(1203)	1.39		0.89	0.50			S6	30	150		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.5 Av. Romao Fernandes(1199)	1.55			1.55				***30***	***150***		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.6 Rue 1229	0.24			0.24				30	150		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
6.7 Av. As Estancias(1030)	0.58			0.58				***30***	***150***		18.00	0.71	1.97	1.26	50.00	0.00	150.00	20.00	0.00	12.00	1.26
7. Rehabilitation of Port Area Roads	0.00																				
7.1 Rue Consigglieri Pedroso(1022)	0.45			0.45				20	200		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
7.2 Rue Joaquim Lapa(1020)	0.25		0.25					20	200		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
7.3 Rue do Bagamayo(1016)	0.45		0.45				S6	***20***	***200***		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
7.4 Rue de Timor Leste(1014)	0.25		0.25					20	200		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
7.5 Av. Martires de Inhaminga(1006)	0.45		0.45					20	200		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
7.6 Other 6 roads	1.68		0.25	1.43				20	200		24.00	0.94	1.72	0.77	40.00	0.00	200.00	16.00	0.00	16.00	1.26
8. Rehabilitation of District 1 Area Roads	0.00																				
8.1 Av. Milargre Mabote(1369)	1.03			0.50	0.53			30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.2 Av. da Malhangalene(1357)	0.99			0.49	0.50			30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.3 Av. Para O Parmar(1426)	1.29			1.29				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.4 Av. Kweme Nkrumah(1250)	1.60		1.00	0.60			S6	30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.5 Av. Paulo Samuel Kankhomba(1152)	2.35			2.35				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.6 Av. Emilia Dausse(1138)	2.27			2.27				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.7 Av. de Maguiguana(1130)	2.40			2.40				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.8 Av. Filipe Samuel Magaia(1183)	1.76			1.76				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
8.9 Av. Friendrich Engels(1009)	1.58		1.08	0.50				30	130		15.60	0.61	1.60	0.99	40.00	0.00	130.00	16.00	0.00	10.40	1.04
9. Rehabilitation of District 2 Area Roads	0.00																				
9.1 Rua 2282/2265	2.36				2.36			***1***	***18***				1.65					0.00	0.00	0.00	0.00
9.2 Rua 2275	2.01				2.01			***None***	***None***				1.65					0.00	0.00	0.00	0.00
9.3 Rua de Xipamanine(2291)	1.13				1.13			***None***	***None***				1.65					0.00	0.00	0.00	0.00
9.4 Rua dos Imaos Roby(2289)	1.30				1.30		S6	4	0				1.65					0.00	0.00	0.00	0.00
9.5 Rua 2315/2313	1.11				1.11			***None***	***None***				1.65					0.00	0.00	0.00	0.00
9.6 Rua 2309/2324	0.68				0.68			***None***	***None***				1.65					0.00	0.00	0.00	0.00
9.7 Av. das Estancias(2000)	1.07				1.07			***3***	***14***				1.65					0.00	0.00	0.00	0.00
10. Rehabilitation of District 3 Area Roads	0.00																				
10.1 Rua da Goa(3027)	0.76				0.76			***1***	***2***				1.61					0.00	0.00	0.00	0.00
10.2 Rua da Lixera(3030)	0.79				0.79			1	5				1.61					0.00	0.00	0.00	0.00
10.3 Av. Milagre Mbote(3001)	1.98				1.98			***None***	***None***				1.61					0.00	0.00	0.00	0.00
10.4 Av. da Malhangalene(3259)	1.86				1.86		S6	***None***	***None***				1.61					0.00	0.00	0.00	0.00
10.5 Rua 1 de Maio(3374)	1.50				1.50			5	15				1.61					0.00	0.00	0.00	0.00
10.6 Rua 3306	0.52				0.52			***None***	***None***				1.61					0.00	0.00	0.00	0.00
10.7 Rua 3523	0.95				0.95			***None***	***None***				1.61					0.00	0.00	0.00	0.00
10.8 Rua 3576	1.10				1.10			***None***	***None***				1.61					0.00	0.00	0.00	0.00
	56.18	0.00	15.46	20.59	20.13	0.00															

* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

Table 18.8.6(3) Pavement Design for New Construction

Pavement Design for New Construction

Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification	$SN_{required}$	Proposed Pavement Thickness			Surface	Base	Subbase	SN
									As Surface (mm)	Base (mm)	Subbase (mm)	0.4	0.14	0.11	
1. Construction of Missing Link on Av. J. Nyrere	4.80					4.80	S6	1.82	70.00	100.00	150.00	28.00	14.00	16.50	2.30

Pavement Design for New Construction

Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification	$SN_{required}$	Proposed Pavement Thickness			Surface	Sandmat	Stabilised Base	SN
									Concrete Block (mm)	Sandmat (mm)	Srtabilised Base (mm)	0.4	0	0.20	
7. Rehabilitation of Port Area Roads	0.00														
7.1 Rue Consigglieri Pedroso(1022)	0.45			0.45				1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
7.2 Rue Joaquim Lapa(1020)	0.25		0.25					1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
7.3 Rue do Bagamayo(1016)	0.45		0.45				S6	1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
7.4 Rue de Timor Leste(1014)	0.25		0.25					1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
7.5 Av. Martires de Inhaminga(1006)	0.45		0.45					1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
7.6 Other 6 roads	1.68		0.25	1.43				1.72	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9. Rehabilitation of District 2 Area Roads	0.00														
9.1 Rua 2282/2265	2.36					2.36		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.2 Rua 2275	2.01					2.01		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.3 Rua de Xipamanine(2291)	1.13					1.13	S6	1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.4 Rua dos Imaos Roby(2289)	1.30					1.30		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.5 Rua 2315/2313	1.11					1.11		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.6 Rua 2309/2324	0.68					0.68		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
9.7 Av. das Estancias(2000)	1.07					1.07		1.65	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10. Rehabilitation of District 3 Area Roads	0.00														
10.1 Rua da Goa(3027)	0.76					0.76		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.2 Rua da Lixera(3030)	0.79					0.79		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.3 Av. Milagre Mbote(3001)	1.98					1.98		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.4 Av. da Malhangalene(3259)	1.86					1.86	S6	1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.5 Rua 1 de Maio(3374)	1.50					1.50		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.6 Rua 3306	0.52					0.52		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.7 Rua 3523	0.95					0.95		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
10.8 Rua 3576	1.10					1.10		1.61	80.00	30.00	100.00	32.00	0.00	20.00	2.05
	27.43	0.00	1.65	1.88	0.00	23.90									

18.9 ROAD FACILITIES DESIGN

18.9.1 Pedestrian Crossing

Pedestrian crossings will be introduced at intersections with trunk roads and near public facilities (such as schools, churches and hospitals, etc.) In addition, humps and appropriate road signs will be introduced to slow down the traffic at places where such facilities are deemed to be necessary.

18.9.2 Bus Facilities Design

The bus route and preliminary bus stop plan are planned as shown in the Chapter 11.3.

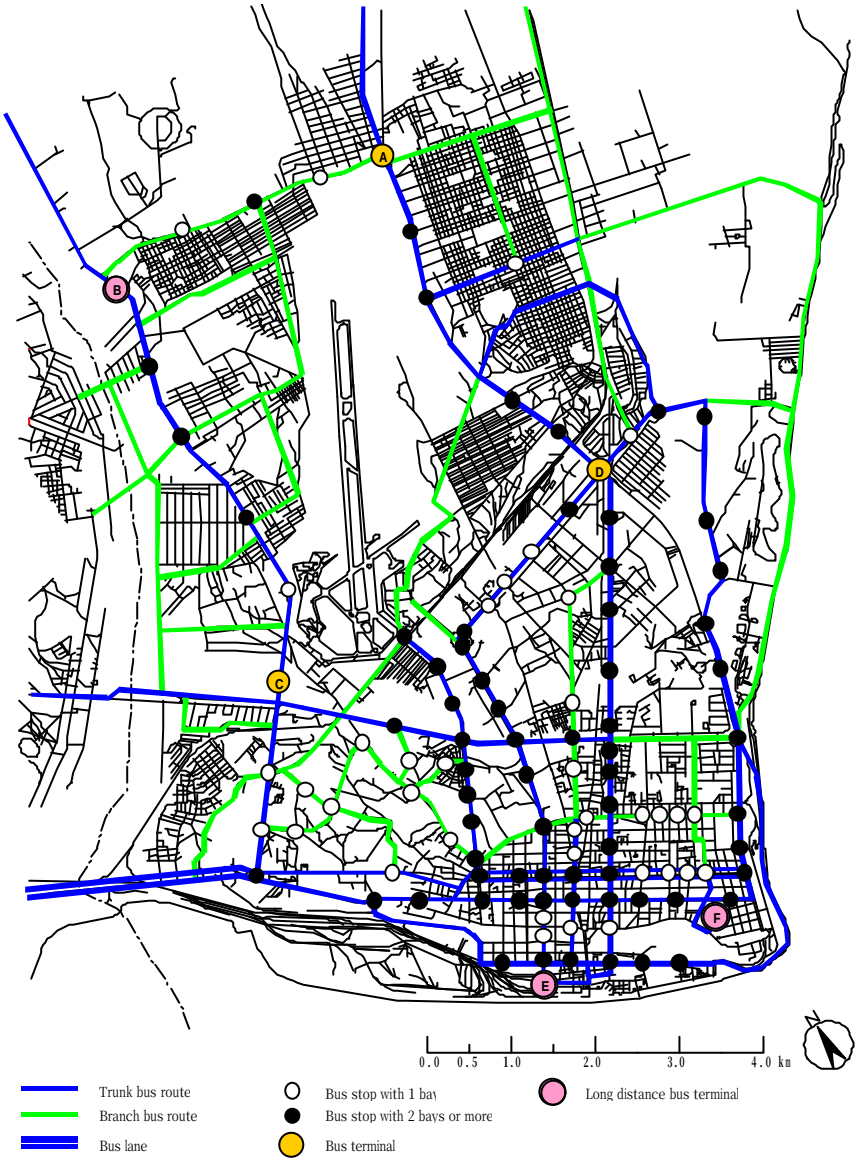


Figure 18.9.1 Location of Bus Routes and Bus Stops

1) General Requirement

(1) Geometric design

Size of bus stop

Bus stops should be scaled for 2-3 buses at junctions of trunk bus routes. Other bus stops will be scaled according to the public transportation development plan.

Size of the bus stop is stipulated as shown in the Figure 18.9.2. However reduction of width to 2.0m should be considered due to difficulties of land acquisition in the high-urbanized area.

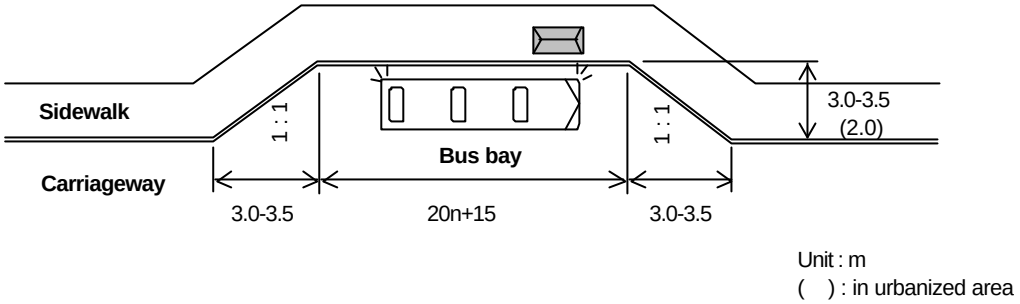


Figure 18.9.2 Size of Bus Stops

Position and dimension

In order to avoid blockage of through traffic at intersections, 3.0m of bus stop width should be secured. Meantime carriageway width should also be secured minimum of 3.0m. Sidewalk width at bus stops should be reduced at the place where difficult to secure the width of bus stop, but preferably it should be secured minimum of 5.0m.

Position of bus stops should be kept away from road edge at major intersections, minimum length of 30m. Accordingly 14 nos. of bus stops near intersections should be relocated.

Position and scale of bus stops should be finalized according to the site situation, it should be avoided in front of entrances to buildings, alleys, etc.

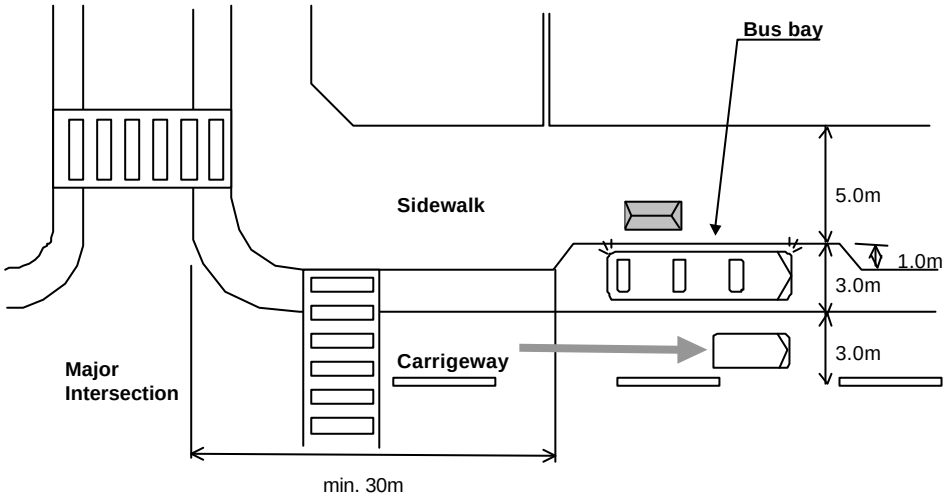


Figure 18.9.3 Position and Dimension at Intersection in the Urban Area

(2) Facilities

Bus stop facilities

At least one bus shelter with bench should be established at each bus stops. Also signboards showing the route number of the buses should be established. Each bus shelter should have information boards showing timetable, route map etc.

In the bus stops, large sized public bus called "TPM" and middle-small sized private bus called "Chapa" will share the same parking space. In order to avoid conflict between these, stopping space should be separated, and road markings or signs should be installed in front of each parking position.

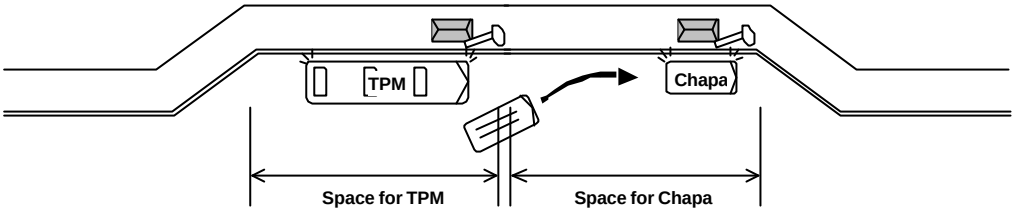


Figure 18.9.4 Share of Parking Space by TPM and Chapa

Parking control

In order to secure smooth bus operation, car parking should be prohibited around bus stops in length of 30m from bus stops. Therefore parking control signs should be established.

2) Design

Typical plan of bus stops are as shown in the Appendix.

3) Implementation Programme

Road development or maintenance project

Bus stops located on the roads nominated to the road development or maintenance project should be included in the above project.

21 nos. of bus stops will be included in the road development and maintenance project.

Traffic management project

Bus stops located near intersections nominated to the traffic management project should be included in the above project.

14 nos. of bus stops will be included in the traffic management project. 8 nos. will require sidewalk cutting in width of 1.0m.

Public transportation project

9 nos. of bus stops located on Av. Vladimir Lenine and 5 nos. on Av. FPLM will be included in the public transportation project. Furthermore 2 bus terminal, Combatentes and Trabalhadores are nominated to the public transportation project.

Other bus stops

Other bus stops, which are not included in the projects on the feasibility study, should be maintained by the road development authority. These bus stops will have small-scaled size and structure.

Location of bus stops included in the above, are shown in the Figure 18.9.5.

Table 18.9.1 Bus Stop List

No.	Road Name	Project category	Type			Total
			Bus Terminal	Bus Bay	Roadside	
T1	Av. Julius Nyerere	Road Development		5		
		Public Transportation	1			
		Traffic Management		3		9
T2	Av. Vladimir Lenine	Public Transportation		9		
		(Excluded)			3	12
T3	Av. Acordos do Lusaka	Road Improvement			4	
		Public Transportation				4
T4	Av. Guerra Popular	Road Development			2	
		Traffic Management		1		
		(Excluded)			1	4
T5	Av. da Angola	Road Improvement			5	5
T9	Av. Marien Ngouabi	Road Development			5	5
T10	Av. da FPLM	Public Transportation			5	5
-	Av. 25 de Setembro	Traffic Management		2		
		(Excluded)			3	5
-	Av. 24 de Julho	Traffic Management		4		
		(Excluded)			5	9
-	Av. Edward Mondlane	Traffic Management		4		
		(Excluded)			5	9
-	Av. Mao Tse Tung	Traffic Management				
		(Excluded)			3	3
C2/C32	Av. da Malhangalene(1357/3259)	Road Rehabilitation		3		3
C16	Av. Martires de Inhaminga(1006)	Public Transportation	1			1
C21	Rua 2282/2265	Road Rehabilitation		3		3
C22	Rua 2275	Road Rehabilitation		1		1
C23	Rua de Xipamanine(2291)	Road Rehabilitation		1		1
C24	Rua dos Imaos Roby(2289)	Road Rehabilitation		3		3
C25	Rua 2315/2313	Road Rehabilitation		2		2
C26	Rua 2309/2324	Road Rehabilitation		1		1

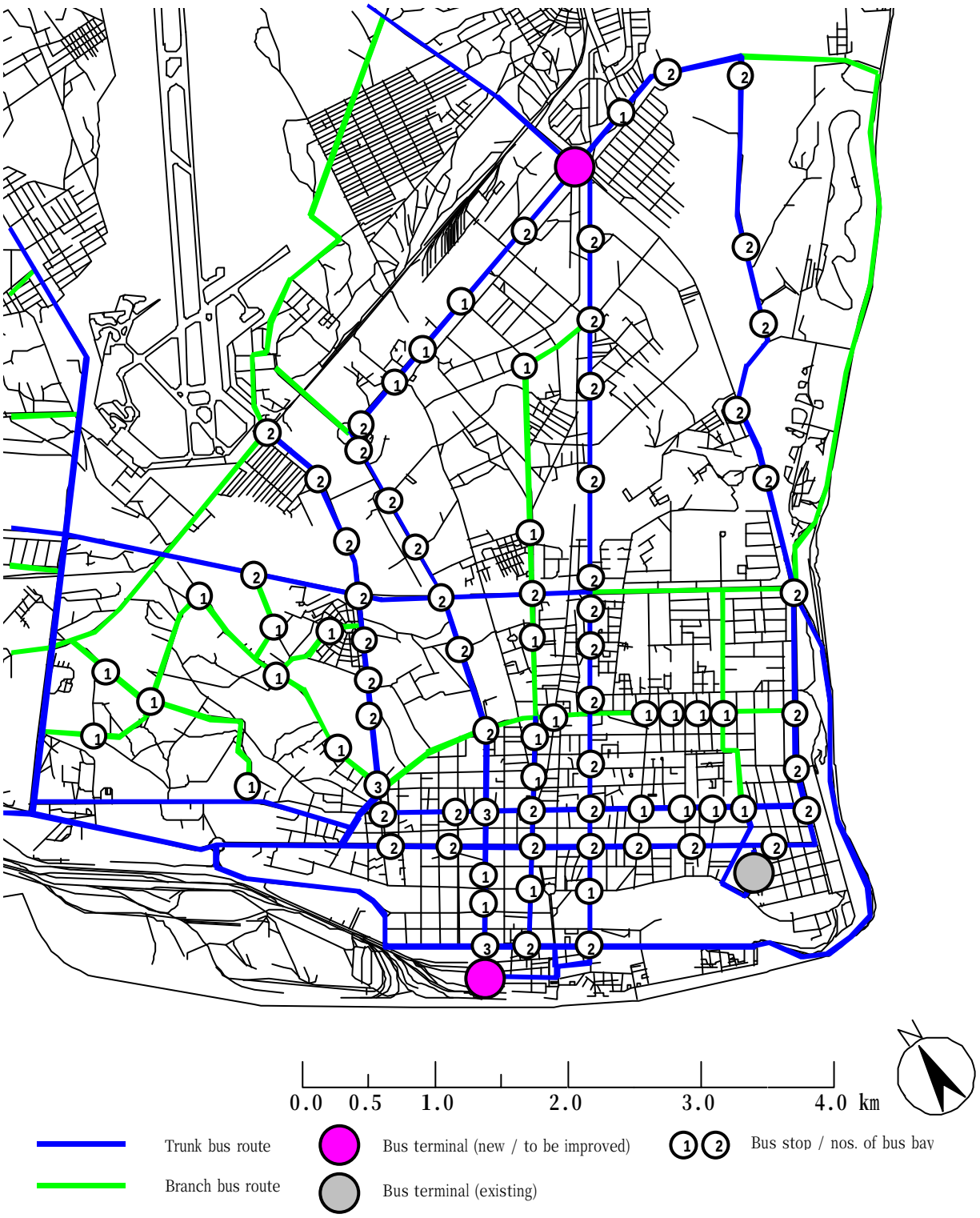


Figure 18.9.5 Location of Bus Stops

18.9.3 Lighting and Other Road Facilities

1) Lighting

Lighting facilities should be introduced at signalled intersections, channelized intersections and pedestrian crossings to ensure safe travelling at night.

2) Chatter-bar

Chatter-bars will be installed along the centre line at those sections without lighting to ensure safe travelling at night.

18.9.4 Road Signs and Markings

1) Road Signs

Road signs shown below should be established.

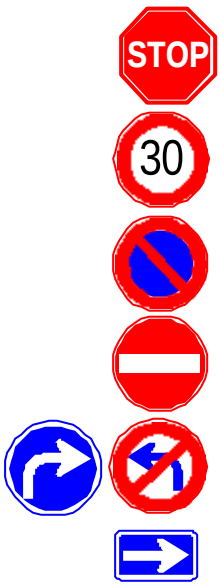
- Warning signs

Pedestrian crossing ahead
- In front of pedestrian crossing

Children crossing ahead
- In front of school, play ground etc.

Hump ahead
- In front of speed hump

- Regulatory signs



Stop sign
- At the exit of the road

Speed limit
- Every 500m on the road

No parking
- In front of place where roadside parking is prohibited

No entry
- At the exit of the one-way street

Direction
- At the entrance of the one-way street, on main road

One way
- At the entrance of the one-way street

- Other

Bus stop
- In front of bus stop

Parking
- At the roadside parking

2) Road Markings

Road markings shown below should be established.

Lane marking (solid line)
- 30-50m from intersections

Lane marking (dotted line)
- Carriageway where over-taking is allowed
- Shift section at intersection
- Boundary of bus bay

Direction arrow
- Intersection, more than two lane

Stop line
- Intersection, 1-2m in front of pedestrian crossings

Channelization zebra
- Intersection, where necessary to channelize the direction of turning traffic

Pedestrian crossing zebra
- Intersection
- In front of school, playground etc.
- Place where pedestrian crossing are much

Roadside parking strip
- At the roadside parking

Roadside strip
- Whole section of roads

Speed hump zebra
- Place where speed hump is established

18.10 RELOCATION AND PROTECTION OF PUBILIC UTILITIES

18.10.1 Relocation of Public Utilities

Relocation of existing utilities is one of the most difficult aspects of road construction in urban areas due to the involvement of many authorities or agencies who have different policies, development time schedules and technical standards.

The existing utilities were investigated by the study team referring to the available data obtained from the authorities and agencies concerned.

Public utilities, either underground or overhead, are planned to be installed at sidewalks or shoulders so that repair and maintenance operations for the services will not hinder traffic and accelerate the deterioration of the road structures after they are opened to traffic. The shoulders and sidewalks will be provide space to contain the following public utilities;

(i) Water main and distribution pipes
(ii) Electric power line and poles
(iii) Telecommunication lines

The inventory of the existing public utilities to be relocated and protected by the Project is shown in a separated volume entitled “Drawing”.

All utilities to be affected by the construction of the proposed roads must be relocated and replaced or protected. Normally, the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephone cables, water main at their own cost.

18.10.2 Compensation of Public Properties

Compensation of public properties will be necessary by widening of the existing road.

(1) Av. Marien Ngouabi / Av. Guerra Popular
In the case of Av Marien Ngouabi and Av. Guerra Popular, compensation of public utilities will be not necessary for widening from 2 to 4 lanes. But some walls of the public properties will be necessary to shift for keep the proposed road width.

(2) Av. V. Lenine
Some of walls of the properties will be necessary to shift for keep the proposed road width at the

proposed bus bay.

(3) District 2 and 3 Area Roads

In case of District 2 and 3 Area Roads, the existing road width is so narrow that compensation of public utilities will be necessary. The numbers of property compensation are shown in Table 18.4.2.

(4) Industrial and Commercial Area Roads/Port Area Roads/District 1 Area Roads

In case of the objective roads such as Industrial and Commercial Area Roads, Port Area Roads and District 1 Area Roads, compensation of properties will not necessary because these roads will not be changed the existing road width.

CHAPTER 19

CONSTRUCTION PLAN AND COST ESTIMATE

CHAPTER 19 : CONSTRUCTION PLAN AND COST ESTIMATE

19.1 GENERAL

The project is composed of these projects as shown below.

1) Road Development Plan

Trunk Road Development Plan

1. Construction of Bypass missing link on Av. Julius Nyerere
2. Improvement of Av. Vladimir Lenine
3. Rehabilitation and improvement of Av. Acordos de Lusaka and Av. Guerra Popular
4. Rehabilitation and improvement of Av. de Angola
5. Rehabilitation and improvement of Av. Marien Ngouabi

Collector Road Development Plan:

1. Rehabilitation of industrial and commercial area roads
2. Rehabilitation of port area roads

Residential Area Roads:

1. Rehabilitation of District 1 area roads
2. Rehabilitation of District 2 area roads
3. Rehabilitation of District 3 area roads

2) Traffic Management Plan:

Rehabilitation and improvement of intersections in the CBD

3) Public Transport Plan:

Rehabilitation and improvement of bus stops and bus terminals

The project cost, which consists of construction cost, land acquisition and compensation cost, physical contingency, costs for engineering services and supervisory services etc. have been estimated with the details being included herein.

19.2 CONDITIONS AFFECTING THE CONSTRUCTION SITES

The estimated workable days for construction planning are estimated based on the assumption of the number of days suspended due to rain, holidays and other conditions.

19.2.1 Social Conditions

1) Holidays

Sunday should be excluded from the workable days. Furthermore, there are national holidays and regional holidays in Mozambique as follows.

- Sunday : 52 days
- National holidays : 7 days
- Religious holidays (Christmas, Easter) : 21 days

2) Working Hours

According to the Labour 's act in Mozambique, the working hours is 8 hours per day, 48 hours per week.

19.2.2 Weather Conditions

Rain season is from November to March. Especially from December and January, efficiency of construction is expected to be descent. During rain season, efficiency of construction works is assumed as follows. These are compared with the efficiency in the dry season.

Table 19.2.1 Efficiency of Construction Works

	Jan	Feb	Mar	Apr-Oct	Nov	Dec	Efficiency
Earthwork	50-60%	50-60%	60-70%	100%	50%	50%	70%
Pavement work	50-60%	50-60%	60-70%	100%	50%	50%	
Drainage work	100%	100%	100%	100%	100%*	100%*	
Structural work	100%	100%	100%	100%	100%	100%	

* : Structural works under the groundwater level is should be stopped in November and December due to groundwater.

19.2.3 Labour Force

For the purpose of the cost estimation, labours engaging in this project are assumed to the labour sent by local contractor. Except foreman or skilled worker, some of these staffs may be from foreign countries such as South Africa etc.

19.2.4 Construction Materials

1) Cement

Cement is assumed to be supplied by local supplier.

2) Ready-Mixed Concrete

Ready-mixed concrete is assumed to be supplied by the local contractor's batching plant located in Matola, 30km from the centre of Maputo city.

3) Crushed Stone

Crushed Stone for concrete and road works is assumed to be supplied from the local contractor's crushing plant located in Boane, 47km from the centre of Maputo city

4) Sand

Sand for concrete is assumed to be supplied from the local contractor's crushing plant located in Boane, 47km from the centre of Maputo city.

5) Filling and Sub-grade Materials

Filling and Sub-grade Materials is assumed to be supplied from the borrow pit along EN4 toll road, 30km from the centre of Maputo city.

6) Pre-cast Concrete Products

Concrete products imported from South Africa, Swaziland etc. are available in Mozambique. Its quality is more reliable comparing with domestic products.
The following pre-cast concrete products are available in Mozambique, however the cost should be considered comparing with cast-in-situ.

- Kerb stone
- L-shaped side ditch
- LU
- Catch pit
- Soaking pit
- Pipe culvert

7) Asphalt (bituminous materials)

Asphalt mixture is assumed to be supplied by the local contractor's mixing plant located in Matola, 30km from the center of Maputo city. Bituminous materials are imported from South Africa.

8) Steel (reinforcement and steel materials)

Reinforcement and other structural steel material is assumed to be imported from South Africa.

19.2.5 Construction Machinery and Plant

Construction machinery and plant which can be procured or leased in Mozambique are as shown in the Table 19.2.2. Situation of possession by foreign contractors (South Africa, Japan, etc.) is same as this.

These are from private companies, machinery and plant owned by government agencies are not investigated in this study.

The cost for maintenance and spare parts is included in rental cost of these machineries.

Table 19.2.2 Construction Machinery and Plant Available in Mozambique

Name of Construction Machinery	Specifications/ Capacity
Bulldozer	15t, 21t
Motor grader	3.1m
Wheel loader	1.4m^3, 1.8 m^3
Vibration roller	0.8-1.0t, 3-4t
Macadam roller	8-12t
Tire roller	8-15t
Dump truck	10t
Truck crane	25t-100t
Vibro-hammer	40Kw
Back hoe	0.2-0.35 m^3
Generator	50-100KVA
Compressor	5-10 m^3/min
Concrete plant	30 m^3/h
Concrete pump car	60m^3/h
Asphalt plant	40t/h
Asphalt finisher	2.4-5m

19.2.6 Local Contractors

Local Contractors are assumed to make a sub-contract to main contractor.

1) Government-Owned Companies

(Not investigated)

2) Private Companies

CMC Co., Ltd.
CETA Co., Ltd.
(Murray & Roberts Co., Ltd)

19.2.7 Access of Construction Materials and Machinery to the Site

Construction materials and machineries are delivered from suppliers warehouse and local contractor's yard to the site through trunk roads.

19.2.8 Relocation of public Utilities

All utilities to be affected by the construction of the proposed roads must be relocated and replaced or protected. Normally the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephone cables, water mains at their own cost.

Relocation should be done maintaining close coordination with the agencies concerned.

19.2.9 Traffic Management During the Construction

The widening of the existing road may sometimes seriously interfere with the traffic flow during construction. Since the proposed roads carry large number of vehicles, special care should be taken for traffic management, especially safety. Diversion roads should be properly provided with appropriate traffic signs and guides. Also, night work should be considered to minimize the traffic congestion during the construction of proposed roads in the centre of the city.

Widening of the existing roads sometimes requires relocation of existing bus bays and bus stops which may hinder not only the operation of the bus services but also the passengers getting on and off.
Temporary facilities should be provided near the existing bus bays for the convenience of passengers during the construction.

19.3 CONDITIONS FOR COST ESTIMATE

The basic premises in estimating cost are as follows.

1) Project cost consists of the following items:
   - Construction cost
     - Construction
     - House compensation and house relocation
     - Structure strengthening
   - Consultant fee
   - Contingency for price escalation and physical change
   - Administration cost of Mozambican Government

2) All construction work will be executed by private contractors.

3) The unit cost of each cost component was determined based on the economic conditions in 2001of Mozambique.

4) The structure strengthening is consists of the training and guidance of the new road maintenance system, the procurements of training and maintenance equipments and the construction of training room. This cost is uniformly estimated at 0.56 million US$.

5) The consultant fee consists of detailed engineering design and construction supervision and has been estimated at 8 % of construction cost. Tendering will be required at the time of tender and it is estimated that this will be equivalent to 2% of construction cost. Therefore the consultant fee will be estimated at 10 % of construction cost.

6) House compensation and relocation utilities costs were determined by the EIA survey.

7) Contingency for price escalation and physical change is estimated at 10 % of construction cost.

8) Administration Cost of Mozambique Government is estimated at 1 % of construction cost.

9) Currency
   Exchange Rate: 1 US$ = 22,000 Mts.= 125.00 Yen, 1 Mts. = 0.00568 Yen (July 2001)

10) Taxation is uniformly 17 % to merchandise as VAT in Mozambique.

11) Maintenance cost is classified into the routine maintenance cost and the periodic maintenance cost. The routine maintenance cost is estimated at annual 1.5 % of construction cost. And the periodic maintenance cost is estimated at 10 % every ten years after completion of construction work.

12) Foreign and Local Currency Portions for Construction Materials are as shown in the Table 19.3.1.

Table 19.3.1 Foreign and Local Currency Portions for Construction Materials

Items		Currency Portion	
		Foreign	Local
a.	Concrete produced by batches plant including material	0%	100%
b.	All equipment and plants for road construction	0%	100%
c.	Asphalt (Bituminous, coat, etc) for pavement material including production costs by plants	0%	100%
d.	Reinforcing bar (deformed steel bar DΦ10～32 mm)	0%	100%
e.	Raw materials such as sand, aggregate, rock, and embankment material are locally available.	0%	100%
f.	Concrete products such as pipes, piles	0%	100%
g.	Form work (timber, steel including manufacturing)	0%	100%
h.	Frame support/ scaffolding work	0%	100%
i.	Labour (including expatriate expert labour)	3%	97%
j.	Fuel (gasoline, diesel)	0%	100%

13) Standard of Productivity

Standard of productivity is given from "Standard Productivity for Construction Works, 2001, Ministry of Land, Infrastructure and Transport, Japan".

19.4 UNIT RATES

19.4.1 Unit Prices of Materials, Labour and Equipment

The unit prices of labour forces, materials and equipments are estimated as shown on the Table 19.4.1. These are made through hearing to the relevant road development authorities and local contractors in Mozambique, on the basis of the similar road or bridge project executed in and around Maputo city.

The equipment cost is including miscellaneous costs such as the site mobilization cost, the inland transportation fee etc.

19.4.2 Unit Costs for Major Working Items

The Table 19.4.2 is showing the unit cost for major working items, calculated for each working items. These are made based on the preliminary construction schedule and method, natural and social conditions, availability of local materials and equipment, labour force etc.

Table 19.4.1 Unit Price

Manpower Cost Currency Unit : US$

NO.	Classification	Unit	taken
1	* Foremen (national)	Day	64.82
	(international)		
2	* Mechanic	Day	31.79
3	* Electrician	Day	46.32
4	* Equipment Operator	Day	28.01
5	* Assistant to Operator	Day	7.45
6	* Driver	Day	29.75
7	* Rigger	Day	27.87
8	* Welder	Day	37.12
9	* Carpenter	Day	26.91
10	* Steel worker	Day	26.41
11	* Concrete worker	Day	26.91
12	* Skilled labor	Day	29.21
13	* Common labor	Day	6.51
14	* Miscellaneous Labor	Day	
15	* Engineer(20 Years experience)	Month	9169.45
16	* Engineer(10 years experience)	Month	7235.40
17	* Engineer(5 years experience)	Month	5940.55
18	* Surveyor	Month	6280.35
19	* Accountant	Month	4071.35
20	* Administrator	Month	7026.45
21	* Secretary	Month	244.25
22	* Draftsman (5 years experience)	Month	370.25
23	* Typist	Month	153.00
24	* Driver	Month	786.54
25	* Office boy	Month	105.00
26	* Guardsman	Month	163.75

Material Cost Currency Unit : US$

NO.	Classification		Unit	taken
1	* Cement	(portland cement)	ton	138.50
2	* Reinforcing bar		ton	847.50
3	* Admixture for concrete		kg	
4	* Coarse aggregate for concrete		m3	29.40
5	* Sand for concrete		m3	24.20
6	* Embankment material for road		m3	6.45
7	* Granular subbase material for road		m3	12.82
8	* Crushed Aggregate basecourse material		m3	31.80
	for road			
9	* Bituminous stabilization treatment material		ton	
10	* Bituminous concrete		ton	98.75
11	* Riprap material for slope		m3	
12	* Wire mesh for Gabion and		m2	31.70
13	* Stone for Gabion and Mattress		m3	27.06
14	* Plywood(+=12mm)		m2	19.20
15	* Dynamite		kg	
16	* Diesel oil		liter	0.51
17	* Gasoline		liter	0.59
18	* Precast concrete pipe	(600mm dia)	m	100.00
19	* Precast concrete pipe	(800mm dia)	m	163.85
20	* Precast concrete pipe	(1,000mm dia)	m	263.50
21	* Precast concrete pile square	450*450mm	m	217.50
	(ultimate capacity=125tonnes per pile			
	allowable capacity=50tonnes per pile)			
22	* Elastomeric bearing pad	(hardness 70)	kg	
23	*Steel expansion joint		kg	
24	* Vinyl chloride pipe	(50mm dia)	m	3.51
25	* Vinyl chloride pipe	(100mm dia)	m	8.64
26	* Structural Steel‥angle ,		ton	2,362.50
	H-beam			
27	*Steel pipe	(100mm dia)	m	35.58
28	* Wood		m3	460.00
29	* Sand bag		no	3.20
30	* Brick		piece	0.17
31	* Wire		kg	0.51
32	* Barbed wire		m	1.03
33	* Nail		kg	0.98
34	* Prestressing bar : Ö26		kg	1.09
35	* Prestressing wire : 12Ö7		kg	1.40
36	* Prestressing strand wire		kg	1.40
37	* Emulsion	SS60%	litre	0.53
38	* Ready mixed concrete	15MPa/20mm	m3	85.00
39	- ditto -	25MPa/20mm	m3	100.00
40	* Metal Form		m2	

Equipment Cost Currency Unit : US$

NO.	Name of Equipment	Capacity	taken	
			(/day)	(/hour)
1	* Dump truck	10ton	308.83	38.60
2	* Cargo truck	4ton	172.16	21.52
3	* Back hoe	0.6m3	536.10	67.01
4	* Back hoe	0.35m3	441.95	55.24
5	* Back hoe	0.2m3	335.58	41.95
6	* Truck crane	100ton		
7	* Truck crane	60ton		
8	* Truck Crane	25ton	587.70	73.46
9	* Crawler Crane	100ton	1606.70	200.84
10	* Crawler Crane	50ton	1354.50	169.31
11	* Crawler Crane	35ton	626.00	78.25
12	* Vibration hammer	40kw		
13	* Water jet	Standard	178.15	22.27
14	* Portable conc. mixer	0.30m3	100.09	12.51
15	* Asphalt sprayer	200ltr	343.60	42.95
16	* Vibrating roller	500kg	100.37	12.55
17	* Welder	300A	107.54	13.44
18	* Winch	2ton		
19	* Bulldozer	15ton	592.07	74.01
20	* Bulldozer	21ton	878.41	109.80
21	* Wheel loader	1.4m3	722.37	90.30
22	* Wheel loader	1.8m3	845.39	105.67
23	* Macadam roller	8-12ton	363.36	45.42
24	* Tire roller	8-15ton	444.41	55.55
25	* Rammer	60kg	42.82	5.35
26	* Concrete bucket	0.6m3	36.44	4.55
27	* Soil compactor	600-800kg	117.43	14.68
28	* Compressor	5m3/min	239.60	29.95
29	* Compressor	7m3/min	323.36	40.42
30	* Compressor	10m3/min	403.14	50.39
31	* Generator	100kva	362.67	45.33
32	* Generator	50kva	186.64	23.33
33	* Water pump	150mm	53.51	6.69
34	* Concrete vibrator	1kw	32.23	4.03
35	* Concrete Breaker	30kg	144.98	18.12
36	* Motor grader	3.1m	711.41	88.93
37	* Clamshell	0.6m3	47.70	5.96
38	* Trailer	40ton	252.33	31.54
39	* Concrete plant	25-30m3/h	541.14	67.64
40	* Concrete Plant	30m3/h	566.14	70.77
41	* Asphalt plant	40T/h	1085.31	135.66
42	* Water Tank Truck	5,500-6,500	530.59	66.32
43	* Asphalt finisher	2.4m-5m	413.34	51.67
44	* Concrete Mixer Truck	5-6m3	460.91	57.61
45	* Vibrating Roller	0.8t - 1.0t	76.52	9.56
46	* Vibrating Roller	3t - 4t	530.71	66.34
47	* Concrete Breaker	1300kg	111.50	13.94
48	* Concrete cutter	blade 45-56cm	96.29	12.04
49	* Dump truck	2ton	92.08	11.51
50	* Concrete Pump	60m3/h	659.76	82.47

Rental cost includes the cost for maintenance, transportation, mobilization, fuel.

Table 19.4.2 Unit Cost for Major Working Items

Item	Spec	Unit	Unit Rate		
			\	US$	Mt
Machine excavation (without obstructions)		cb.m		1.96	
Machine excavation (with obstructions)		cb.m		3.13	
Excavation for foundation (without obstructions)		cb.m		2.76	
Excavation for foundation (with obstructions)		cb.m		3.36	
Manual excavation		cb.m		5.08	
Backfill		cb.m		4.08	
Manual embankment (fill)		cb.m		3.05	
Compaction by tamper		cb.m		1.76	
Embankment slope trimming		sq.m		2.21	
Cutting slope trimming		sq.m		3.26	
Soil transportation (less than 0.5km distance)		cb.m		2.45	
Removal of surplus soil (less than 10km distance)		cb.m		10.52	
Embankment (borrow material)		cb.m		9.66	
Embankment (in-situ material)		cb.m		3.01	
Foundation crushed stone (t=20cm)		sq.m		11.49	
Formwork (leveling concrete)		sq.m		6.44	
Formwork (reinforced concrete, plain concrete)		sq.m		12.37	
Formwork (small structure II)		sq.m		10.03	
Reinforcement		t		1,007.68	
Concrete placement (manual casting)	ó28＝15MPa	cb.m		105.19	
Concrete placement (manual casting)	ó28＝25MPa	cb.m		115.64	
Concrete placement (pump casting)	ó28＝15MPa	cb.m		103.12	
Concrete placement (pump casting)	ó28＝25MPa	cb.m		111.25	
Scafolding		sq.m		9.78	
Supporting		cb.m		18.64	
RC pipe placing (ö400)		m		90.00	
RC pipe placing (ö600)		m		119.24	
RC pipe placing (ö800)		m		185.07	
RC pipe placing (ö1000)		m		296.28	
RC pipe placing (ö1200)		m		400.00	
RC pipe placing (ö1600)		m		550.00	
Pavement cutting (t = less than 10cm)		m		0.19	
Pavement demolition (t = less than 10cm)		sq.m		0.88	
Transportation of crushed stone		cb.m		16.85	
		sq.m		1.13	
Subbase course (t=15cm)		sq.m		7.26	
Base course (t=10cm)		sq.m		5.65	
Shoulder pavement by penetration macadam		sq.m		3.75	
Stabilized base course (in place) t=200mm pulverize mixer		sq.m		8.50	
Stabilized base course (in place) t=200mm plant		sq.m		13.37	
Stabilized base course (in place) t=200mm hand		sq.m		17.02	
Stabilized base course (central mixing) t=100mm pulverize mixer		sq.m		4.36	
Stabilized base course (central mixing) t=100mm plant		sq.m		7.28	
Stabilized base course (central mixing) t=100mm hand		sq.m		9.47	
Transportation of asphalt concrete		cb.m		24.09	
Binder course t=4cm		sq.m		12.32	
Surface course t=3cm		sq.m		9.19	
Surface course t=4cm				13.43	
Surface course t=5cm				14.54	
Semiflexible pavement				1.13	
Overlay t=4cm		sq.m		13.00	
Overlay t=5cm				16.00	
Overlay t=6cm				19.00	
Waste transportation		cb.m		10.19	
Interlocking concrete block pavement t=8cm		sq.m		18.00	
Interlocking concrete block pavement t=5cm		sq.m		15.00	
Kerb		m		12.00	
Drainage cleaning by mam-power		m		3	
Sodding		sq.m		8.00	
Marking		m		3	
Removal of existing pavement		cb.m		10	

19.5 WORK QUANTITIES

The work quantities are calculated on the basis of the preliminary engineering design described in the Chapter 18. The summary of the work quantities for major working items is as shown in the Table 19.5.1.

19.6 ESTIMATED CONSTRUCTION COSTS

The summary of the construction cost for major working items is as shown in the Table 19.6.1.

Table 19.5.1 Work Quantities (1)

Item		Unit	Missing Link Julius Nyerere		Trunk Roads						
			On Line	Off Line	Av. V. Lenine	Av. A. Lusaka	Av. G. Popular	Av. Angola	Rua S.Cabral / Largo de Dela	Av. Marien Ngouabi	Trunk Roads Total
Maintenance		m				0	0	0		0	
Overlay		m				350	650	2550	650	1320	
Re Base		m				100		500		500	
Road Length(m)		m			0	3,600	650	3,050	650	1,820	9,770
Road Width		m			14	28	20	20	18	20	16~20
Carriageway		m			8	18	13	12	12	13	
Sidewalk		m			4	8	7	8	6	7	
Drain		m									
Utility		m			4	2					
Total Width(m)		m			14	28	20	20	18	20	
Embankment Height(m)		no.									
Access Road (no)	80	no.				12	3	20		15	
Bus bay	245	no.			14	10	2	8		10	
Extra bus bay	135				1,256	5	2	5		10	
Improvement Intersection		no.			1	2	1	1		3	
Earth Works											
Embankment		cu.m	200,000	80,000							
Cut		cu.m	220,000	82,000							
Excavation common		cu.m									
Removal of existing pavement(t=5cm)		cu.m	9,000	9,000		90	0	300	0	325	715
Cut Slope		sq.m	25,200	18,900							
Fill Slope		sq.m	4,350	29,100							
Slope Protection		sq.m	29,550	47,300							
(Sub-total)			sub-total	sub-total							
Pavement Works											
Carriageway											
Overlay	40	sq.m				63,000	5,200			10,560	78,760
	50	sq.m						17,850	4,550		22,400
	60	sq.m									0
	70	sq.m									0
Asphalt Surface Course	30	sq.m	19,770	38,310							0
	40	sq.m								13,900	13,900
	50	sq.m	6,900	6,780		2,600	3,410	18,750	3,250		28,010
Asphalt Binder Course	30	sq.m									0
	40	sq.m	21,670	40,210							0
Semi Flexible Pavement	50	sq.m	1,900	1,900	800	3,600	1,300	1,200	0	3,900	10,800
Base course (Graded Crushed Stone)	100	sq.m	20,690	39,230							0
Base course (Stabilised Existing Material)	100	sq.m	36,360	61,370	2,056	800	3,250	12,750	3,250	7,400	29,506
	150	sq.m				1,800	0	6,000	0	6,500	14,300
Subbase course (Stabilised)	150	sq.m			2,056	800	160	640	0	800	4,456
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)		sq.m			2,056						2,056
Compacted Subgrade		sq.m	36,360	61,370							
Shoulder		sq.m									0
DBST		sq.m	7,790	14,380							0
Base course (Stabilised)	100	sq.m									0
Sidewalk		sq.m									0
DBST		sq.m	14,090	44,490							
Base course (Stabilised)	100	sq.m	14,090	44,490							
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)		sq.m			1,280	14,400	22,750	12,200	1,950	6,370	58,950
Base course (Stabilised)	100	sq.m			1,280	14,400	22,750	12,200	1,950	6,370	58,950
Kerb Stone		m	2,160	5,015	480	960	1,300	480	0	3,220	6,440
(Sub-total)			sub-total	sub-total							
Drainage Works											
Cleaning and flushing of existing drainage pipe		m					1,073			3,003	4,076
Open Drain		m									0
B0.3 x H0.3		m									0
B0.3 x H0.4		m	1,900	7,252							
		m									
Keshane drain		m									0
Gerle ditch		m	1,748	1,748							0
Lshaped drain		no.									
0.4 x 0.4		m									
0.45 x 0.45		m									0
0.5 x 0.5		m									
0.5 x 0.6		m									
0.6 x 0.6		m									0
0.6 x 0.7		m									0
0.7 x 0.7		m									0
0.7 x 0.8		m									0
0.7 x 0.9		m									
0.7 x 1.0		m									
0.7 x 1.1		m									
0.7 x 1.2		m									
0.7 x 1.3		m									
1.0 x1.1		m		480							
Open Drain (Stone Pitching) 0.7 x 0.7		m									0
Open Drain (Stone Pitching) 0.8 x 0.8		m									
1.0 x 1.0		m									
1.0 x 1.2		m									
1.0 x 1.5		m									
Open Drain (Stone Pitching) 1.0 x 1.0		m									0
Open Drain (Stone Pitching) 1.2 x 0.9		m	470								
Open Drain (Stone Pitching) 1.2 x 1.2		m	520								
Open Drain (Stone Pitching) 0.8 x 0.6		m	1,120	1,200							
Open Drain (Stone Pitching) 1.2 x 0.6		m	400								
Earth Drain 0.3 x 0.4		m	2,480	3,520							
U		m									
0.5 x 0.5		m				0					0
0.5 x 085		m									7,100
Catch pit		no	93	129		235	65	75	65	182	622
Soaking Pit		no				125	0	230			355
Collection Conduit		m	810	2,490							
Pipe culvert		no.									
D300		m					101.25			550	651
D400		m									0
D600		m	80							500	500
D800		m									
D1000		m									
D1500		m									
(Sub-total)			sub-total	sub-total							
Outlet Construction											
Block Pitching		sq.m	0	3,846							
Sodding		sq.m	0	7,480							
Excavation&Filling		cu.m	0	5,100							
Box culvert											
3000x3000		m	100	0							
2500x2500		m	50	0							
2500x2000		m	20	50							
3000x2000x2		m	0	50							
(Sub-total)			sub-total	sub-total							
Miscellanious Works											
Lane Marking		m	1,920	3,290	0	7200	1300	6100	1300	5460	21,360
Roundabout		no			1						1
Chatter bar		no			0	720	130	305	65	364	1,584
signal(including pedestrian signal)		no			4	8	4	4	0	12	33
Shift of signal(including pedestrian signal)		no									
Busstop shelter		no			28	20	4	16	0	20	88
Hump		no									0
concrete slab(1.5 x 1.0 x 0.15)		no		1390							0
Boundary Block		m	1,040	2,521							
Tree Block		m	398	589							
Tree		set	300	166							
Street Light		set	40	460							0
Gabion		cu.m	460	250							
Vertical Drain		m	480								
Removal Gabion		cu.m	11,300	930							
Removal Kerb Stone		m	930	930							
Removal Boundary Block		m	930	2,500							
Grass		sq.m		sub-total							
(Sub-total)			sub-total								
Relovation of Utility											0
Electricity Line(Overhead)33kv		m									0
Electricity Line(Overhead)22kv		m									0
Electricity Line(Overhead)11kv		m	1,200	2,600			1,300			1,800	3,100
Electricity Line(Underground)33kv		m									0
Electricity Line(Underground)22kv		m									
Electricity Line(Underground)11kv		m									
Telephone Line(Overhead)		m		1800							0
Telephone Line(Underground)		m									
Water Main D<300		m									0
Water Main D≥300		m									0
Sewerage		m									0
(Sub-total)			sub-total	sub-total							
House compensation											0
Residence(small)		no	215	352							0
Residence(middium)		no									0
Residence(big)		no									0
Commercial Building(small)		no									0
Commercial Building(middium)		no									0
Commercial Building(big)		no									0
Factory		no									0
(Sub-total)											

Table 19.5.1 Work Quantities (2)

Item	Unit	Industrial and Commercial Area Roads								Port Area Roads						
		Av. J. Michel	Av. F. de Magalhaes	Av. Z. Magalhaela	Av. M. Siad Barre	Av. Romao Fernandes	Rue 1229	Av. As Estancias	I/C Area Roads Total	Rua Consigglieri Pedroso	Rua Joaquim Lapa	Rua do Bagamayo	Rua de Timor Leste	Av. Martires de Inhaminga	Other 6 roads	Port Area Roads Total
Maintenance	m	0	0	0	0	0										
Overlay	m	1750	500	700	500	0										
Re Rose	m	0	790	1000	870	1570	260	570								
Road Length(m)	m	1,750	1,290	1,700	1,370	1,570	260	570	8,510	450	250	450	250	450	1,540	3,390
Road Width	m	16	20	20	16	16	16	12	12~ 20	13	14	12	13	19	14	12~ 19
Carriageway	m	8	12	15	12	8	12	8		8	8	6	9	14	6	
Sidewalk	m	8	8	5	4	8	4	4		5	6	6	4	5	4	
Drain	m									0	0	0	0	0	2	
Utility	m									0	0	0	0	0	2	
Total Width(m)	m	16	20	20	16	16	16	12		13	14	12	13	19	14	
Embankment Heighht(m)	no.							0.5								
Access Road (no) 80	no.									5	2	3				
Bus bay 245	no.															
Extra bus bay 139																
Improvement Intersection	no.	1,600	1,600	1,600												
Earth Works																
Embankment	cu.m	0	0	0	0	0	0	81	81							
Cut	cu.m															
Excavation common	cu.m	320	2,216	3,320	2,088	2,512	624	912	11,992	840	0	0	0	0	1,389	2,229
Removal of existing pavement(t=5cm)	cu.m	0	474	750	522	628	156	228	2,758	0	0	0	0	0	0	0
Cut Slope	sq.m															
Fill Slope	sq.m															
Slope Protection	sq.m															
(Sub-total)									sub-total							sub-total
Pavement Works									0							0
Carriageway																0
Overlay 40	sq.m								0							0
50	sq.m								0		2160	2940	2250	6075	9240	22,665
60	sq.m	14,000	6,000	10,500	6,000	0	0	0	36,500							0
70	sq.m								0							0
Asphalt Surface Course 30	sq.m															0
40	sq.m								0							0
50	sq.m	1,600	11,080	16,600	10,440	12,560	3,120	4,560	59,960							0
Asphalt Binder Course 30	sq.m								0							0
40	sq.m								0							0
Semi Flexible Pavement 50	sq.m															0
Base course (Graded Crushed Stone) 100	sq.m								0							0
Base course (Stabilised Existing Material) 100	sq.m									4000	0	0	0	0	6615	10,615
150	sq.m	1,600	11,080	16,600	10,440	12,560	3,120	4,560	59,960							0
Subbase course (Stabilised) 150	sq.m								0	4000	0	0	0	0	6615	10,615
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)	sq.m								0	4000					6615	10,615
Commacted Subgrade	sq.m															
Shoulder	sq.m															
DBST	sq.m															0
Base course (Stabilised) 100	sq.m															0
Sidewalk	sq.m	50%	50%	50%	50%	50%	50%	100%	4							0
DBST	sq.m	7,000	5,160	4,250	2,740	6,280	520	2,280	28,230							0
Base course (Stabilised) 100	sq.m	7,000	5,160	4,250	2,740	6,280	520	2,280	28,230							
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)	sq.m									1125	687.5	1350	500	1125	3080	7,868
Base course (Stabilised) 100	sq.m								0	1125	687.5	1350	500	1125	3080	7,868
Kerb Stone	m								0							
(Sub-total)									sub-total							
Drainage Works																0
Cleaning and flushing of existing drainage pipe	m	2,450	2,064	2,975	2,192	2,198	416	798	13,093	630	350	585	363	754	2,002	4,683
Open Drain	m								0							0
B0.3 x H0.3	m								0							0
B0.3 x H0.4	m								0							
	m								0							0
K-shape drain	m								0							0
side ditch	m								0							0
U shaped drain	no								0							0
0.4 x 0.4	m															0
0.45 x 0.45	m								0							0
0.5 x 0.5	m								0							
0.5 x 0.6	m								0							
0.6 x 0.6	m								0							
0.6 x 0.7	m								0							
0.7 x 0.7	m								0							0
0.7 x 0.8	m								0							0
0.7 x 0.9	m								0							0
0.7 x 1.0	m															0
0.7 x 1.1	m															0
0.7 x 1.2	m															
0.7 x 1.3	m															
1.0 x 1.1	m															
Open Drain (Stone Pitching) 0.7 x 0.7	m								0							0
Open Drain (Stone Pitching) 0.8 x 0.8	m															
1.0 x 1.0	m															
1.0 x 1.2	m															
1.0 x 1.5	m															
Open Drain (Stone Pitching) 1.0 x 1.0	m								0							0
Open Drain (Stone Pitching) 1.2 x 0.9	m															
Open Drain (Stone Pitching) 1.2 x 1.2	m															
Open Drain (Stone Pitching) 0.8 x 0.6	m															
Open Drain (Stone Pitching) 1.2 x 0.6	m															
Earth Drain 0.3 x 0.4	m															
U	m															
0.5 x 0.5	m															
0.5 x 085	m															
Catch pit	no	175	129	170	137	157	26	57	851	45	25	45	25	45	154	339
Soaking Pit	no															0
Collecting Conduit	m															
Pipe culvert	no.															0
D300	m								0							0
D400	m															
D600	m															
D800	m															
D1000	m															
D1500	m												450	450		900
(Sub-total)									sub-total							
Outlet Construction																
Block Pitching	sq.m															
Sodding	sq.m															
Excavation&Filling	cu.m															
Box culvert																
3000x3000	m															
2500x2500	m															
2500x2000	m															
3000x2000x2	m															
(Sub-total)																
Miscellanious Works																
Lane Marking	m	1,750	1,290	1,700	1,370	1,570	260	570	8,510	450	250	450	250	450	1,540	3,390
Roundabout	no															
Chatter bar	no															
signal(including pedestrian signal)	no															
Shift of signal(including pedestrian signal)	no															
Busstop shelter	no															
Hump	no															
concrete slab(1.5 x 1.0 x 0.15)	no															
Boundary Block	m															
Tree Block	m															
Tree	set															
Street Light	set															
Gabion	cu.m															
Vertical Drain	m															
Removal Cabion	cu.m															
Removal Kerb Stone	m															
Remoaval Boundary Block	m															
Grass	sq.m															
(Sub-total)																
Relovation of Utility																
Electricity Line(Overhead)33kv	m															
Electricity Line(Overhead)22kv	m															
Electricity Line(Overhead)11kv	m															
Electricity Line(Underground)33kv	m															
Electricity Line(Underground)22kv	m															
Electricity Line(Underground)11kv	m															
Telephone Line(Overhead)	m															
Telephone Line(Underground)	m															
Water Main D>300	m															
Water Main D<300	m															
Sewerage	m															
(Sub-total)																
House compensation																
Residence(small)	no															
Residence(middium)	no															
Residence(big)	no															
Commercial Building(small)	no															
Commercial Building(middium)	no															
Commercial Building(big)	no															
Factory	no															
(Sub-total)																

Table 19.5.1 Work Quantities (3)

Item	Unit	District 1 Area Roads									
		Av. Milangre Mabote	Av. da Malhan galene	Av. Para O Parmar	Av. Kaweme Nkrumah	Av. Paulo Samuel Kankhomba	Av. Emilia Dausse	Av. de Maguiguana	Av. Filipe Samuel Magaia	Av. Friendrich Engels	Dist. 1 Area Roads Total
Maintenance	m										
Overlay	m				1500	1320	756	2421	120	1080	
Re Base	m	1030	983		120	1000	1500		500	500	
Road Length(m)	m	1,030	983	0	1,620	2,320	2,260	2,420	1,760	500	12,895
Road Width	m	16	12		12	20	20	20	20	12	
Carriageway	m	9	8		8	8	8	8	12	8	
Sidewalk	m	7	4		4	12	12	12	8	4	
Drain	m									0	
Utility	m									0	
Total Width(m)	m	16	12	0	12	20	20	20	20	12	12~20
Embankment Height(m)	no.										
Access Road (no)	80 no.		7		26	28	16	21	8		
Bus bay	245 no.		2								
Extra bus bay	135		0								
Improvement Intersection	no.	20	20								
			3000								
Earth Works											
Embankment	cu.m										0
Cut	cu.m										
Excavation common	cu.m										0
Removal of existing pavement(t=5cm)	cu.m	464	394	0	48	400	600	0	300	200	2,406
Cut Slope	sq.m										
Fill Slope	sq.m										
Slope Protection	sq.m										
(Sub-total)											sub-total
Pavement Works											0
Carriageway											
Overlay 40	sq.m	0	0	0	12000	10560	6080	19360	15120	8640	71,760
50	sq.m										
60	sq.m										0
70	sq.m										0
Asphalt Surface Course 30	sq.m										0
40	sq.m			0	960	8000	12000	0	6000	4000	30,960
50	sq.m										
Asphalt Binder Course 30	sq.m										0
40	sq.m										0
Semi Flexible Pavement 50	sq.m	1800	1600								
Base course (Graded Crushed Stone) 100	sq.m										0
Base course (Stabilised Existing Material) 100	sq.m	9270	8930								18,200
150	sq.m			0	960	8000	12000	0	6000	4000	30,960
Subbase course (Stabilised) 150	sq.m	9270	8930								18,200
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)	sq.m	9270	8930								18,200
Compacted Subgrade	sq.m										
Shoulder	sq.m										0
DBST	sq.m	3605	4970								8,575
Base course (Stabilised) 100	sq.m	3605	4970								8,575
Sidewalk	sq.m										0
DBST	sq.m										0
Base course (Stabilised) 100	sq.m										0
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)	sq.m			0	3240	13200	13560	14520	7040	1000	53,280
Base course (Stabilised) 100	sq.m			0	3240	13200	13560	14520	7040	1000	53,280
Kerb Stone	m										0
(Sub-total)											
Drainage Works											0
Cleaning and flushing of existing drainege pipe	m	1,494	1,379	0	2,268	3,248	3,164	3,388	2,816	700	18,457
Open Drain	m										0
B0.3 x H0.3	m										
B0.3 x H0.4	m										0
	m										0
K-shape drain	m										0
Gate ditch	m	2060	1500								3,560
U shaped drain	no.										0
0.4 x 0.4	m										0
0.45 x 0.45	m										0
0.5 x 0.5	m										0
0.5 x 0.6	m		60								60
0.6 x 0.6	m										0
0.6 x 0.7	m										
0.7 x 0.7	m										0
0.7 x 0.8	m										0
0.7 x 0.9	m										0
0.7 x 1.0	m										0
0.7 x 1.1	m										0
0.7 x 1.2	m										0
0.7 x 1.3	m										0
1.0 x1.1	m										
Open Drain (Stone Pitching) 0.7 x 0.7	m										0
Open Drain (Stone Pitching) 0.8 x 0.8	m										0
1.0 x 1.0	m										0
1.0 x 1.2	m										0
1.0 x 1.5	m										0
Open Drain (Stone Pitching) 1.0 x 1.0	m										0
Open Drain (Stone Pitching) 1.2 x 0.9	m										
Open Drain (Stone Pitching) 1.2 x 1.2	m										
Open Drain (Stone Pitching) 0.8 x 0.6	m										
Open Drain (Stone Pitching) 1.2 x 0.6	m										
Earth Drain 0.3 x0.4	m										0
U	m										0
0.5 x 0.5	m		900								900
0.5 x 085	m										0
Catch pit	no.	103		0	162	232	226	242	176	50	1,191
Soaking Pit	no.										
Collection Conduit	m										
Pipe culvert	no.										
D300	m										0
D400	m										0
D600	m		70								70
D800	m										0
D1000	m										
D1500	m										0
(Sub-total)											
Outlet Construction											0
Block Pitching	sq.m										
Sodding	sq.m										
Excavation&Filling	cu.m										
Box culvert											
3000x3000	m										
2500x2500	m										
2500x2000	m										
3000x2000x2	m										
(Sub-total)											
Miscellanious Works											0
Lane Marking	m	1,030	983	0	1,620	2,320	2,260	2,420			10,635
Roundabout	no										0
Chatter bar	no		0								0
signal(including pedestrian signal)	no	4	4								8
Shelf of signal(including pedestrian signal)	no										0
Bussbus shelter	no										
Hump	no	1	2		3	3	3	3			15
concrete slab(1.5 x 1.0 x 0.15)	no										0
Boundary Block	m										
Tree Block	m										
Tree	set										
Street Light	set										
Gabion	cu.m										
Vertical Drain	m										
Removal Gabion	cu.m										
Removal Kerb Stone	m										
Removal Boundary Block	m										
Grass	sq.m										
(Sub-total)											
Relovation of Utility											0
Electricity Line(Overhead)33kv	m										0
Electricity Line(Overhead)22kv	m										
Electricity Line(Overhead)11kv	m										
Electricity Line(Underground)33kv	m										0
Electricity Line(Underground)22kv	m										
Electricity Line(Underground)11kv	m										
Telephone Line(Overhead)	m										0
Telephone Line(Underground)	m										0
Water Main D>300	m										0
Water Main D<300	m										0
Sewerage	m										0
(Sub-total)											
House compensation											0
Residence(small)	no										0
Residence(middium)	no										0
Residence(hin)	no										0
Commercial Building(small)	no										0
Commercial Building(middium)	no										0
Commercial Building(hin)	no										0
Factory	no										
(Sub-total)											

Table 19.5.1 Work Quantities (4)

Item		Unit	District 2 Area Roads							
			Rua 2282/2265	Rua 2275	Rua de Xipamanine	Rua dos Imaos Roby	Rua 2315/2313	Rua 2309/2324	Av. das Estancias	Dist. 2 Area Roads Total
Maintenance		m								
Overlay		m								
Re Base		m								
Road Length(m)		m	2,360	2,010	1,190	1,310	730	1,030	500	9,130
Road Width		m	1.4	12.14	1.9	1.9	1.2	1.4	1.2	12~14
Carriageway		m	6	6	6	9	6	6	8	
Sidewalk		m	4	3	3	3	3	4	4	
Drain		m	2	2	2	0	2	2	0	
Utility		m	2	1	1	0	1	2	0	
Total Width(m)		m	1.4	1.2	1.2	1.2	1.2	1.4	1.2	
Embankment Height(m)		no	0.2	0.2	0.2	0.0	0.2	0.2	0.5	
Access Road (no)	80	no	21	24	10	14	4	18		
Bus bay	245	no	4	5	1	4	2	2		
Extra bus bay	135					3,000		2,000		
Improvement Intersection		no								
Earth Works										
Embankment		cu.m	7,316	5,427	3,213		1,971	3,193	3,375	24,495
Cut		cu.m								
Excavation common		cu.m	3,304	2,412	1,428		876	1,442	600	10,062
Removal of existing pavement(t=5cm)		cu.m								0
Cut Slope		sq.m								
Fill Slope		sq.m								
Slope Protection		sq.m								
(Sub-total)										sub-total
Pavement Works										0
Carriageway										0
Overlay	40	sq.m								0
	50	sq.m								0
	60	sq.m								0
	70	sq.m								0
Asphalt Surface Course	30	sq.m								0
	40	sq.m								0
	50	sq.m				13,890			4,000	17,890
Asphalt Binder Course	30	sq.m								0
	40	sq.m								0
Semi Flexible Pavement	50	sq.m								
Base course (Graded Crushed Stone)	100	sq.m								0
Base course (Stabilised Existing Material)	100	sq.m	16,820	15,205	8,185		5,190	8,340	4,000	57,740
	150	sq.m				13,890				13,890
Subbase course (Stabilised)	150	sq.m	16,820	15,205	8,185		5,190	8,340	4,000	57,740
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)		sq.m	16,820	15,205	8,185		5,190	8,340		53,740
Compacted Subgrade		sq.m								
Shoulder		sq.m								0
DBST		sq.m								0
Base course (Stabilised)	100	sq.m								0
Sidewalk		sq.m								0
DBST		sq.m	9,440	6,030	3,570	3,930	2,190	4,120	2,000	31,280
Base course (Stabilised)	100	sq.m	9,440	6,030	3,570	3,930	2,190	4,120	2,000	31,280
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)		sq.m								0
Base course (Stabilised)	100	sq.m								0
Kerb Stone		m								0
(Sub-total)										
Drainage Works										0
Cleaning and flushing of existing drainage pipe		m								0
Open Drain		m								0
B0.3 x H0.3		m		1,460			380	2,060		3,900
B0.3 x H0.4		m		1,400	600		380			2,380
		m								0
X-shape drain		m					700			700
side ditch		m			280	2,620				2,900
U shaped drain		no								0
0.4 x 0.4		m								0
0.45 x 0.45		m								0
0.5 x 0.5		m	0							0
0.5 x 0.6		m								0
0.6 x 0.6		m		0					0	0
0.6 x 0.7		m								0
0.7 x 0.7		m								0
0.7 x 0.8		m			1,500					1,500
0.7 x 0.9		m								0
0.7 x 1.0		m								0
0.7 x 1.1		m								0
0.7 x 1.2		m	2,000							2,000
0.7 x 1.3		m								0
1.0 x1.1		m								
Open Drain (Stone Pitching) 0.7 x 0.7		m	2,720	1,160					1,000	2,000
Open Drain (Stone Pitching) 0.8 x 0.8		m								0
1.0 x 1.0		m								0
1.0 x 1.2		m								0
1.0 x 1.5		m								0
Open Drain (Stone Pitching) 1.0 x 1.0		m								0
Open Drain (Stone Pitching) 1.2 x 0.9		m								
Open Drain (Stone Pitching) 1.2 x 1.2		m								
Open Drain (Stone Pitching) 0.8 x 0.6		m								
Open Drain (Stone Pitching) 1.2 x 0.6		m								
Earth Drain 0.3 x0.4		m								0
U		m								0
0.5 x 0.5		m	500							500
0.5 x 085		m								0
Catch pit		no								0
Soaking Pit		no								0
Collecting Conduit		m								
Pipe culvert		no								0
D300		m								0
D900		m	147	168	70		28	126	0	539
D600		m								0
D800		m	800							800
D1000		m								0
D1500		m								0
(Sub-total)										
Outlet Construction										0
Block Pitching		sq.m								
Sodding		sq.m								
Excavation&Filling		cu.m								
Box culvert										
3000x3000		m								
2500x2500		m								
2500x2000		m								
3000x2000x2		m								
(Sub-total)										
Miscellaneous Works										0
Lane Marking		m	2,360	2,010	1,190	1,310	730	1,030	500	9,130
Roundabout		no	1	1	0	0	1	1		4
Chatter bar		no								0
signal(including pedestrian signal)		no								0
Shift of signal(including pedestrian signal)		no								
Busstop shelter		no								0
Huron		no	1	3	2	2	2	2		12
concrete slab(1.5 x 1.0 x 0.15)		no	236	201	119	131	73	103	50	913
Boundary Block		m								
Tree Block		m								
Tree		set								
Street Light		set								
Gabion		cu.m								
Vertical Drain		m								
Removal Gabion		cu.m								
Removal Kerb Stone		m								
Remoavl Boundary Block		m								
Grass		sq.m								
(Sub-total)										
Relocation of Utility										0
Electricity Line(Overhead)33kv		m	0	0	0	0	0	0	0	0
Electricity Line(Overhead)22kv		m	0	0	0	0	0	0	0	0
Electricity Line(Overhead)11kv		m								0
Electricity Line(Underground)33kv		m	0	0	0	0	0	0	0	0
Electricity Line(Underground)22kv		m	0	0	0	0	0	0	0	0
Electricity Line(Underground)11kv		m	0	0	0	0	0	0	0	0
Telephone Line(Overhead)		m								0
Telephone Line(Underground)		m	0	0	0	0	0	0	0	0
Water Main D>300		m	0	0	0	0	0	0	0	0
Water Main D<300		m	2,360	1,780	890	0	0	0	0	5,030
Sewerage		m								0
(Sub-total)										
House compensation										0
Residence(small)		no								0
Residence(middium)		no								0
Residence(big)		no								0
Commercial Building(small)		no								0
Commercial Building(middium)		no								
Commercial Building(big)		no								
Factory		no								
(Sub-total)										

Table 19.5.1 Work Quantities (5)

Item		Unit	District 3 Area Roads								Public Transportation			Traffic Manage-ment
			Rua da Goa	Rua da Lixera	Av. Milagre Mbote	Av. da Malhan-galene	Rua 1 de Maio	Rua 3306	Rua 3523	Rua 3576	Dist. 3 Area Roads Total	Bus terminal Port area	Bus terminal V.Lenine / J.Nyerere	Bus Terminal Total	Improve of Intersection
Maintenance		m													0
Overlay		m													0
Re Base		m													0
Road Length(m)		m	780	790	1,980	1,860	1,500	520	500	1,150	9,080				0
Road Width		m	10	10	10	12	14	14	14	14	10~14				0
Carriageway		m	6	6	6	6	6	6	6	6					0
Sidewalk		m	2	2	2	3	4	4	4	4					0
Drain		m	1	1	1	2	2	2	2	2					0
Utility		m	2	2	2	1	2	2	2	2					0
Total Width(m)		m	10	10	10	12	14	14	14	14					0
Embankment Height(m)		no.	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2					0
Access Road (no)	80	no.	2	2	16	19	27	15	19	42					0
Bus bay	245	no.				4	4								0
Extra bus bay	135				4,400	2,500									
Improvement Intersection		no.													
															0
Earth Works															0
Embankment		cu.m	1,794	1,817	4,554	5,022	4,650	1,612	1,550	3,565	24,564			0	159
Cut		cu.m									0				0
Excavation common		cu.m	780	790	1,980	2,232	2,100	728	700	1,610	10,920			0	8,063
Removal of existing pavement(t=5cm)		cu.m									0			0	0
Cut Slope		sq.m													
Fill Slope		sq.m													
Slope Protection		sq.m													
(Sub-total)														0	0
Pavement Works											0				0
Carriageway											0				0
Overlay	40	sq.m									0			0	73,429
	50	sq.m									0	9602	4652	14,254	0
	60	sq.m									0			0	0
	70	sq.m									0			0	0
Asphalt Surface Course	30	sq.m									0			0	0
	40	sq.m									0			0	6,866
	50	sq.m									0			0	0
Asphalt Binder Course	30	sq.m									0			0	0
	40	sq.m									0			0	0
Semi Flexible Pavement	50	sq.m										2897	1260	4,157	80,295
Base course (Graded Crushed Stone)	100	sq.m									0			0	
Base course (Stabilised Existing Material)	100	sq.m	4,840	4,900	21,960	18,660	12,140	4,320	4,520	10,260	81,600		5912	5,912	6,866
	150	sq.m									0			0	
Subbase course (Stabilised)	150	sq.m	4,840	4,900	21,960	18,660	12,140	4,320	4,520	10,260	81,600		5912	5,912	6,866
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)		sq.m	4,840	4,900	17,560	16,160	12,140	4,320	4,520	10,260	74,700			0	0
Compacted Subgrade		sq.m									0				0
Shoulder		sq.m									0			0	0
DBST		sq.m									0			0	0
Base course (Stabilised)	100	sq.m			4,400	2,500					6,900			0	0
Sidewalk		sq.m									0			0	0
DBST		sq.m	1,170	1,185	2,970	5,580	6,000	2,080	2,000	4,600	25,585		16922	16,922	0
Base course (Stabilised)	100	sq.m	1,170	1,185	2,970	5,580	6,000	2,080	2,000	4,600	25,585		16922	16,922	
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)		sq.m									0			0	1,061
Base course (Stabilised)	100	sq.m									0			0	1,061
Kerb Stone		m									0		3898	3,898	3,810
(Sub-total)														0	
Drainage Works											0			0	0
Cleaning and flushing of existing drainage pipe		m									0			0	0
Open Drain		m									0			0	0
B0.3 x H0.3		m			1,980	1,250	1,500				4,730			0	0
B0.3 x H0.4		m		790	700	350	350		1,000		3,190			0	0
		m									0			0	0
K-shape drain		m									0			0	0
Leside ditch		m									0	440	390	830	0
U shaped drain		no									0			0	0
0.4 x 0.4		m									0			0	0
0.45 x 0.45		m									0			0	0
0.5 x 0.5		m									0			0	0
0.5 x 0.6		m									0			0	0
0.6 x 0.6		m									0			0	0
0.6 x 0.7		m									0			0	0
0.7 x 0.7		m				500	550				1,050			0	0
0.7 x 0.8		m									0			0	0
0.7 x 0.9		m				610					610			0	0
0.7 x 1.0		m									0			0	0
0.7 x 1.1		m			1,200						1,200			0	0
0.7 x 1.2		m			530						530			0	0
0.7 x 1.3		m				610					610			0	0
1.0 x 1.1		m									0				0
Open Drain (Stone Pitching) 0.7 x 0.7		m	1,560	790	300	900	600				4,150			0	0
Open Drain (Stone Pitching) 0.8 x 0.8		m			380						380			0	0
1.0 x 1.0		m						520			520			0	0
1.0 x 1.2		m						520			520				0
1.0 x 1.5		m								2,300	2,300		500	500	0
Open Drain (Stone Pitching) 1.0 x 1.0		m									330			500	0
Open Drain (Stone Pitching) 1.2 x 0.9		m													0
Open Drain (Stone Pitching) 1.2 x 1.2		m													0
Open Drain (Stone Pitching) 0.8 x 0.6		m													0
Open Drain (Stone Pitching) 1.2 x 0.6		m													
Earth Drain 0.3 x0.4		m									0			0	
U		m									0			0	
0.5 x 0.5		m									0			0	
0.5 x 085		m									0			0	
Catch pit		no									0	22	20	42	730
Soaking Pit		no									0			0	0
Collecting Conduit		m													0
Pipe culvert		no.									0			0	
D300		m												0	6,278
D400		m	14	14		67	95		133		322			0	0
D600		m			112	67	95	105		294	672			0	0
D800		m									0			0	0
D1000		m									0			0	122
D1500		m									0			0	0
(Sub-total)															
Outlet Construction											0			0	0
Block Pitching		sq.m													
Sodding		sq.m													
Excavation&Filling		cu.m													
Box culvert															
3000x3000		m													
2500x2500		m													
2500x2000		m													
3000x2000x2		m													
(Sub-total)															
Miscellanious Works											0			0	
Lane Marking		m	780	790	1,980	1,860	1,500	520	500	1,150	9,080	1047	784	1,831	33,282
Roundabout		no				1					1			0	0
Chatter bar		no									0			0	829
signal(includign pedestrian signal)		no									0			0	178
Shift of signal(including pedestrian signal)		no									0			0	29
Busstop shelter		no												0	92
Hump		no	1	1	1	2	4	1		1	11			0	0
concrete slab(1.5 x 1.0 x 0.15)		no	78	79	255	211	150	52	50	115	990				0
Boundary Block		m													
Tree Block		m													0
Tree		set													0
Street Light		set													0
Gabion		cu.m													0
Vertical Drain		m													0
Removal Gabion		cu.m													0
Removal Kerb Stone		m													0
Remoavl Boundary Block		m													0
Grass		sq.m													0
(Sub-total)															
Relovation of Utility											0			0	0
Electricity Line(Overhead)33kv		m	0	0	0	0	0	0	0	0	0			0	
Electricity Line(Overhead)22kv		m	0	0	0	0	0	0	0	0	0				
Electricity Line(Overhead)11kv		m									0				
Electricity Line(Underground)33kv		m	0	0	0	0	0	0	0	0	0			0	
Electricity Line(Underground)22kv		m	0	0	0	0	0	0	0	0	0				
Electricity Line(Underground)11kv		m	0	0	0	0	0	0	0	0	0				
Telephone Line(Overhead)		m									0				
Telephone Line(Underground)		m	0	0	0	0	0	0	0	0	0				
Water Main D>300		m	0	0	0	0	0	0	0	0	0			0	
Water Main D<300		m	380	0	500	350	0	0	0	0	1,230			0	
Sewerage		m									0			0	122
(Sub-total)															
House compensation											0			0	0
Residence(small)		no									0			0	0
Residence(middium)		no									0			0	0
Residence(big)		no									0			0	0
Commercial Building(small)		no									0			0	0
Commercial Building(middium)		no													0
Commercial Building(big)		no													0
Factory		no													0
(Sub-total)															

Table 19.6.1 Construction Cost (1)

Item	Unit	Unit Price	Missing Link Julius Nyerere				Trunk Roads			Industrial/Commercial Area Roads		Port Area Roads		District 1 Area Roads	
			On Line	On Line Amount	Off Line	Off Line Amount	Unit Price	Trunk Roads Total	Trunk Roads Amount	I/C Area Roads Total	I/C Area Roads Amount	Port Area Roads Total	Port Area Roads Amount	Dist. 1 Area Roads Total	Dist. 1 Area Roads Amount
Maintenance	m														
Overlay	m														
Re Base	m														
Road Length(m)	m							9,770		8,510		3,390		12,895	
Road Width	m							16~20		12~20		12~20		12~20	
Carriageway	m														
Sidewalk	m														
Drain	m														
Utility	m														
Total Width(m)	m													12~20	
Embankment Height(m)	no.														
Access Road (no)	80	no.													
Bus bay	245	no.													
Extra bus bay	135														
Improvement Intersection		no.													
Earth Works															
Embankment	cu.m	5.47	200,000	1,093,154	80,000	437,261	3.01		0	81	244		0	0	0
Cut	cu.m	1.96	220,000	431,335	82,000	160,770									
Excavation common	cu.m			0		0	1.96		0	11,992	23,512	2,229	4,371	0	0
Removal of existing pavement(t=5cm)	cu.m	0.50	9,000	4,500	9,000	4,500	0.00	715	0	2,758	0	0	0	2,408	0
Cut Slope	sq.m	3.26	25,200	82,173	18,200	59,347									
Fill Slope	sq.m	2.21	4,350	9,608	29,100	64,276									
Slope Protection	sq.m	8.00	29,550	236,400	47,300	378,400									
(Sub-total)			sub-total	1,857,170	sub-total	1,104,555	sub-total		0	sub-total	23,756	sub-total	4,371	sub-total	0
Pavement Works										0		0		0	
Carriageway												0		0	
Overlay	40	sq.m		0		0	13.00	78,760	1,023,880	0	0	0	0	71,760	932,880
	50	sq.m		0		0	16.00	22,400	358,400	0	0	22,665	362,640		0
	60	sq.m		0		0	19.00	0	0	36,500	693,500	0	0	0	0
	70	sq.m		0		0		0	0	0	0	0	0	0	0
Asphalt Surface Course	30	sq.m	9.19	19,770	181,752	38,310	352,107	0	0		0	0	0	0	0
	40	sq.m		0		0	13.43	13,900	186,677	0	0	0	0	30,960	415,793
	50	sq.m	14.54	6,900	100,309	6,780	98,564	14.54	28,010	407,195	59,960	871,669	0	0	0
Asphalt Binder Course	30	sq.m		0		0		0	0	0	0	0	0	0	0
	40	sq.m	12.32	21,670	266,954	40,210	495,350	0	0	0	0	0	0	0	0
Semi Flexible Pavement	50	sq.m	10.00	1,900	19,000	1,900	19,000	3.75	10,800	40,489		0	0	0	0
Base course (Graded Crushed Stone)	100	sq.m	5.65	20,690	116,860	39,220	221,553	5.65	0	0	0	0	0	0	0
Base course (Stabilised Existing Material)	100	sq.m	4.36	38,380	158,530	61,370	267,573	4.36	29,508	128,646	0	10,615	46,281	18,200	79,352
	150	sq.m		0		0	6.43	14,300	91,949	59,960	385,543	0	0	30,960	199,073
Subbase course (Stabilised)	150	sq.m		0		0	6.43	4,456	28,652	0	0	10,615	68,254	18,200	117,026
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)		sq.m		0		0	18.00	2,056	37,008	0	0	10,615	191,070	18,200	327,600
Compacted Subgrade		sq.m	1.13	36,360	40,988	61,370	69,177								
Shoulder		sq.m		0		0		0	0		0		0		0
DBST		sq.m	3.75	7,790	29,202	14,380	53,905	3.75	0	0	0	0	0	8,575	32,145
Base course (Stabilised)	100	sq.m		0		0	4.36	0	0		0	0	0	8,575	37,387
Sidewalk		sq.m		0		0		0	0	4	0	0	0	0	0
DBST		sq.m	3.75	14,090	52,818	44,490	166,777	3.75		28,230	105,824	0	0	0	0
Base course (Stabilised)	100	sq.m	4.36	14,090	61,432	44,490	193,976	4.36		28,230	123,083		0	0	0
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)		sq.m		0		0	15.00	58,950	884,250		0	7,868	118,013	53,280	799,200
Base course (Stabilised)	100	sq.m		0		0	4.36	58,950	257,022	0	0	7,868	34,302	53,280	232,301
Kerb Stone		m	12.00	2,160	25,920	5,015	60,180	12.00	6,440	77,280	0		0	0	0
(Sub-total)			sub-total	1,053,770	sub-total	1,998,289	sub-total			3,521,445	sub-total	2,179,618		820,561	3,172,756
Drainage Works															
Cleaning and flushing of existing drainage pipe	m						3.00	4,076	12,227	13,093	39,279	4,683	14,050	18,457	55,370
Open Drain	m							0	0	0	0	0	0	0	0
BD.3 x HD.3	m			0		0	61.96	0	0	0	0		0	0	0
BD.3 x HD.4	m	36.66	1,900	69,652	7,252	265,844	61.96		0	0	0		0	0	0
	m			0		0			0	0	0	0	0	0	0
K-shape drain	m			0		0	15.00		0	0	0	0	0	0	0
side ditch	m	16.00	1,748	27,974	1,748	27,974	16.00	0	0	0	0	0	0	3,560	56,960
U shaped drain	no			0		0			0	0	0	0	0	0	0
0.4 x 0.4	m			0		0			0		0	0	0	0	0
0.45 x 0.45	m			0		0	104.35	0	0	0	0	0	0	0	0
0.5 x 0.5	m			0		0	113.90		0	0	0		0	0	0
0.5 x 0.6	m			0		0	157.62		0	0	0		0	600	94,586
0.6 x 0.6	m			0		0	164.61	0	0	0	0		0	0	0
0.6 x 0.7	m			0		0	180.71	0	0	0	0		0		0
0.7 x 0.7	m			0		0	187.81	0	0	0	0	0	0	0	0
0.7 x 0.8	m			0		0	204.15	0	0	0	0	0	0	0	0
0.7 x 0.9	m			0		0	220.61		0	0	0	0	0	0	0
0.7 x 1.0	m			0		0	0.00		0		0	0	0	0	0
0.7 x 1.1	m			0		0	0.00		0		0	0	0	0	0
0.7 x 1.2	m			0		0	0.00		0		0		0	0	0
0.7 x 1.3	m			0		0	0.00		0		0		0	0	0
1.0 x 1.1	m	441.69		0	480	212,000									
Open Drain (Stone Pitching) 0.7 x 0.7	m			0		0	65.65	0	0	0	0	0	0	0	0
Open Drain (Stone Pitching) 0.8 x 0.8	m			0		0	76.42		0		0		0	0	0
1.0 x 1.0	m			0		0	0.00		0		0		0	0	0
1.0 x 1.2	m			0		0	0.00		0		0		0	0	0
1.0 x 1.5	m			0		0	0.00		0		0		0	0	0
Open Drain (Stone Pitching) 1.0 x 1.0	m			0		0	100.93	0	0	0	0	0	0	0	0
Open Drain (Stone Pitching) 1.2 x 0.9	m	99.12	470	46,586		0									
Open Drain (Stone Pitching) 1.2 x 1.2	m	61.97	570	35,320		0									
Open Drain (Stone Pitching) 0.8 x 0.6	m	57.78	1,120	64,712	1,200	69,335									
Open Drain (Stone Pitching) 1.2 x 0.6	m	69.67	400	27,867		0									
Earth Drain 0.3 x 0.4	m	4.57	2,480	11,332	3,520	16,084			0		0		0	0	0
U	m			0		0			0		0		0	0	0
0.5 x 0.5	m			0		0	130.00	0	0		0		0	900	117,000
0.5 x 085	m			0		0	190.00	7,100	1,349,000		0		0	0	0
Catch pit	no	30.00	93	2,790	179	5,370	30.00	622	18,660	851	25,530	339	10,170	1,191	35,730
Soaking Pit	no			0		0	200.19	355	71,067		0	0	0		0
Collecting Conduit	m	100.00	810	81,000	2,490	249,000									
Pipe culvert	no.			0		0			0		0	0	0		0
D300	m			0		0	100.00	651	65,125	0	0	0	0	0	0
D400	m			0		0	132.33	0	0		0		0	0	0
D600	m	178.15	80	14,252		0	178.15	500	89,075		0		0	70	12,471
D800	m			0		0	270.71		0		0		0	0	0
D1000	m			0		0	410.90		0		0		0		0
D1500	m			0		0	748.78		0		0	900	673,883	0	0
(Sub-total)			sub-total	381,486	sub-total	845,616	sub-total		1,605,154	sub-total	64,809		698,103		372,116
Outlet Construction														0	
Block Pitching	sq.m	20.00	0	0	3,846	76,920									
Spidding	sq.m	8.13	0	0	7,480	60,812									
Excavation&Filling	cu.m	4.97	0	0	5,100	25,359									
Box culvert				0		0									
3000x3000	m	1,910.81	100	191,081	0	0									
2500x2500	m	1,530.32	50	76,516	0	0									
2500x2000	m	1,282.84	20	25,657	50	64,142									
3000x2000x2	m	2,635.27	0	0	50	131,763									
(Sub-total)			sub-total	293,254	sub-total	358,997									
Miscellanious Works														0	
Lane Marking	m	3.00	1,920	5,760	3,290	9,870	3.00	21,360	64,080	8,510	25,530	3,390	10,170	10,635	31,905
Roundabout	no			0		0	761.68	1	762		0		0	0	0
Chatter bar	no			0		0	20.00	1,584	31,680		0		0	0	0
signal(including pedestrian signal)	no			0		0	2,000.00	32	64,000		0		0	8	16,000
Shift of signal(including pedestrian signal)	no														
Busstop shelter	no			0		0	1,000.00	88	88,000		0		0	0	0
Hump	no			0		0	1,000.00	0	0		0		0	15	15,000
concrete slab(1.5 x 1.0 x 0.15)	no			0		0	60.00	0	0		0		0	0	0
Boundary Block	m	12.00	1,040	12,480	1,390	16,680									
Tree Block	m	12.00	390	4,770	2,521	30,251									
Tree	set	10.00	300	3,000	589	5,890									
Street Light	set	3,000.00	40	120,000	165	495,000									
Gabion	cu.m	300.00	460	138,000	460	138,000									
Vertical Drain	m	61.68	480	29,608	250	15,421									
Removal Gabion	cu.m	10.00	11,300	113,000		0									
Removal Kerb Stone	m	6.00	930	5,580	930	5,580									
Removal Boundary Block	m	6.00	930	5,580	930	5,580									
Grass	sq.m	8.13			2,590	21,057									
(Sub-total)			sub-total	437,874	sub-total	743,329	sub-total		248,522	sub-total	25,530		10,170		62,905
Relovation of Utility								0						0	
Electricity Line(Overhead)33kv	m	20.00		0		0	28	0			0		0	0	0
Electricity Line(Overhead)22kv	m	11.00		0		0	11	0	0		0		0		0
Electricity Line(Overhead)11kv	m	10.00	1,200	12,000	2,600	26,000	10	3,100	31,000		0		0		0
Electricity Line(Underground)33kv	m	28.00		0		0	28	0	0		0		0	0	0
Electricity Line(Underground)22kv	m	28.00		0		0	28		0		0		0		0
Electricity Line(Underground)11kv	m	15.00		0		0	15		0		0		0		0
Telephone Line(Overhead)	m	8.80		0	1,800	15,840	9	0	0		0		0	0	0
Telephone Line(Underground)	m	35.80		0		0	36		0		0		0		0
Water Main D>300	m	150.00		0		0	150	0	0		0		0	0	0
Water Main D<300	m	75.00		0		0	75	0	0		0		0	0	0
Sewerage	m	0.00		0		0		0	0		0		0	0	0
(Sub-total)			sub-total	12,000	sub-total	41,840	sub-total		31,000	sub-total	0		0		0
House compensation								0						0	
Residence(small)	no		215		352			0	0		0		0	0	0
Residence(middium)	no							0	0		0		0	0	0
Residence(big)	no							0	0		0		0	0	0
Commercial Building(small)	no							0	0		0		0	0	0
Commercial Building(middium)	no							0	0		0		0	0	0
Commercial Building(big)	no							0	0		0		0	0	0
Factory	no							0	0		0		0		0
(Sub-total)							sub-total		0	sub-total	0		0		0
							total		5,375,120		2,293,713		1,533,204		3,607,727

Table 19.6.1 Construction Cost (2)

Item		Unit	District 2 Area Roads		District 3 Area Roads		Public Transportation		Traffic Management	
			Dist. 2 Area Roads Total	Dist. 2 Area Roads Amount	Dist. 3 Area Roads Total	Dist. 3 Area Roads Amount	Bus Terminal Total	Bus Terminal Amount	Improve of Intersection	Intersection Amount
Maintenance		m							0	
Overlay		m							0	
Re Base		m							0	
Road Length(m)		m	9130		908				0	
Road Width		m	12~14		10~14				0	
Carriageway		m							0	
Sidewalk		m							0	
Drain		m							0	
Utility		m							0	
Total Width(m)		m							0	
Embankment Heioht(m)		no.							0	
Access Road (no)	80	no.							0	
Bus bay	245	no.							0	
Extra bus bay	138								0	
Improvement Intersection		no.								
Earth Works									0	
Embankment		cu.m	24455	73774	2456	73983	0	0	153	475
Cut		cu.m							0	0
Excavation common		cu.m	10062	19729	1092	21419	0	0	8063	0
Removal of existing pavement(t=5cm)		cu.m	0	0	0	0	0	0		
Cut Slope		sq.m								
Fill Slope		sq.m								
Slope Protection		sq.m								
(Sub-total)			subtotal	93503		95402	0	0	0	475
Pavement Works			0		0				0	
Carriageway			0		0		0		0	
Overlay	40	sq.m	0	0	0	0	0	0	73429	954587
	50	sq.m	0	0	0	0	14254	228064	0	0
	60	sq.m	0	0	0	0	0	0	0	0
	70	sq.m	0	0	0	0	0	0	0	0
Asphalt Surface Course	30	sq.m	0	0	0	0	0	0	0	0
	40	sq.m	0	0	0	0	0	0	6866	92208
	50	sq.m	17890	260078	0	0	0	0	0	0
Asphalt Binder Course	30	sq.m	0	0	0	0	0	0	0	0
	40	sq.m	0	0	0	0	0	0	0	0
Semi Flexible Pavement	50	sq.m		0		0	4157	15583	80395	300998
Base course (Graded Crushed Stone)	100	sq.m	0	0	0	0	0	0		0
Base course (Stabilised Existing Material)	100	sq.m	5774	251748	8160	355776	5912	25776	6866	29938
	150	sq.m	13890	89313	0	0	0	0	0	0
Subbase course (Stabilised)	150	sq.m	5774	371268	8160	524688	5912	38014	6866	44141
Concrete Block Pavement(t=80mm)+sandbed(t=30mm)		sq.m	5374	967332	7470	1344600	0	0	0	0
Compacted Subgrade		sq.m								
Shoulder		sq.m	0	0	0	0	0	0	0	0
DBST		sq.m	0	0	0	0	0	0	0	0
Base course (Stabilised)	100	sq.m	0	0	690	30084	0	0	0	0
Sidewalk		sq.m	0	0	0	0	0	0	0	0
DBST		sq.m	31280	117255	2558	95900	16922	63455	0	0
Base course (Stabilised)	100	sq.m	31280	136368	2558	111576	16922	73784	0	0
Concrete Block Pavement(t=40mm)+sandbed(t=30mm)		sq.m	0	0	0	0	0	0	1061	15919
Base course (Stabilised)	100	sq.m	0	0	0	0	0	0	1061	4667
Kerb Stone		m	0	0	0	0	3808	45716	3810	45715
(Sub-total)				2193363		2462609	0	491428		1488133
Drainage Works			0		0		0		0	
Cleaning and flushing of existing drainage pipe		m	0	0	0	0	0	0	0	0
Open Drain		m	0	0	0	0	0	0	0	0
B0.3 x H0.3		m	3900	241668	473	29302	0	0	0	0
B0.3 x H0.4		m	2380	147483	3190	197658	0	0	0	0
		m	0	0	0	0	0	0	0	0
K-shape drain		m	700	10500	0	0	0	0	0	0
Gabi gutter		m	2900	46400	0	0	83	13280	0	0
U shaped drain		no	0	0	0	0	0	0	0	0
0.4 x 0.4		m	0	0	0	0	0	0	0	0
0.45 x 0.45		m	0	0	0	0	0	0	0	0
0.5 x 0.5		m	0	0	0	0	0	0	0	0
0.5 x 0.6		m	0	0	0	0	0	0	0	0
0.6 x 0.6		m	0	0	0	0	0	0	0	0
0.6 x 0.7		m	0	0	0	0	0	0	0	0
0.7 x 0.7		m	0	0	105	197193	0	0	0	0
0.7 x 0.8		m	1500	306222	0	0	0	0	0	0
0.7 x 0.9		m	0	0	618	134575	0	0	0	0
0.7 x 1.0		m	0	0	0	0	0	0	0	0
0.7 x 1.1		m	0	0	120	0	0	0	0	0
0.7 x 1.2		m	2000	0	53	0	0	0	0	0
0.7 x 1.3		m	0	0	618	0	0	0	0	0
1.0 x 1.1		m								
Open Drain (Stone Pitching) 0.7 x 0.7		m	2000	131294	415	272458	0	0	0	
Open Drain (Stone Pitching) 0.8 x 0.8		m	0	0	38	29088	0	0	0	0
1.0 x 1.0		m	0	0	53	0	0	0	0	0
1.0 x 1.2		m	0	0	53	0	0	0	0	0
1.0 x 1.5		m	0	0	230	0	50	0	0	0
Open Drain (Stone Pitching) 1.0 x 1.0		m	0	0	334	337116	50	50466	0	
Open Drain (Stone Pitching) 1.2 x 1.2		m							0	0
Open Drain (Stone Pitching) 0.8 x 0.6		m								
Open Drain (Stone Pitching) 1.2 x 0.6		m								
Earth Drain 0.3 x0.4		m	0	0	0	0	0	0		
U		m	0	0	0	0	0	0	0	0
0.5 x 0.5		m	500	65000	0	0	0	0	0	0
0.5 x 085		m	0	0	0	0	0	0	0	0
Catch pit		no	0	0	0	0	42	1245	733	21900
Soaking Pit		no	0	0	0	0	0	0	0	0
Collecting Conduit		m								
Pipe culvert		no.	0	0	0	0	0	0	0	0
D300		m	0	0		0	0	0	6728	627800
D400		m	530	71328	32	42612	0	0	0	0
D600		m	0	0	67	119715	0	0	0	0
D800		m	800	216572	0	0	0	0	0	0
D1000		m	0	0	0	0	0	0	122	50130
D1500		m	0	0	0	0	0	0	0	0
(Sub-total)				1236433		1623413		64991		699830
Outlet Construction			0		0		0		0	
Block Pitching		sq.m								
Sodding		sq.m								
Excavation&Filling		cu.m								
Box culvert										
3000x3000		m								
2500x2500		m								
2500x2000		m								
3000x2000x2		m								
(Sub-total)			0							
Miscellanious Works			0		0		0			
Lane Marking		m	9130	27390	908	27240	1831	5493	33282	99846
Roundabout		no	4	3047	3	762	0	0	0	0
Chatter bar		no	0	0	0	0	0	0	833	16658
signal(including pedestrian signal)		no	0	0	0	0	0	0	173	38125
Shift of signal(including pedestrian signal)		no							28	0
Busstop shelter		no	0	0	0	0	0	0	92	92000
Hump		no	12	12000	11	11000	0	0	0	0
concrete slab(1.5 x 1.0 x 0.15)		no	913	54780	90	59300	0	0	0	0
Boundary Block		m								
Tree Block		m								
Tree		set								
Street Light		set								
Gabion		cu.m								
Vertical Drain		m								
Removal Gabion		cu.m								
Removal Kerb Stone		m								
Remoavl Boundary Block		m								
Grass		sq.m								
(Sub-total)				97217		98372		5493		607176
Relocation of Utility			0		0		0		0	
Electricity Line(Overhead)33kv		m	0	0	0	0	0	0	0	0
Electricity Line(Overhead)22kv		m	0	0	0	0		0	0	0
Electricity Line(Overhead)11kv		m	0	0	0	0		0	0	0
Electricity Line(Underground)33kv		m	0	0	0	0	0	0	0	0
Electricity Line(Underground)22kv		m	0	0	0	0	0	0	0	0
Electricity Line(Underground)11kv		m	0	0	0	0	0	0	0	0
Telephone Line(Overhead)		m	0	0	0	0	0	0	0	0
Telephone Line(Underground)		m	0	0	0	0	0	0	0	0
Water Main D>300		m	0	0	0	0	0	0	0	0
Water Main D<300		m	5030	377251	1230	92250	0	0	0	0
Sewerage		m	0	0	0	0	0	0	122	0
(Sub-total)				377251		92250	0	0		0
House compensation			0		0		0		0	
Residence(small)		no	0	0	0	0	0	0	0	0
Residence(middlium)		no	0	0	0	0	0	0	0	0
Residence(big)		no	0	0	0	0	0	0	0	0
Commercial Building(small)		no	0	0	0	0	0	0	0	0
Commercial Building(middlum)		no		0		0		0	0	0
Commercial Building(big)		no		0		0		0	0	0
Factory		no		0		0		0	0	0
(Sub-total)				0		0		0		0
				3620510		4279784		561912		2795619

19.7 HOUSE / BUILDING COMPENSATION COST, UTILITIES RELOCATION COST AND OTHER COSTS

The project cost consists other costs shown below.

1) House / building compensation cost

House / building compensation cost was estimated based on the unit cost obtained through environmental survey shown in the Chapter 16. The house / building compensation cost for each building is 1,500 US$ in District 2, 1,700US$ in District 3, 2,000US$ on the existing alignment of Av. Julius Nyerere.
The estimated compensation costs for project roads are as shown in the Table 19.7.1.

Table 19.7.1 House / Building Compensation Cost

Group No	Existing minimum road width (m)	Proposed road width (m)	House compensation cost(USD) W=14m	House compensation cost(USD) Proposed Width
9. Rehabilitation of District 2 Area Roads			**324,000**	**79,500**
9.1 Rua 2282/2265	6	8,10,14	147,000	25,500
9.2 Rua 2275	6	8,10,12,14	123,000	34,500
9.3 Rua de Xipamanine(2291)	6	10,12	24,000	3,000
9.4 Rua dos Imaos Roby(2289)	12m (street type)	12m (street type)	0	0
9.5 Rua 2315/2313	6	10,14	18,000	7,500
9.6 Rua 2309/2324	6	14	12,000	9,000
9.7 Av. das Estancias(2000)	12m (street type)	12m (street type)	0	0
10. Rehabilitation of District 3 Area Roads			**319,600**	**57,800**
10.1 Rua da Goa(3027)	5	10	13,600	1,700
10.2 Rua da Lixera(3030)	7	10	39,100	0
10.3 Av. Milagre Mbote(3001)	8	8,10	107,100	5,100
10.4 Av. da Malhangalene(3259)	6	8,10,12	119,000	22,100
10.5 Rua 1 de Maio(3374)	6	8	40,800	28,900
10.6 Rua 3306	14	14	0	0
10.7 Rua 3523	14	14	0	0
10.8 Rua 3576	14	14	0	0
Construction of Missing Link on Av. Julius Nyerere(On Line)				**502,000**
Construction of Missing Link on Av. Julius Nyerere(Off Line)				**528,000**
Construction of Bus Terminal(Combatentes)				**138,000**

2) Utilities relocation cost

Utilities relocation cost was estimated based on the unit cost obtained through hearing to local contractors.
The estimated relocation costs for project roads are as shown in the Table 19.7.2.

Table 19.7.2 Utilities Relocation Cost

	Unit price (USD/m)	On-line (J.N)		Off-line (J.N)		Trunk		Indus/Commer		Port		Dist.1		Dist.2		Dist.3	
		Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)	Length(m)	Cost(USD)
Electricity Line(Overhead)33kv	20		0		0		0	0	0	0	0	0	0		0		0
Electricity Line(Overhead)22kv	11		0		0		0	0	0	0	0	0	0		0		0
Electricity Line(Overhead)11kv	10	1,200	12,000	2,600	26,000	3,100	31,000	0	0	0	0	0	0	2,150	21,500	2,180	21,800
Electricity Line(Underground)33kv	28		0		0		0	0	0	0	0	0	0		0		0
Electricity Line(Underground)22kv	28		0		0	3,100	86,800	0	0	0	0	0	0		0		0
Electricity Line(Underground)11kv	15		0		0		0	0	0	0	0	0	0		0		0
Telephone Line(Overhead)	9		0	1,800	15,840		0	0	0	0	0	0	0	2,540	22,352	2,190	19,272
Telephone Line(Underground)	36		0		0		0	0	0	0	0	0	0		0		0
Water Main D>300	150		0		0		0	0	0	0	0	0	0		0		0
Water Main D<300	75		0		0		0	0	0	0	0	0	0	5,030	377,250	1,230	92,250
Total (USD)			**12,000**		**41,840**		**117,800**		**0**		**0**		**0**		**421,102**		**133,322**

G.Popular	1,300	13,000
M.Ngouabi	1,800	18,000
Total	3,100	31,000

3) Other costs

- Engineering cost : 10% of the construction cost
- Contingency cost : 10% of the construction cost consisting 5% of physical and 5% of price contingencies
- Administration cost : Total 1% of the construction cost during preparation and implementation

19.8 SUMMARY OF THE PROJECT COSTS

The project cost including construction cost, compensation cost for houses and buildings, physical contingency and price contingency as well as the engineering costs etc., is shown in the Table 19.8.1.

Table 19.8.1 Summary of the Project Costs

Unit:mil.US$

Phase	Project Road Length (km)	Grand Total*			
		C/C		H/C	
(1) Construction Cost					
- Av. J. Nyerere	5.6	5.05	(11.60)	0.53	(0.50)
- Av. V. Lenine	---	0.13	←	0.00	←
- Av. A. Lusaka	2.8	1.76	←	0.00	←
- Av. Angola	3.7	2.05	←	0.00	←
- Av. M. Ngouabi	2.6	1.43	←	0.12	←
- Industrial/ Commercial Area	6.0	2.29	←	0.00	←
- Port Area	3.9	1.53	←	0.00	←
- District 1 Roads	8.7	3.61	←	0.00	←
- District 2 Roads	10.2	3.62	←	0.50	←
- District 3 Roads	9.5	4.28	←	0.18	←
- Traffic Management Facilities	---	2.80	←	0.00	←
- Bus Stops and terminals	---	0.56	←	0.14	←
Sub Total (a)		**29.12**	**(35.67)**	**1.47**	**(1.44)**
(2) Structural Strengthening Cost		0.56	(0.56)	---	---
Sub Total (b)		**0.56**	**(0.56)**	**---**	**---**
Total Construction Cost (a)+(b)		**29.68**	**(36.23)**	**1.47**	**(1.44)**
(3) Consultant Fee (DD/SV=10% of Construction Cost)		2.91	(3.57)	---	---
(4) Contingency for Price Escalation and Physical Change (10% of Construction Cost)		2.91	(3.57)	---	---
(5) Administration Cost of Mozambique Government (1% of Construction Cost)		---	---	0.29	(0.36)
Sub Total (6) = (3) + (4) + (5)		**5.82**	**(7.13)**	**0.29**	**(0.36)**
Total (1) + (2) + (6)		**35.50**	**(43.36)**	**1.76**	**(1.80)**

* : C/C: Construction Cost ( ) = Julius Nyerere Plan 4
H/C: House Compensation including Relocation of Utilities
Exchange Rate 1 US$ = 22,000 Mts = ¥125.00 (July 2001),
or 1 Mt = ¥0.00568

19.9 MAINTENANCE COST

Road maintenance costs, which are required after completion of the project, are divided into the routine maintenance and the periodic maintenance.

Annual routine maintenance cost is estimated as 1.5% of the construction cost, periodic maintenance cost is estimated as 10% of the construction cost, it will be cost 10 years after opening of the project roads.

CHAPTER 20

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 20 : ENVIRONMENTAL IMPACT ASSESSMENT

20.1 GENERAL

20.1.1 Objective of EIA

In road development projects, it is imperative to harmonize the planned work with environmental issues. In this chapter, the environmental impact assessment (EIA) has been conducted in respect of the proposed high priority road development programmes, which constitute the Feasibility Study, that were selected in the Master Plan. The objective of the EIA is summarized as follows:

- To identify existing environmental situations in the project area
- To estimate and evaluate possible environmental impacts of the proposed project
- To consider countermeasure to mitigate negative impacts of the project

20.1.2 Environmental Items

As a" scoping "result of the initial environmental examination (IEE), the environmental items requiring an environmental impact assessment of the project and further surveys have been selected already in the Master Plan. These items are reviewed in Table 20.1.1.

Table 20.1.1 Environmental Items requiring EIA and Further Study

Environmental Items	Requiring EIA	Requiring Further Study
Social Environment	•Resettlements	•Economic Activities •Traffic and Public Facilities •Cultural Property
Natural Environment	---	•Flora and Fauna
Environmental Pollution	•Prediction of NO_2 and CO •Prediction of Noise level and Vibration level	---

In addition to those items mentioned above, following items will be in consideration for environmental impact assessment.

-Geomorphology, Geology and Soils
-Flood hazard
-Water resources
-Solid waste
-Health, Safety and Well being

20.2 DESCRIPTION OF PROPOSED PROJECT

(1) Objectives of Project

- To link missing link
- To prevent flood hazard
- To function as a basic corridor for future expansion
- To decrease traffic congestion
- To smooth vehicle running
- To provide better public transport

(2) Characteristics of Projects

- Type of Project: New construction / Rehabilitation / Improvement
- Characteristics of Road: Trunk road / Collector road

(3) Target Year

- 2010

(4) Project Summary

The high priority projects of feasibility study consist of three categories, namely, road development plan, traffic management plan and public transport plan. The summary of proposed projects is shown in Table 20.2.1.

Table 20.2.1 Summary of Proposed Project

	FS Project	Project Measures/Component	Length (km)	Width (m)	[1] . of Lanes	Type of Road	Terrain Condition	Land-use Situation	Proposed Design Speed (km/hr)
Trunk Roads	1.Construction of Missing Link on Av. Julius Nyerere	Early linking of the missing link on Av. Julius Nyerere through construction of two-lane trunk road	5.6	22	2	Street	Flat/Rolling	Urban area	60
	2.Restoration of Av. Juluis Nyerere	Restoration of Av. Juluis Nyerere along original route site	3.1	22	2	Street	Flat	Urban area	60
	3.Improvement of AV.Vladimir Lenine	Construction of bus bays and improvement of intersections on AV.Vladimir Lenine	3.2	16	2	Street	Flat	Urban area	50
	4.Rehabilitation and Improvement of AV. Acordos de Lusaka and Av. Guerra Popular	Rehabilitation of pavement and drainage of AV. Acordos de Lusaka	2.8	28	4	Street	Flat	Urban area	60
		Widening of Av. Guerra Popular from 2 to 4 lane road	0.7	20	4	Street	Flat	Urban area	50
	5.Rehabilitation and Improvement of AV. Angola and Rua S. Cabral/Largo de Deta	Rehabilitation of pavement and drainage of AV. Angola	3.1	20	2	Street	Flat	Urban area	50
		Rehabilitation of pavement and drainage of Rua S. Cabral/Largo de Deta	0.6	20	2	Street	Flat	Urban area	40
	6.Rehabilitation and Improvement of AV. Marien Ngouabi	Widening of Av. Marien Gouabi (from Av. Mau Tse Tung to Av. Acordos Lusaka) from 2 to 4 lane road	0.9	20	4	Street	Flat	Urban area	50
		Reconstruction of pavement and drainage of Av. Marien Gouabi (from Av. Acordos Lusaka to Rue Joao Arbasini)	1.0	20	2	Street	Flat	Urban area	50
Collector Roads	1.Rehabilitation of Industrial and Commercial Area Roads	Rehabilitation of pavement and drainage of area roads	6.03	12～20	2	Street	Flat	Urban area	40
	2.Rehabilitation of Port Area Roads	Rehabilitation of pavement and drainage of area roads	3.9	10～19	2	Street	Flat	Urban area	30
Residential Area Roads	1.Rehabilitation of District 1 Area Roads	Rehabilitation of pavement and drainage of District 1 area roads	8.7	12～20	2	Street	Flat/Rolling	Urban area	40
	2.Rehabilitation of District 2 Area Roads	Rehabilitation of pavement and drainage of District 2 area roads	10.2	8～14	2	Road	Flat	Semi-urban	40
	3.Rehabilitation of District 3 Area Roads	Rehabilitation of pavement and drainage of District 3 area roads	9.5	8～14	2	Road/Street	Flat	Semi-urban	40
Rehabilitation and Improvement of Traffic Management Facilities		Construction of right-turn lanes and signals (14 intersections) and control of on street parking in intersection areas	--	--	--	--	--	--	--
Rehabilitation and Improvement of Bus Stops and Terminals		To Provide suitable location and size of bus bays (22 bus bays) and one terminal and to equip required function on to the bus terminal	--	--	--	--	--	--	--

20.3 SITE CONDITIONS

Table 20.3.1 summarizes the social-economic, physical and natural aspects of the environment and the present condition of public nuisance along the priority roads. Site condition is, in general, as follows:

- Decreasing safety margin for flood control due to the accumulated sand and garbage in the drainage channels

  Haphazard expansion of residential areas has caused soil erosion leading to more accumulation of sand in the drainage channels and the raising-up of the bed of channels which blocks the smooth flow of water. In addition, solid wastes are thrown into the drainage channels, lowering flow capacity of the stream and causing the water flow to stagnate.

- Roadside environment of most roads with rich greenery

  Most of areas along the priority roads creates a nice roadside environment with rich greenery, where roadside trees together with trees in private yards create a green belt.

- Air pollution due to the dust generated by traffic vehicles

Due to roads with an unpaved or damaged surface, dust is flung up as motor vehicles pass by thus causing deterioration of clean air conditions. This is because sand from flooding has accumulated on the roads.

Table 20.3.1 Outline of Environment along the Proposed Roads/Projects

F/S Project		Social and Economical Environment	Physical and Natural Environment	Public Nuisance
Trunk Roads	1.Construction of Missing Link on Av. Julius Nyerere	・More and more houses have been built in the coastal plain, and some of elementary school are also located here.	・Swamps of coastal plain are located here. Rich in the greenery of trees.	・Heavy dust is flung up when motor vehicles run on the road where the surface is not paved.
	2.Restoration of Av. Juluis Nyerere	・Many residences are located here.	・Rich in the greenery of trees.	・The erosion damages are very significant due to the heavy rain. Av. Juluis Nyerere wre cut.
	3.Improvement of AV.Vladimir Lenine	・Many residences as well as commercial facilities (market) are located here.	・Poor in the greenery of trees.	・The traffic volume of this road is generally heavy, resulting in severe traffic congestion.
	4.Rehabilitation and Improvement of AV. Acordos de Lusaka and Av. Guerra Popular	・Many residences as well as commercial facilities are located here.	・Trees are lined along the road and cultural property of Estatua"samora machel" (Samora machel statue)are located here.	・The traffic volume of these roads are generally heavy, therefore, it cannot be said that the current situation of air and sound environments of the area are favorable.
	5.Rehabilitation and Improvement of AV. Angola and Rua S. Cabral/Largo de Deta	・Many factories and commercial facilities as well as residences are located here.	・Open drainage canal is installed along this road.	
	6.Rehabilitation and Improvement of AV. Marien Ngouabi	・Many residences as well as commercial facilities are located here.	・Many trees are lined along the road.	・Heavy dust is flung up when motor vehicles run on the road where the surface is damaged.
Collector Roads	1.Rehabilitation of Industrial and Commercial Area Roads	・Many factories and warehouses are located here. the port is also located in this area.	・Some trees are planted along roads.	・Surface are badly damaged on these areas, and accordingly dust is flung up when motor vehicles pass over the roads. It worsens the atmospheric environment of the roadside area.
	2.Rehabilitation of Port Area Roads	・Many factories and warehouses as well as commercial facilities are located here. Railway station is also located in the area.	・Trees are lined along the road and many of the cultural properties are located in this area.	
Residential Area Roads	1.Rehabilitation of District 1 Area Roads	・Many residences are located in these areas.	・Trees are planted from place to place along roads and around houses.	・Due to the surface of roads are badly damaged as well as unpavement, heavy dust is flung up when motor vehicles run on the roads.
	2.Rehabilitation of District 2 Area Roads			
	3.Rehabilitation of District 3 Area Roads			
Rehabilitation and Improvement of Bus Terminal		・Many residences and one market are located here.	---	・The congestion of bus terminal

20.4 ENVIRONMENTAL IMPACT ESTIMATION AND ASSESSMENT

This section provides the results of the impact assessment and the methodology employed in identifying and assessing the significance of the various potential impacts. A summary table indicating the potential impacts and their significance with and without mitigation is presented in Table 20.4.1. A description of the impacts is provided in Sections 20.4.1 – 20.4.11.

The environmental assessment covers all activities associated with the upgrade and construction of the proposed project roads, but excludes the sourcing and transport of base-coarse material from the quarry. For convenience, the project has been broken up into a number of different components, viz:

- The construction of a new section along Av. Juluis Nyerere, adjacent to the golf course to intercept Rua 4.500 and join Av. De Mozambique at the Praca dos Combaterites.
- The restoration of Av. Juluis Nyerere along its original route.
- Widening of the Streets Av. Guerra Popular and Av. Marien Ngouabi to accommodate two lane-two way traffic.
- Upgrading and widening of roads within the Chamanculo, Xipamanine, Maxaquene, Minkadjuine, Polana-Canico and Aeroporto sub districts.
- General Improvements to streets within the central sub districts
- General improvements to the roads in Light industrial areas (e.g. Av de Angola, Av de Lusaka, Av. De Mozambique).

The assessment included both **Short Term** impacts incurred directly as a result of construction activities and **Long Term** impacts from the general improvements of the target roads.

Table 20.4.1 Summary of Environmental Impact

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.1 Resettlement of Residents										
		Resettlement of residents within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts due to road widening	The social impacts of removal and resettlement of residents located alongside the target roads within these districts.	N	H	H	M	H	H	M
20.4.2 Air Pollution										
		Construction activities	Dust generated	N	M	L	M	M	M	L
		Raising speed of vehicle due to improvement of roads	Exhaust gas caused by vehicle traffic	P	M	H	M	M	M	M/ H
		Restoration of original JN[1)]	Formation of roadside buffer belt		-NO_x; 0.015～0.019 ppm ＜ 0.08 ppm (WHO 24 hr. Avg.) -CO; 0.524～0.569 ppm ＜ 10 ppm (Japan 24 hr. Avg)					

H = High, M = Medium, L = Light (refer to Appendix 20.1 for definitions for severity, duration, probability and spatial extent)

1) JN = Av. Julius Nyerere

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.3 Noise										
		Construction activities	Noise generated by construction activities and diversion of traffic to accommodate construction	N	M	L	M	M	M	L
		Improved road conditions following construction	Noise generated by improved road conditions following construction.	P	M/L	H	M	M	M/L	M/H
					Daytime;L_{Aeq}＝60.1〜64.5＜65 dB Nighttime;L_{Aeq}＝51.9〜57.4＜60 dB (Japanese standard)					
		Restoration of JN	Formation of roadside buffer belt							
20.4.4 Vibration										
		Construction activities	Vibration generated by construction activities and diversion of traffic to accommodate construction	N	M	L	M	M	M	L
		Improved road conditions following construction	Vibration generated by improved road conditions following construction.	P	M/L	H	M	M	M/L	M/H
					Daytime;L_{Aeq}＝38.8〜47.2＜70 dB Nighttime;L_{Aeq}＝33.3〜42.7＜65 dB (Japanese standard)					
		Restoration of JN	Formation of roadside buffer belt							
20.4.5 Geomorphology, Geology and Soils										
		Construction of New Section on JN	The impact of construction activities on the soils of the low-lying coastal areas and swamps in the Costa de Sol District	N	M	M	M	L	M	M
		Restoration of original JN	The impact on soil erosion	P	H	H	H	L	M	H
		Upgrading of target roads and construction of stormwater drains	The impact of upgrading and repair of trunk, collector and area roads which are currently in existence, on the underlying geology and soils	Not significant since roads are currently already existing						
		Sourcing of road building material	The impact of quarrying road building material on geomorphology, geology and soils	This does not form part of the scope of works.						

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.6 Flood Hazard										
		Construction of New Section on JN and restoration of original JN Upgrading of target roads and construction of stormwater drains	The impact of flood hazard due to stormwater	P	H	H	H	H	H	H
20.4.7 Water Resources										
		Construction of New Section on JN.	The impact of construction activities on the natural surface water flow and quality within the Low-lying coastal areas and Mangroves.	N	M	M	M	M	H	M/H
		Upgrading of target roads and construction of stormwater drains	The impact of stormwater drains on surface water quality.	P	H	H	H	M	H	H
			The impact of stormwater drains on groundwater levels.	No Impact anticipated other than possible slight lowering of water table due to effective drainage of surface water						
20.4.8 Protected or ecologically sensitive zones										
	Swamps	Construction of New Section on JN.	The impact of road construction on the ecological functioning of the Swamps in the Costa de Sol District: Direct impact of construction.	N	M	L	M	L	H/M	M
			The impact of road construction on the ecological functioning of the Swamps in the Costa de Sol District: Indirect impact of introducing new settlements to area.	N	H	H	M	H	H	M

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA: Severity	CRITERIA: Duration	CRITERIA: Probability	CRITERIA: Spatial extent	SIGNIFICANCE: Without mitigation	SIGNIFICANCE: With mitigation
20.4.9 Urban Environmental Quality										
(1)	Aesthetics (Street trees)	The upgrading, improvement of target roads within the Central Districts	The impact of resurfacing and upgrading target roads on street trees	No impact anticipated as trees will not be removed.						
		The widening of the roads Av. GP[2] and Av MN[3]	The impact of road widening on street trees	N	M	M	M	L	M	H
(2)	Solid Waste	Construction activities	The impact of solid waste and hazardous waste generated during construction on the environment	N	M	L	M	L	M	M
20.4.10 Social and Cultural Environments										
(1)	Social and cultural environment:Provision of services and access to facilities	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on Public Transport	P	H	L	H	M	H	---
			Impact on waste collection services	P	H	L	M	M	H	---
			Impact on supply and maintenance of services	P	M	L	M	M	M	---
			Impact on access to markets, hospitals, schools and other facilities	P	H	L	H	M	H	---
		Construction of New section of JN and restoration of original JN	Impact on access to markets, hospitals, schools and other facilities	P	M	L	M	M	M	---
		Upgrade of target roads within Central District	Impact on access to markets, hospitals, schools and other facilities	P	M	H	H	M	M	---

2) GP=Av. Guerra Popular
3) MN= Av. Marien Ngouabi

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
(2)	Health, Safety and Well Being	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on pedestrian and motorist safety	P	H	H	H	M	H	---
			Impact on Residents health by improving access to waste collection trucks and provision of effective drainage.	P	H	H	H	M	H	---
		Widening of. GP and MN	Impact on pedestrian and motorist safety	P	H	H	H	L	H	---
		Construction activities	The impact of construction activities on motorist and pedestrian safety.	N	M/L	L	M/L	L	M/L	L
(3)	Cultural Environment	Upgrading, improvement and resurfacing of roads within the Central District	The impact of road reconstruction and repair activities on cultural properties.	No impact anticipated other than short term inconvenience during construction and long-term benefits of improved access to these sites						

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.11 Economic environment										
(1)	Formal commercial activities	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on businesses located along target roads.	N	M	L	M	L	M	L
			The long term impacts on the businesses of improved road surfaces	P	H	H	H	M	H	---
		Upgrading of roads within the Central District	The short term impacts of construction activities on businesses located along target roads.	N	M/L	L	M	L	M/L	L
			The long term impacts on the businesses of improved road surfaces	P	M	H	H	M	M	H
		Construction of the new JN section and restoration of original JN	The impact on improved access to Av Marginal from the Polana-Canico district	P	M	H	M	M	M	---
(2)	Markets and informal commercial activities	Construction of the new JN section, Upgrading of roads within Minkadjuine and aeroporto districts	Short term impact on the Praca dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	N	M	L	M	L	M	L
			Long term impact on the Praca dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	P	M	H	M	M	M	H

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
(3)	Informal individual traders (ie tomatoe, cashew nut etc vendors)	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on vendors located along target roads.	P	M	L	M	L	M	H
			The long term impacts of improved road surfaces and access on the businesses.	No significant impact since most of the trade comes from surrounding residents, although conditions for selling would be improved by the addition of a sidewalk.						
(4)	Industrial activities	Upgrade of target roads	The impact of road upgrades on light and heavy industries located along	P	M/L	H	M	L	M/L	---
(5)	Employment opportunities	Employment of Unskilled labour	The impact of employment on social upliftment and increase spending power	P	M	L	M	M	M	H
(6)	Maputo economic growth	Upgrade of all target roads according to 2020 plan	The impact of road upgrades on general economic growth in Maputo.	P	H	H	H	H	H	---

20.4.1 Resettlement of Residents

The displacement of families living alongside the roads designated for widening, and their relocation elsewhere is perhaps the most significant negative impact associated with the project.

The situation in the districts of Chamanculo, Xipamanine, Aeroporto and Maxaquene is of a different nature but no less severe. Discussions with long-term residents revealed that the original road was paved and much wider than is currently the case. The deterioration of the road due to poor drainage and lack of maintenance had lead to the disintegration of the surface. The influx of additional families into the area has restricted the amount of available space and led to houses being established right on the original road surface. This has resulted in the width of the road has been narrowed to accommodate only one way traffic in some places. The upgrading of the roads Rua 2282/2265, Rua 2275, Rua de Xipamanine, Rua 2315/2313, Rua 2309/2324, Rua 1 de Maio, Ave Milagre Mabote and Av de Malhangalene and as well as Av. Julius Nyerere (Restoration of original route and construction of a new section) will involve the removal of dwellings at least one property deep along particularly narrow sections.

Displaced families will have to be compensated according to their constitutional rights either by financial compensation or the provision of a new house of similar or improved standard. Related studies have revealed a number of pitfalls associated with expropriation and relocation of residents:

- Difficulty in identifying a suitable site for relocation which has the same property value, accessibility to markets, schools, hospitals, places of work, transport routes and water supply.
- Lack of financial capacity to build an equivalent house in the new place.
- Dissatisfaction among some or all of the residents being relocated with regards to the location and provision of services.
- Opportunism, with some people selling new houses and returning to the affected area expecting to benefit a second time around.

Most of the 54 households interviewed indicated that they would prefer to be offered an alternative house than to receive financial compensation. When asked to list the services required at a new location, water and electricity connections and access to medical facilities and schools received the highest priority.
Residents in houses located in Av. Marien Ngouabi and Av. Guerra Popular indicated that

they would not be prepared to move unless they could be offered the exact same accommodation within easy access of their places of work, schools, medical facilities etc.

The residents of the two different sectors discussed above, differ on a fundamental level: Those living in the lower income areas approve of the road improvements even if it meant relocating, since they anticipated benefiting from improved houses and services, while flat residents disapprove as they fear losing the position and access to services that they current enjoy.

Expropriation and forced resettlement of residents to a prescribed location is an extremely sensitive undertaking which is in danger of infringing on the rights of individuals. All alternatives to resettlement should be explored in full before such a step is taken. These may include the redesign of traffic flow or the upgrading of traffic signals and improved policing. Only if all alternatives fall short of the desired mark and the widening of the road is proved to be in the best interests of the public at large, should resettlement be resorted to.

Regarding the impact of resettlement on two cases of Plan 4 Route (The restoration of Av. Juluis Nyerere along it original route) and Master Plan Route (The construction of a new section along Av. Juluis Nyerere), amount of families displaced are 394 in case of Plan 4 Route and 529 in case of Master Plan Route. The impact of resettlement in case of Plan 4 Route is smaller than one in case of Master Plan Route.

20.4.2 Air Pollution

(1) Estimation

1) General

Since exhaust gases from traffic vehicles will affect the air quality in residential areas, concentration of pollutants in the atmosphere has been estimated and assessed.

a) Estimated pollutants: Nitrogen dioxide (NO_2), Carbon monoxide (CO)

b) Target year: the year 2010

c) Condition of roads assumed for estimation

Table 20.4.2 Condition of Roads Assumed for Estimation

Name of Roads		Location (1)	Width (m)	1 of Lanes	Terrain Condition	Design Velocity (km/hr)	Pavement Condition
Trunk Roads	Missing Link on AV. Julius Nyerere	1	22	2	Flat	60	Asphalt
	Restoration of original AV. Julius Nyerere	2	22	2	Flat	60	Asphalt
	AV.Vladimir Lenine (S)	3	16	2	Flat	50	Asphalt
	AV.Vladimir Lenine (N)	4	16	2			
	AV. Acordos de Lusaka	5	28	4	Flat	60	Asphalt
	Av. Guerra Popular	6	20	4	Flat	50	Asphalt
	Av. de Angola (S)	7	20	2	Flat	50	Asphalt
	Av. de Angola (N)	8	20	2			
	Av. Marien Ngouabi (E)	9	20	4	Flat	50	Asphalt
	Av.Marien Ngouabi (W)	10	20	2	Flat	50	Asphalt
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	16	2	Flat	40	Asphalt
	Av. Martires de Inhaminga(Port Area Road)	12	16	2	Flat	30	Asphalt
Residential Area Roads	Av. Milagre Mabote	13	10	2	Flat	40	Concrete
	Av. Da Malhangalene	14	12	2	Flat	40	Concrete
	Av. Kaweme Nkrumah	15	14	2	Flat	40	Asphalt
	Rua dos Imaos Roby	16	12	2	Flat	40	Asphalt

d) Location

Location is selected as shown in Figure 20.4.1, allowing for land use of the areas along the proposed roads and traffic condition.

Figure 20.4.1 Location Subject to Estimation on Air Pollution, Noise and Vibration

2) Method of Estimation

The annual mean concentration of air pollutants caused by vehicle exhaust gases were estimated, using a diffusion equation, with the assumed height being as at 1.0 meter above the ground at the roadside. The calculation procedures are shown in Appendix 20.2.

a) Forecast formula

A plume model equation was employed for windy conditions (in case where the wind velocity exceeded 1 m/s), and a puff model equation was used for less windy conditions (in case where the wind velocity is below 1 m/s).

b) Determination of diffusion with

The diffusion width used for the calculation was determined in consideration of the stirring and mixing effects near to the road caused by passing motor vehicles, referring to Pasquill, Gifford and Turner's parameters.

c) Wind velocity

Wind velocity at the height of the exhaust source was estimated by the following equation using the wind velocity data obtained from weather observation records:

$$U = U_0 \left(\frac{H}{H_0} \right)^P ,$$

where:

U: Estimated wind velocity (m/s) at height H (m)

U_0:Wind velocity (m/s) at the reference height H_0 (m)

P: Exponent (0.333 for urban area was used)

d) Background concentration

A survey of concentration of pollutants was carried out at two points at Maputo city where the effect of exhaust gases from motor vehicles is considered to few. The measurement data were used as the background concentration values for the target year:

NO_2: 0.009 ppm, CO: 0.5 ppm (Note; ppm = parts per million, ml/m^3)

e) Traffic condition (see Appendix 20.2)

- Future hourly traffic volume of vehicle type for each cross section
- Average driving speed

Design speed of each road was employed as mean driving speed (Table 20.4.2).

- Coefficients of exhaust gases

Coefficients of exhaust gases indicated by the Ministry of Construction of Japan in 1983 were used.

f) Meteorological condition (see Appendix 20.2)

The hourly wind direction and velocity throughout the year based on the data observed in the year 2000 at Maputo city was used in the forecast of concentration of pollutants.

3) Result of Estimation

Table 20.4.3, 20.4.4 show the estimated concentration of NO_2 at 1.0 meter above the road ground and Table 20.4.5, 20.4.6 show the estimated concentration of CO.

Table 20.4.3 Estimated Concentration of NO_2 (daily mean, Plan 4 Route)

Name of Roads		Location 1	NO_2 Concentration (ppm)		
			Contributory Concentration	Background Concentration	Daily Mean
Trunk Roads	Restoration of orginal AV. Julius Nyerere	2	0.0094	0.0090	0.0184
	AV.Vladimir Lenine (S)	3	0.0084		0.0174
	AV.Vladimir Lenine (N)	4	0.0081		0.0171
	AV. Acordos de Lusaka	5	0.0082		0.0172
	Av. Guerra Popular	6	0.0100		0.0190
	Av. de Angola (S)	7	0.0098		0.0188
	Av. de Angola (N)	8	0.0065		0.0155
	Av. Marien Ngouabi (E)	9	0.0069		0.0159
	Av.Marien Ngouabi (W)	10	0.0069		0.0159
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	0.0080		0.0170
	Av. Martires de Inhaminga(Port Area Road)	12	0.0077		0.0167
Residential Area Roads	Av. Milagre Mabote	13	0.0071		0.0161
	Av. Da Malhangalene	14	0.0063		0.0153
	Av. Kaweme Nkrumah	15	0.0058		0.0148
	Rua dos Imaos Roby	16	0.0069		0.0159

Table 20.4.4 Estimated Concentration of NO_2 (daily mean, Master Plan Route)

Name of Roads		Location 1	NO_2 Concentration (ppm)		
			Contributory Concentration	Background Concentration	Daily Mean
Trunk Roads	Missing Link on AV. Julius Nyerere	1	0.0075	0.0090	0.0165
	AV.Vladimir Lenine (S)	3	0.0084		0.0174
	AV.Vladimir Lenine (N)	4	0.0081		0.0171
	AV. Acordos de Lusaka	5	0.0082		0.0172
	Av. Guerra Popular	6	0.0100		0.0190
	Av. de Angola (S)	7	0.0098		0.0188
	Av. de Angola (N)	8	0.0065		0.0155
	Av. Marien Ngouabi (E)	9	0.0069		0.0159
	Av.Marien Ngouabi (W)	10	0.0069		0.0159
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	0.0080		0.0170
	Av. Martires de Inhaminga(Port Area Road)	12	0.0077		0.0167
Residential Area Roads	Av. Milagre Mabote	13	0.0071		0.0161
	Av. Da Malhangalene	14	0.0063		0.0153
	Av. Kaweme Nkrumah	15	0.0058		0.0148
	Rua dos Imaos Roby	16	0.0069		0.0159

Table 20.4.5 Estimated Concentration of CO (daily mean, Plan 4 Route)

Name of Roads		Location [1]	CO Concentration (ppm)		
			Contributory Concentration	Background Concentration	Daily Mean
Trunk Roads	Restoration of orginal AV. Julius Nyerere	2	0.0531	0.5000	0.5531
	AV.Vladimir Lenine (S)	3	0.0478		0.5478
	AV.Vladimir Lenine (N)	4	0.0383		0.5383
	AV. Acordos de Lusaka	5	0.0331		0.5331
	Av. Guerra Popular	6	0.0694		0.5694
	Av. de Angola (S)	7	0.0634		0.5634
	Av. de Angola (N)	8	0.0236		0.5236
	Av. Marien Ngouabi (E)	9	0.0320		0.5320
	Av.Marien Ngouabi (W)	10	0.0287		0.5287
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	0.0387		0.5387
	Av. Martires de Inhaminga(Port Area Road)	12	0.0439		0.5439
Residential Area Roads	Av. Milagre Mabote	13	0.0412		0.5412
	Av. Da Malhangalene	14	0.0320		0.5320
	Av. Kaweme Nkrumah	15	0.0295		0.5295
	Rua dos Imaos Roby	16	0.0415		0.5415

Table 20.4.6 Estimated Concentration of CO (daily mean, Master Plan Route)

Name of Roads		Location [1]	CO Concentration (ppm)		
			Contributory Concentration	Background Concentration	Daily Mean
Trunk Roads	Missing Link on AV. Julius Nyerere	1	0.0313	0.5000	0.5313
	AV.Vladimir Lenine (S)	3	0.0478		0.5478
	AV.Vladimir Lenine (N)	4	0.0383		0.5383
	AV. Acordos de Lusaka	5	0.0331		0.5331
	Av. Guerra Popular	6	0.0694		0.5694
	Av. de Angola (S)	7	0.0634		0.5634
	Av. de Angola (N)	8	0.0236		0.5236
	Av. Marien Ngouabi (E)	9	0.0320		0.5320
	Av.Marien Ngouabi (W)	10	0.0287		0.5287
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	0.0387		0.5387
	Av. Martires de Inhaminga(Port Area Road)	12	0.0439		0.5439
Residential Area Roads	Av. Milagre Mabote	13	0.0412		0.5412
	Av. Da Malhangalene	14	0.0320		0.5320
	Av. Kaweme Nkrumah	15	0.0295		0.5295
	Rua dos Imaos Roby	16	0.0415		0.5415

(2) Assessment

1) Environmental Target

As Mozambique has not established own environmental quality standards on air pollution, the standards of WHO and developed country will be adopted. With regard to nitrogen dioxide, the environmental quality standards specified by WHO have been adopted as the environmental preservation targets in this study. For carbon monoxide, the Japanese environmental quality standards were used instead of WHO's, because the daily mean is not specified in the WHO standards. There are shown below.

Table 20.4.7 Environmental Preservation Target for Air Pollution

Pollutant	Target
Nitrogen dioxide (NO_2)	Daily mean of hourly concentration shall be less than 0.08 ppm
Carbon monoxide (CO)	Daily mean of hourly concentration shall be less than 10 ppm

2) Result of Assessment

The estimated concentration of NO_2 at all locations in two cases which are Plan 4 Route and Master Plan Route is less than 0.08 ppm, and CO at all locations in the two cases is less than 10 ppm. Comparing the estimated amounts with the environmental preservation target, it is revealed that they would meet the targets. Accordingly, the possible impacts of the exhaust gases from traffic vehicles would be minimal.

Regarding the two cases of Plan 4 Route and Master Plan Route, as the difference of forecasted traffic volumes in the future are very few, The estimated concentration of NO_2 and CO at all locations between the two cases are the same.

20.4.3 Noise

(1) Estimation

1) Method of Estimation (see Appendix 20.3)

Road traffic noise was estimated at 1.2 meters above the ground next to houses of roadside. Estimation was made within each time zone of daytime (06:00～22:00) and nighttime (22:00～06:00).

- Estimation equation

An estimation equation proposed by the Japan Acoustics Society was utilized in estimation the road traffic noise.

- Traffic condition

The hourly traffic volume, and mean vehicle speed used in the estimation are the same as those that were predetermined for estimating of the air pollution.

2) Results of Estimation

Table 20.4.8, 20.4.9 show the estimated road traffic noise for buildings along the roadside.

Table 20.4.8 Estimated Road Traffic Noise (Plan 4 Route)

Name of Roads		Location [1]	Estimated Noise Level L_{eq} (dB)	
			Daytime(06:00～22:00)	Nighttime(22:00～06:00)
Trunk Roads	Restoration of original AV. Julius Nyerere	2	63.9	55.4
	AV.Vladimir Lenine (S)	3	64.2	57.1
	AV.Vladimir Lenine (N)	4	63.8	55.8
	AV. Acordos de Lusaka	5	63.4	55.6
	Av. Guerra Popular	6	64.5	57.4
	Av. de Angola (S)	7	64.2	56.3
	Av. de Angola (N)	8	61.5	53.6
	Av. Marien Ngouabi (E)	9	63.6	55.2
	Av.Marien Ngouabi (W)	10	62.2	54.0
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	62.8	54.1
	Av. Martires de Inhaminga(Port Area Road)	12	62.4	53.9
Residential Area Roads	Av. Milagre Mabote	13	61.8	53.8
	Av. Da Malhangalene	14	60.8	52.1
	Av. Kaweme Nkrumah	15	60.1	51.9
	Rua dos Imaos Roby	16	62.3	53.7

Table 20.4.9 Estimated Road Traffic Noise (Master Plan Route)

Name of Roads		Location [1]	Estimated Noise Level L_{eq} (dB)	
			Daytime(06:00～22:00)	Nighttime(22:00～06:00)
Trunk Roads	Missing Link on AV. Julius Nyerere	1	63.0	54.5
	AV.Vladimir Lenine (S)	3	64.2	57.1
	AV.Vladimir Lenine (N)	4	63.8	55.8
	AV. Acordos de Lusaka	5	63.4	55.6
	Av. Guerra Popular	6	64.5	57.4
	Av. de Angola (S)	7	64.2	56.3
	Av. de Angola (N)	8	61.5	53.6
	Av. Marien Ngouabi (E)	9	63.6	55.2
	Av.Marien Ngouabi (W)	10	62.2	54.0
Collector Roads	Av. Josina Michel(Industrial and Commercial Area Road)	11	62.8	54.1
	Av. Martires de Inhaminga(Port Area Road)	12	62.4	53.9
Residential Area Roads	Av. Milagre Mabote	13	61.8	53.8
	Av. Da Malhangalene	14	60.8	52.1
	Av. Kaweme Nkrumah	15	60.1	51.9
	Rua dos Imaos Roby	16	62.3	53.7

(2) Assessment

1) Environmental Preservation Target

Environmental quality standards and regulation standards on noise have been established in developed countries including Japan, the United States and European nations. Referring to the environmental quality standards in Japan and in consideration of the present acoustic condition in Maputo, the environmental preservation target on noise have been determined as below.

Table 20.4.10 Environmental Preservation Target on Road Traffic Noise

Unit: dB

Area Classification	Daytime(06:00～22:00)	Nighttime(22:00～06:00)
Area facing a road with two or more lanes	Less than 65	Less than 60

2) Results of Assessment

The traffic noise at all locations in two cases which are Plan 4 Route and Master Plan Route was estimated to be less than 65 dB during the daytime and less than 58 dB during the nighttime. Therefore, It is revealed that they would meet the targets and the possible impacts of the traffic noise to the residents along the priority roads would be minimal.

As the difference of forecasted traffic volumes in the future are very few between the two cases, the estimated traffic noise at all locations between the two cases are the same.

20.4.4 Vibration

(1) Estimation

1) Method of Estimation (see Appendix 20.4)

Road traffic vibration was estimated at the ground level next to houses of roadside. Estimation was made at a specific hour when the vibration level reaches to the maximum within each time zone of daytime (06:00～22:00) and nighttime (22:00～06:00).

- Estimation equation

An estimation equation proposed by the Public Works Research Institute of the Ministry of Land, Infrastructure and Transport of Japan was utilized in estimation the road traffic vibration.

- Traffic condition

The hourly traffic volume, and mean vehicle speed used in the estimation are the same as those that were predetermined for estimating of noise.

2) Results of Estimation

Table 20.4.11, 20.4.12 show the estimated results of road traffic vibration for buildings along the roadside.

Table 20.4.11 Estimated Road Traffic Vibration (Plan 4 Route)

Name of Road	Location ( )	Estimated Vibration Level L_{10} (dB)	
		Daytime (6:00～22:00)	Nighttime (22:00～6:00)
Restoration of original Av. Julius Nyerere	2	43.9	40.7
Av.Vladimir Lenine (S)	3	43.6	41.1
Av.Vladimir Lenine (N)	4	43.2	40.7
Av. Acordos de Lusaka	5	42.8	40.9
Av. Guerra Popular	6	43.9	41.7
Av. de Angola (S)	7	43.9	42.3
Av. de Angola (N)	8	40.6	38.5
Av. Marien Ngouabi (E)	9	40.3	35.3
Av.Marien Ngouabi (W)	10	41.1	38.5
Av. Josina Michel	11	42.7	38.9
Av. Martires de Inhaminga	12	47.2	42.5
Av.Milagre Mabote	13	45.4	42.7
Av. Da Mahangalene	14	44.3	40.4
Av. Kwame Nkrumah	15	38.8	33.3
Rua dos Imaos Roby	16	40.6	37.6

Table 20.4.12 Estimated Road Traffic Vibration (Master Plan Route)

Name of Road	Location ( )	Estimated Vibration Level L_{10} (dB)	
		Daytime (6:00～22:00)	Nighttime (22:00～6:00)
Missing Link on Av. Julius Nyerere	1	42.2	38.5
Av.Vladimir Lenine (S)	3	43.6	41.1
Av.Vladimir Lenine (N)	4	43.2	40.7
Av. Acordos de Lusaka	5	42.8	40.9
Av. Guerra Popular	6	43.9	41.7
Av. de Angola (S)	7	43.9	42.3
Av. de Angola (N)	8	40.6	38.5
Av. Marien Ngouabi (E)	9	40.3	35.3
Av.Marien Ngouabi (W)	10	41.1	38.5
Av. Josina Michel	11	42.7	38.9
Av. Martires de Inhaminga	12	47.2	42.5
Av.Milagre Mabote	13	45.4	42.7
Av. Da Mahangalene	14	44.3	40.4
Av. Kwame Nkrumah	15	38.8	33.3
Rua dos Imaos Roby	16	40.6	37.6

(2) Assessment

1) Environmental Preservation Target

The environmental preservation target of the road traffic vibration were determined in reference to the road traffic vibration limit based on the Japanese" Vibration Regulation Law " as follows:

Table 20.4.13 Environmental Preservation Target on Road Traffic Vibration

Unit: dB

Area Classification	Daytime(06:00～22:00)	Nighttime(22:00～06:00)
Residential area	Less than 70	Less than 65

2) Results of Assessment

Since the estimated road traffic vibration for buildings at all locations in two cases which are Plan 4 Route and Master Plan Route was less than 48 dB both at daytime and at nighttime, this meets the environmental Preservation Target and, as such the impact of the traffic vibration to the residents along the proposed roads will be minimal. As the difference of forecasted traffic volumes in the future are very few between the two cases, the estimated road traffic vibration at all locations between the two cases are the same.

20.4.5 Geomorphology, Geology and Soils

Since the bulk of the project is comprised of repairing and upgrading of existing roads – most of which are currently or have at some stage been paved - the impact on the underlying geology and soils will be limited. The exception to this is the proposed new alignment of Julius Nyerere across the open plain below the Polana-Caniça quarter, where the negative impact on the topsoil and subsoil's directly affected by construction is likely to be significant. It is unlikely that the morphology of the site will be significantly affected as the slope will remain the same.

The construction of a storm water drainage system associated with each of the roads, as well as paving of the sidewalks will have a significant positive impact on the soils as it will reduce the likelihood of surface runoff and hence soil erosion.

The base coarse material required for reconstruction and upgrading of existing roads and construction of new alignments will likely be sourced at an existing hard rock quarry located some 50km inland of Maputo. Since the scope of this study did not extend to the sourcing of material, the impacts of this activity have not been assessed.

20.4.6 Flood Hazard

As a storm water drainage system associated with each of the roads will be constructed, a significant positive impact on reducing flood hazard would be anticipated.

20.4.7 Water Resources

The provision of an effective drainage system for the Maputo Municipal area is recognised as one of the most significant challenges facing the city. The condition of many of the roads currently earmarked for repair or upgrading is largely due to insufficient drainage during wet conditions.

Storm water drainage channels have been incorporated into the design of all of the routes earmarked for repair and upgrading, allowing for effective drainage of runoff from the paved surface away from the adjacent properties. The paving of the roads will minimise the risk of erosion and transport of sediments into the drains and thereby reduce the risk of drain siltation. This system is however at risk of further collapse if maintenance is neglected and the drains allowed to become silted or blocked with foreign material, such as solid waste.

It is likely that the construction of the new Julius Nyerere alignment in the low-lying areas to the east of the Polana-Caniço B quarter will have a negative impact on surface water movement of the southern extremity of the mangrove swamps. The impacts of development within this ecologically sensitive zone are discussed in detail in the following section.

The surface water quality may be affected by pollutants deposited on the surface of the pavement and washed off by the first intense rain following a dry period. The levels of pollutants are however not likely to be significant as the storm water from the roads will be diluted by general runoff from the area.

Groundwater is unlikely to be significantly affected by the proposed project, other than the possible lowing of the groundwater levels due to the effective drainage of surface water.

20.4.8 Protected or Ecologically Sensitive Zones

The majority of the roads targeted for improvement lie within the urban built-up environment which has been significantly altered from its original natural condition. The new section of construction of Av. Julius Nyerere lie the coastal plain.

The coastal plain, described above under Chapter 16 has been significantly impacted by existing developments such as the coastal road and the housing developments which have taken place on the primary dunes and on sections of the Mangrove swamps which have undergone reclamation. Vast tracts of mangrove forests have been cut level with the surface, and although there is evidence of regrowth, it is likely to take many decades of sound environmental management and protection before the forests re-establish completely. Even if such protection measures are possible, the nature and functioning of the area has been altered to such an extent by roads and residential developments, that the complete recovery of this ecosystem is no longer thought to be possible.

The potential impacts of road construction on the coastal plains are twofold: direct impacts due to construction of the road and obstruction of natural water flow, and indirect impacts resulting from the settlement of people alongside the road, which will invariably occur once the access route has been established.

While the direct impacts may be managed by minimising the area affected, rehabilitating the roadside and constructing the road to accommodate seasonal and tidal flow of water within the swamp, the indirect impacts as a result of settlement are more difficult to control.

The new route will be a major conduit into the business centre of Maputo and is therefore likely to attract the large volumes of traffic which are currently resulting in severe congestion on the alternative route of Ave. Vladimir Lenin. Without the proper control, the establishment of informal markets and settlements alongside the route is an inevitability.

20.4.9 Urban Environmental Quality

(1) Aesthetics (Street trees)

An inventory was made of all street trees located along each of the target roads, even though only those planted in sections of Av. Guerra Popular and Av. Marien Ngouabi designated for widening will be directly impacted. Although all trees are regarded as protected in terms of the City's bylaws, none of the trees are regarded as having an ecological or conservation

protection status. Allowance should simply be made for obtaining the necessary permits and re-establishing the street flora once construction has been concluded.

(2) Solid Wastes

Solid waste generated by the upgrading/construction of the target roads is likely to be limited to the following:

- Construction waste. I.e. old pavement surfaces, drainage pipes etc.
- Hydrocarbon spillage from road building machinery

Provided that all solid waste is disposed of at a designated area and any hazardous wastes handled responsibly according to recommendations provided in the following section, the impacts of solid waste disposal from road building is likely to be of low significance.

20.4.10 Social and Cultural Environment

(1) Provision of services and access to facilities

The upgrading of in particular the collection roads within the districts of Chamanculo, Xipamanine, Aeroporto and Maxaquene residential areas will have a positive impact on the provision of services such as public transport and waste collection. The municipal solid waste collection system currently only extends a regular service to the Central, Polana Cimento (Cement City) and Sommerschild Districts. Mounds of rotting waste lining the access roads is a feature of the more informal/unplanned sectors. Although perhaps not the only reason, the condition of the roads within these areas certainly contributes towards the lack of formal waste management. Without any alternative, many of the residents resort to disposing of their own waste in holes within their property.

In extreme conditions, collector roads within the districts of Chamanculo, Xipamanine, Aeroporto and Maxaquene may become impassable to even minibus taxis, thereby stranding residents without access to public transport. Improved surfaces (with bus stops) will facilitate more effective public transport and the incorporation of bus stops in the congested Av. Vladimir Lenin will relieve the flow of vehicles along this route significantly.

Improved access to more remote areas would facilitate the maintenance of water, electrical and communication lines before a disaster occurs. There is some danger that service lines, such as water pipeline, electricity and telecommunication lines and sewage pipes might be

impacted during construction, especially since there appears to be no detailed plans of the networks. This would result in a temporary disruption to services and should be avoided by careful exploration of the area prior to excavation.

Improved roads in many cases means easier and quicker access to markets, hospitals, schools and other facilities. Access to markets was stated as one of the most popular reasons for approval of the proposed upgrades in the household survey undertaken during the study.

(2) Health, safety and well-being.

Narrow, slippery roads, poor road surfaces and traffic congestion all contribute towards a significant safety hazard for pedestrians and motorists alike. According to the vehicle accident statistics, vehicle accidents were 2163 in Maputo in 1999 and 170 people died by the traffic accident. Vehicle collisions and accidents involving pedestrians appear to be a commonplace occurrence in Maputo. Road safety was highlighted as one of the major concerns raised by residents during the household survey.

The bottlenecking of traffic at the single lane section of Av. Guerra Popular - which is also a popular bus route - is the motivation for the proposed widening to two lanes. This was emphasised during the survey when a bus was observed side-swiping a parked car. Likewise, the improvements to Av. Marien Ngouabi will negate the dangerous staggered intersection in to Av. Mao Tse Tung.

The improvement of the road surfaces and widths, provisions of pedestrian sidewalks and proper drainage of the road will have a significantly positive impact on the safety and comfort of pedestrians and motorists following completion of construction.

Rerouting of traffic and the use of heavy machinery on busy routes during construction will need to be closely management and monitored to prevent accidents from occurring.
The provision of services such as regular waste collection will reduce the residents exposure to pathogens and vermin and hence their susceptibility to disease. Physiologically, people will benefit from a cleaner, safer and more organised environment.

(3) Impacts on cultural property

Although a number of monuments and museums were identified in the study (see Chapter 16) no cultural property will be negatively affected in the long term by the proposed upgrading of the target roads. Short-term impacts may involve limited obstruction of traffic to these

facilities.

20.4.11 Economic Environment

(1) Formal commercial activities

The short-term effects of upgrading roads within the districts of Chamanculo, Xipamanine, Aeroporto and Maxaquene will likely be negative as some of the businesses bordering the road are affected by the widening, and traffic flow through the area disrupted during construction. In the long-term – once construction has been completed – businesses stand to benefit from improved access. Many of the shop owners interviewed cited the condition of the road as one of the main reasons why they were battling financially: customers were simply not prepared to drive on the muddy, rutted roads.

Likewise, businesses located within the central and Polana Cimento Districts may experience some drop off in sales during road resurfacing activities as customers patronise other more accessible establishments. This is not anticipated to be highly significant as the roads located within the dense business areas – such as near the harbour – will only require resurfacing which is a relatively quick process.

Ultimately, these businesses will benefit from improved access to customers – particularly since many of the streets are currently rapidly deteriorating into a hazard for sedan vehicles.

The restoration of original Av. Julius Nyerere or construction of the new Section of Av. Julius Nyerere will likely benefit the Av. de Marginal as access to the area is improved and a throughflow of traffic created.

(2) Markets and informal commercial activities

This section applied to formal and informal markets situated throughout the project, in particular those located at Praça dos Combatentes, on Rua dos Irmaos Roby, Rua 2522 (Aeroporto B district) and Av. Emillia Dausse.

With the exception of the Market on Av. Emillia Dausse, improvements to the target roads will impact directly on these markets as stalls will need to be cleared in order to accommodate the new alignment. The most severe of these cases will occur at the Praça dos Combaterites market where the existing road has been completely obliterated by the market. Although many of these markets are regarded as informal or in some cases, illegal provision

will need to be made for an alternative site at a suitable location not too far removed from the original. As a result of the disruption, traders will likely experience a blow to their regular income, but this might be offset in the short-term by the presence of construction workers and increased buying power of labour employed locally on the road upgrade projects.

The long term impacts to this markets will likely be positive as newer, better planned facilities are provided and traffic flow in general increases in the area.

(3) Informal individual traders.

The traders being referred to under this category are the informal vendors who line the streets in the districts of Chamanculo, Xipamanine, Aeroporto and Maxaquene selling anything from vegetables and nuts to balloons and toothbrushes from outside their houses. In the short term, their business might be impacted negatively by construction as they are forced to remove themselves from the road. The long term impacts or benefits of the road improvement will be negligible as most of their business is likely to originate from the surrounding residents in any case.

(4) Industrial activities

Light industries located on Av. De Anglo, Av. De Lusaka and Av. de Mozambique are likely to be affected in a similar fashion to that described above for formal commercial activities.

(5) Employment opportunities

The short term impacts experienced by residents and businesses during construction will to a large extent be offset by improved employment opportunities and the resulting increase in customer buying power. This assumes that the contractor will be making use of labour intensive methods of construction, and employing unskilled labour on a district-by-district basis.

Although somewhat short-term, the employment of locally-based labour could have a significant knock-on effect throughout the different sectors of the district as families benefit from increased income and improved quality of life, and businesses from their increased buying power. Long-term benefits may arise out of the development of skills acquired while employed on the job, which effectively increase their chances of re-employment on other projects.

(6) Maputo economic growth environment

The entire economy of Maputo city stands to benefit from the improvements to the transportation network as proposed by the 2020 strategic plan. Not only will the improvements to the main feeder routes into the city and out to industrial and residential areas stimulate economic activity within Maputo, but the general upgrading of the cities infrastructure will improve the outlook for outside industrial and commercial investment.

The construction activity itself will have significant downstream impact into almost all sectors of the city's economy and society through the demand for human and material resources and services. These benefits may be maximised by employing a policy of using local labour and suppliers where possible.

20.4.12 Conclusion

A number of potential impacts and benefits have been identified in the above discussions. Most of the impacts are short term and the benefits are long term.

In viewing the entire project, the benefits to the community of Maputo in terms of improving access, increasing road safety and public transport systems and reducing dust levels, need to be balanced against the social impacts of having to relocate a number of affected households to alternative premises. The process of expropriation should be approached with fairness, transparency and sensitively only once all other alternatives have been fully investigated.

Regarding to the air pollution of NO_2 and CO, noise and vibration, the estimated results for buildings at all locations meet the environmental Preservation Target, therefore, the impact on air pollution, noise and vibration to the residents along the proposed roads will be minimal.

The benefits which are likely to accrue to the community should be maximised by employing labour-intensive construction methods, providing job opportunities for local residents and making use of local suppliers where possible. Furthermore, the community should be consulted and involved in aspects of the design of the roads, such as the placement of bus stops, speed humps or pedestrian crossings.

There are Plan 4 Route (Av. Julius Nyerere On line) and Master Plan Route (Av. Julius Nyerere Off line) to provide an alternative plan in this study. In the case of Master Plan Route, there should be necessity to design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps. In the case of Plan 4 Route, as roadside buffer

belt are anticipated to form along Av. Juluis Nyerere of its original route, the environmental impacts to houses of roadside on air pollution, noise and vibration will be improved by the restoration of Av. Julius Nyerere.

About the impact of resettlement on the two plans, amounts of families displaced are 251 in the case of Plan 4 Route and 352 in the case of Master Plan Route. The impact of resettlement in the case of Plan 4 Route is smaller than one in the case of Master Plan Route.

Table 20.4.14 shows the result of the total environmental impact assessment of the road development alternatives and the Plan 4 Route is recommended as the benefit is larger and the impact is smaller on social, natural environment and urban environment quality for the high priority road development projects.

Table 20.4.14 Result of the total environmental impact assessment

Affected environment	Indicator	Plan 4 Route (Av. Julius Nyerere On line)		Master Plan Route (Av. Julius Nyerere Off line)	
		Impact	Benefit	Impact	Benefit
1.Resettlement of residents	No. of families displaced	M	---	H	---
2.Air pollution					
2.1 Construction activities	Dust generated	M	---	M	---
2.2 During Operation Phase	Raising speed of vehicles and formation of roadside buffer belt	---	M	---	L
3.Noise					
3.1 Construction activities	Dust generated	M	---	M	---
3.2 During Operation Phase	Raising speed of vehicles and formation of roadside buffer belt	---	M	---	L
4.Vibration					
4.1 Construction activities	Dust generated	M	---	M	---
4.2 During Operation Phase	Raising speed of vehicles and formation of roadside buffer belt	---	M	---	L
5.Geomorphology, geology and soils	Soil (erosion)	---	M	M	---
6.Flood hazard	Flood hazard	---	H	---	H
7.Water resources	Natural surface water flow within the coastal area	---	---	M	---
8. Protected sensitive	Swamps	---	---	M	---
9. Urban environmental quality					
9.1 Street trees	Street trees	L	---	L	---
9.2 Soild waste	Construction activities	M	---	M	---
10.Social and cultural environment					
10.1 Provision of services and access to facilities	Public transport, waste collection services and access to public facilities	---	H	---	H
10.2 Health, safety and Well Being	Health, safety and Well Being	---	H	---	H
11. Economic environment					
11.1 Formal commercial activities	Short term	M	---	M	---
	Long term	---	H	---	H
11.2 Markets and informal commercial activities	Short term	M	---	M	---
	Long term	---	H	---	H
11.3 Informal individual traders	Short term	---	M	---	M
11.4 Industrial activities	Upgrade of target roads	---	H	---	H
11.5 Employment opportunities	Employment of unskilled labour	---	M	---	M
11.6 Maputo economic growth environment	Upgrade of all target roads	---	H	---	H
Total evaluation		L	VH	M	H

VH = Very high, H = High, M = Medium, L = Light, --- = No impact

20.5 RECOMMENDATION OF MITIGATION MEASURES

The objective of this section is to present recommendations for how the negative impacts identified in the previous section may be mitigated, and the benefits maximised. Summaries of the mitigation measures concerning the possible environmental impacts during the project implementation and responsible body considered are presented in Table 20.5.1.

Table 20.5.1 Summary of Mitigation Measures on Environmental Impact and Responsible Body

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positiv	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.1 Resettlement of Residents							
	Resettlement of residents within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts due to road widening	The social impacts of removal and resettlement of residents located alongside the target roads within these districts.	N	-To establish a rule on compensation for resettlement by the government.	○	--	--
				-To explore alternative options to resettlement	○	--	--
				-To undertake a complete inventory and assessment of each affected property	○	△	--
				-To undertake an investigation for a suitable alternative location for displaced families	○	--	--
20.5.2 Air Pollution							
	Construction activities	Dust generated	N	-To provide a water sprinkling system at the construction site	--	--	○
	Raising speed of vehicle due to improvement of roads	Exhaust gas caused by vehicle traffic	P	-To establish National standard regarding air quality, emission of vehicle exhaust gas quantity and quality	○	--	--
				-To introduce an obligatory car inspection system	○	--	--
				-To improve traffic flow	○	--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.3 Noise							
	Construction activities	Noise generated by construction activities and diversion of traffic to accommodate construction	N	-Construction activities to be limited to normal working hours only	--	--	○
	Improved road conditions following construction	Noise generated by improved road conditions following construction.	P	-To introduce obligatory systems for equipping muffler devices with adequate quality controlled by a technical standard and a muted horn with a national standard on every vehicle. -Conversion of land use from residential to commercial in urban area	○ ○	-- --	-- --
20.5.4 Vibration							
	Construction activities	Vibration generated by construction activities and diversion of traffic to accommodate construction	N	-Construction activities to be limited to normal working hours only	--	--	○
	Improved road conditions following construction	Vibration generated by improved road conditions following construction.	P	-To manage the maintenance of road pavement	○	--	--
20.5.5 Geomorphology, Geology and Soils							
	Construction of New Section on JN	The impact of construction activities on the soils of the low-lying coastal areas and mangrove swamps in the Costa de Sol District	N	-All topsoil and subsoil removed during construction activities should be stockpiled in such a manner as to maintain its viability and protected against erosion.	--	--	○

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.6 Flood Hazard							
	Construction of New Section on JN Upgrading of target roads and construction of stormwater drains	The impact of flood hazard due to stormwater	P	-To design and construct new drainage systems which have enough capacity	--	○	○
20.5.7 Water Resources							
	Construction of New Section on JN.	The impact of construction activities on the natural surface water flow and quality within the Low-lying coastal areas and Mangroves.	N	-To take precautions to ensure that neighbouring residences are not impacted by stormwater runoff from the road during construction	△	--	○
				-To allow for the unimpeded flow of tidal and seasonal waters within the swamps	--	○	--
20.5.8 Protected or ecologically sensitive zones							
Swamps	Construction of New Section on JN.	The impact of road construction on the ecological functioning of the swamps in the Costa de Sol District: Direct impact of construction.	N	-To limit every activity within this region as small an area as possible	--	○	○
				-To design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps	--	○	--
				-To make a financial provision for the remediation of sensitive areas damaged during construction	○	--	--
		The impact on the ecological functioning of the swamps in the District: Indirect impact of introducing new settlements to area	N	-To control strictly inflow of new settlements to this area	○	--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positiv	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.9 Urban Environmental Quality							
(1) Aesthetics (Street trees)	The upgrading, improvement of target roads within the Central Districts	The impact of resurfacing and upgrading target roads on street trees		-All trees not directly affected by construction activities, should nevertheless be protected against accidental damage.	--	○	--
	The widening of the roads Av. GP and Av. MN	The impact of road widening on street trees	N	-To acquire permits for all trees which will be removed during construction activities	○	--	--
				-To make financial provision for the replacement of all trees removed during construction	○	--	△
(2) Solid Waste	Construction activities	The impact of solid waste and hazardous waste generated during construction on the environment	N	-To dispose of all solid waste produced during construction at the municipal landfill site north of Maputo	--	--	○
20.5.10 Social and Cultural Environments							
(1)Social and cultural environment: Provision of services and access to facilities	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on Public Transport	P	-Allowance to be made for formal bus stops on collector roads.	--	○	--
		Impact on waste collection services	P	-To devise a waste collection strategy for areas currently not serviced by the municipal trucks	○	--	--
		Impact on supply and maintenance of services	P	-To identify the location of pipelines and cables supplying services to the area prior to initiating construction activities in order to minimise the chance of interference	--	○	○
		Impact on access to markets, hospitals, schools and other	P				
	Construction of New section of JN and restoration of original JN	Impact on access to markets, hospitals, schools and other facilities	P				
	Upgrade of target roads within Central District	Impact on access to markets, hospitals, schools and other facilities	P				

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positiv	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
(2) Health, Safety and Well Being	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on pedestrian and motorist safety	P	-Safe pedestrian crossing points to be provided opposite school, markets, churches, bus terminals etc	--	○	--
		Impact on Residents health by improving access to waste collection trucks and provision of effective drainage.	P				
	Widening of GP and MN	Impact on pedestrian and motorist safety	P				
	Construction activities	The impact of construction activities on motorist and pedestrian safety.	N	-A safety officer to be appointed at each construction site.	○	--	○
				-Effective traffic control and monitoring to be provided at construction sites and along detours.	○	--	○
(3)Cultural Environment	Upgrading, improvement and resurfacing of roads within the Central District	The impact of road reconstruction and repair activities on cultural properties.		-To maintain access to cultural sites during construction	○	--	○
				-To make provision for adequate parking in close vicinity to cultural sites	○	--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.11 Economic environment							
(1)Formal commercial activities	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on businesses located along target roads.	N	-To restrict to disruption of access to businesses during road resurfacing activities as a short period as possible	--	--	○
	Upgrading of roads within the Central District	The short term impacts of construction activities on businesses located along target roads.	N	-To restrict to disruption of access to businesses during road resurfacing activities as a short period as possible	--	--	○
(2)Markets and informal commercial activities	Construction of the new JN section, Upgrading of roads within Minkadjuine and aeroporto districts	Short term impact on the Praca dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	N	-To provide an alternative location for all markets displaced by the road upgrading/construction activities	○	--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
(3)Informal individual traders (ie tomatoe, cashew nut etc vendors)	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on vendors located along target roads.	P	-To make allowance on sidewalks and pavements to accommodate informal vendors	○	--	--
(4)Industrial activities	Upgrade of target roads	The impact of road upgrades on light and heavy industries located along target roads	P	-To restrict disruption of access to businesses during road resurfacing activities to as short a period as possible	--	--	○
(5)Employment opportunities	Employment of Unskilled labour	The impact of employment of social upliftment and increase spending power	P	-Labour intensive means of construction should be applied. -Unskilled labour should be sourced from the district in which the construction is being undertaken.	○ ○	-- --	○ ○
(6)Maputo economic growth environment	Upgrade of all target roads according to 2020 plan	The impact of road upgrades on general economic growth in Maputo.	P	-A policy of using local suppliers of goods and services should be applied where ever possible.	○	--	--

20.5.1 Resettlement of Residents

- There should be necessity to establish a rule on compensation for resettlement by the government.

- Alternative options to resettlement should be explored before a final decision to proceed with expropriation and relocation is effected.

- A complete inventory and assessment of each affected property be undertaken prior to establishing the cost of compensation.

- An investigation for a suitable alternative location for displaced families should be undertaken. This should fulfil the requirements of the affected parties, within reason, – such as access to places of work, markets, public transport, medical facilities, schools and provision of services such as water, electricity, sewage and telecommunications.

- Expropriation and resettlement process to be undertaken in an open and participatory manner involving all stakeholders.

20.5.2 Air Pollution

(1) During Construction Period

- The levels of dust generated during construction should be monitored and dust suppression by regular wetting of the road surface practiced, where this is deemed to reach levels of discomfort.

- In addition, dust covers may be required over the beds of trucks that will be used for transportation of materials.

(2) During Operation Phase

- Establishment of a national standard regarding air quality, emission of vehicle exhausts gas quantity and quality.

- Introduction of an obligatory car inspection system.

- Improvement of traffic flow: Improvement of speed and control of starting and stopping is

expected to reduce the concentration of exhaust gas from vehicles.

- To build up a public traffic system, and convert car use to public traffic use.

20.5.3 Noise

(1) During Construction Period

- Construction activities should be limited to normal working hours only.

(2) During Operation Phase

- Introduction of obligatory systems for equipping muffler devices with adequate quality controlled by a technical standard and a muted horn with a national standard on every vehicle will be principal measures for mitigating road noise.

- Conversion of land use from residential to commercial in urban area will also be effective.

20.5.4 Vibration

(1) During Construction Period

- Construction activities should be limited to normal working hours only.

(2) During Operation Phase

The management for maintenance of road pavement that keep the surface of roads in smooth will be principal measures for mitigation vibration.

20.5.5 Geomorphology, Geology and Soils

- All topsoil and subsoil removed during construction activities will be stockpiled in such a manner as to maintain its viability and protected against erosion until such time that it can be used for rehabilitation of road verges, construction camps and other areas disturbed during construction.

- An awareness programme should be undertaken to inform local residents of maintenance of open stormwater drains, and the consequence of their blockage. Monitors should be

appointed to ensure that the drains remain free of debris. Regular monitoring by council officials should be undertaken.

20.5.6 Flood Hazard

There should be necessity to design and construct new storm drainage system which have enough capacity.

20.5.7 Water Resources

- Precautions should be taken to ensure that neighbouring residences are not impacted by stormwater runoff from the road during construction. Temporary side drains should be constructed to divert runoff away from houses until such time as the concrete u-shaped drains have been completed.

- The design of the Julius Nyerere extension should allow for the unimpeded flow of tidal and seasonal waters within the swamps.

20.5.8 Protected or Ecologically Sensitive zones

- Any activity within this region should be limited to as small an area as possible.

- There should be necessity to design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps.

- Financial provision should be made for the remediation of sensitive areas damaged during construction.

- Inflow of new settlements to this region should be limited strictly.

20.5.9 Urban Environmental Quality

(1) Aesthetics (Street trees)

- Permits should be acquired for all trees which will be removed during construction activities.

- Financial provision should be made for the replacement of all trees removed during

construction.

- All other trees not directly affected by construction activities, should nevertheless be protected against accidental damage.

(2) Solid waste

- All solid waste produced during construction to be disposed of at the municipal landfill site north of Maputo.

20.5.10 Social and Cultural Environments

(1) Provision of services and access to facilities

- Allowance to be made for formal bus-stops on collector roads.

- A waste collection strategy to be devised for areas currently not serviced by the municipal trucks. Existing refuse heaps to be cleaned up and removed to the landfill site.

- The location of pipelines and cables supplying services to the area should be identified prior to initiating construction activities in order to minimise the chance of interference.

(2) Health, Safety and Well-being

- A safety officer to be appointed at each construction site.

- Effective traffic control and monitoring to be provided at construction sites and along detours.

- Safe pedestrian crossing points to be provided opposite schools, markets, churches, bus terminals etc. The community should be consulted as to the placement of bus stops, pedestrian crossings and speed humps.

(3) Cultural Environment

- Access to cultural sites should be maintained during construction.

- Provision should be made for adequate parking in close vicinity to cultural sites.

20.5.11 Economic Environment

(1) Formal commercial activities.

- Disruption of access to businesses during road resurfacing activities should be restricted to as short a period as possible.

(2) Markets and informal commercial activities

- An alternative location should be provided for all markets displaced by the road upgrading/construction activities. This should be in the same vicinity as the last so as not to affect sales or inconvenience consumers.

(3) Informal individual traders

- Allowance should be made on sidewalks and pavements to accommodate informal vendors.

(4) Industrial activities

- Disruption of access to businesses during road resurfacing activities should be restricted to as short a period as possible.

(5) Employment opportunities

- Labour intensive means of construction should be applied.

- Unskilled labour should be sourced from the district in which the construction is being undertaken.

- A skills training programme should be initiated among unskilled labour.

(6) Maputo economic environment

- A policy of using local suppliers of goods and services should be applied where ever possible

20.6 CONCLUSIONS

The investigation has revealed the benefits and impacts on socio-economic, natural environment and urban environment quality associated with the proposed upgrading of the target roads within the city of Maputo.

In summary, the environmental impact assessment shows that the impact of the project on the roadside environment and the surrounding areas will be less than the allowable level for the assessed items and it will be possible to maintain the quality of the environment at an appropriate level. To mitigate the negative impacts and maximise the benefits, possible measures to deal with all of the environmental issues in the future are recommended to ensure that the city of Maputo will be with the favourable urban environment being created.

The followings summarize the results of the assessment and recommendation on main 5 items:

(1) Resettlement of residents

The upgrading of the roads within the residential of Chamanculo, Xipamanine, Aeroporto, Maxaquene, Polana-Canico and other districts is something of a double-edged sword: while the general population stands to benefit from improved access to schools, markets, public transport and customers - not to mention safer conditions for pedestrians and motorists and a healthier living environment - residents directly affected by the road widening stand to be displaced and resettled elsewhere. The impact that expropriation and relocation may have on the social fabric of communities and families, especially when there is a history of displacement due to wars and floods, cannot be underestimated.

Therefore, it is necessary to recommend mitigation measures. In the road development plan of the priority project, the alignment of each road has been carefully examined so as to keep the resettlement of the residents necessitated by the road construction and widening to a minimum. However, it is found that 251 families in the case of Plan 4 Route (Av. Julius Nyerere On line) and 351 families in the case of Master Plan Route (Av. Julius Nyerere Off line) need to be removed before the improvement of roads. Various problems involved in the resettlement of the residents will probably be resolved by taking mitigation measures against social and economic impacts of the resettlement. The mitigation measures are concluded as following:

- Resettlement should be approached with transparency and equality, upholding the rights of

the individual as entrenched in the country's constitution.

- There should be necessity to establish a rule on compensation for resettlement by the government.

- Alternative options to resettlement should be explored before a final decision to proceed with expropriation and relocation is effected.

- A complete inventory and assessment of each affected property be undertaken prior to establishing the cost of compensation.

- An investigation for a suitable alternative location for displaced families should be undertaken. This should fulfil the requirements of the affected parties, within reason, – such as access to places of work, markets, public transport, medical facilities, schools and provision of services such as water, electricity, sewage and telecommunications.

(2) Air pollution

It is predicted that the atmospheric environment along the roads will become much worse as the population and the number of motor vehicles increases, unless the present road network and conditions are improved. After the roads are widened and improved as a result of the road development plan, the atmospheric environment will be improved due to raising speed of vehicles and elimination of traffic congestion. Also, at areas along the unpaved roads where the air quality is currently not well due to dust from the roads, the atmospheric environment will be improved.

According to the result of the estimation, the atmospheric environment along the principle roads meets the environmental preservation target.

However, in order to maintain a nice atmospheric environment in the city, following necessary preventative measures should be taken in the near future:

- Establishing an air pollution control law.

- Establishing a national standard regarding air quality, emission of vehicle exhausts gas quantity and quality.

- Introducing periodic and obligatory car inspection system.

- Build up a public traffic system, and converting car use to public traffic use.

(3) Noise and Vibration

According to the result of the estimation, noise and vibration from motor vehicles meet the environmental preservation target. Thus, it will be possible to preserve the living environment of the residents along the roads.

However, in order to achieve a comfortable urban environment in the city, following necessary preventative measures should be taken in the near future:

- In Mozambique, it is necessary to establish regulations for controlling noise and vibration in the principle cities including Maputo.

- Introduction of obligatory systems for equipping muffler devices with adequate quality controlled by a technical standard and a muted horn with a national standard on every vehicle will be principal measures for mitigating road noise.

- Conversion of land use from residential to commercial in urban area will also be effective.

- The management for maintenance of road pavement that keep the surface of roads in smooth will be principal measures for mitigation vibration.

(4) Flood hazard

At some of places where overflow on roads is currently observed due to damaged road surfaces and insufficient drainage arrangements, the overflow on roads will be eliminated after the road surface is improved and drainage systems are designed and installed as a part of the project.

However, as the coverage of the system is limited and its function is degraded because of insufficient maintenance, it is necessary to accelerate improvement of the rainwater drainage system and to conduct proper maintenance regularly.

(5) Ecological sensitive zones

In the case of Master Plan Route, the new section of construction of Av. Julius Nyerere is located the coastal plain where is near a part of ecological area.

As explained before, the potential impacts of road construction on the coastal plains are twofold: direct impacts due to construction of the road and obstruction of natural water flow, and indirect impacts resulting from the settlement of people alongside the road, which will invariably occur once the access route has been established.

To mitigate the impacts, mitigation measures are proposed as followings:

- Selecting other alternative route that is not located the coastal plain.

- Any activity within this region should be limited to as small an area as possible.

- There should be necessity to design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps.

- Financial provision should be made for the remediation of sensitive areas damaged during construction.

- Inflow of new settlements to this region should be limited strictly.

CHAPTER 21

IMPLEMENTATION PLAN

CHAPTER 21 : IMPLEMENTATION PLAN

21.1 GENERAL

In this chapter, the basic aspects including executing agency, construction period, construction packages, preparatory works, implementation schedule and investment plan to be applied for the proposed roads have been studied.

21.2 EXECUTING AGENCY

The Directorate of Roads and Bridges, the Municipal Council of Maputo is the government agency responsible for the execution of the implementation of the Project. And National Roads Administration is also the executing agency for supporting the Municipal Council of Maputo.

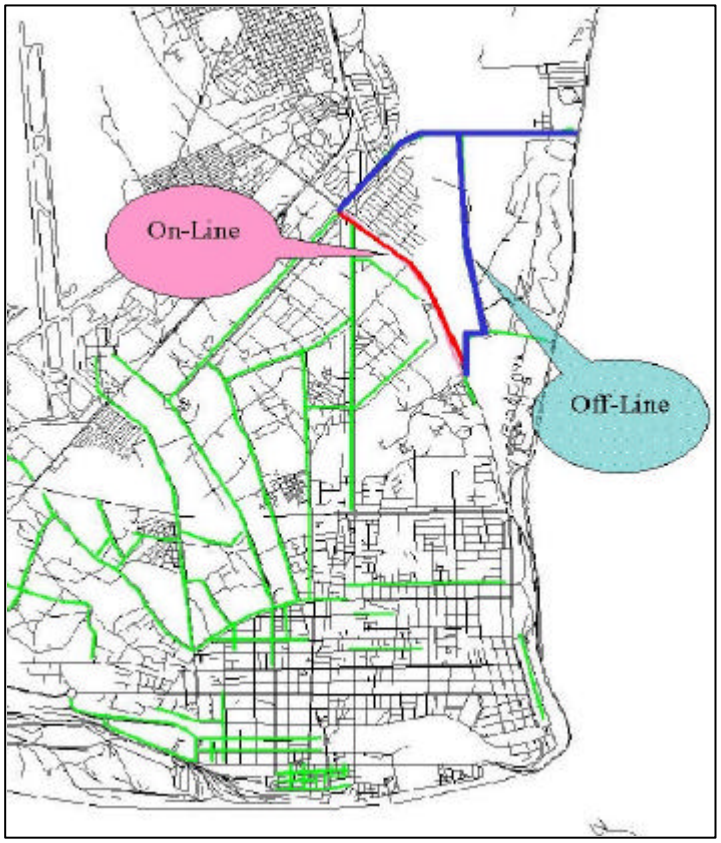
The required land/house acquisitions and compensations as well as the relocations of utilities shall be undertaken by the said agency prior to the commencement of the Project.

21.3 PROJECT PACKAGING

21.3.1 Selection of the best alternative route of Av. Julius Nyerere

Before setting implementation schedule of the projects, the first critical question that should be solved is the selection of the best route of Av. J. Nyerere. Since it is expected to play an important role of the road network of Maputo, draft economic analysis is primarily conducted on the two alternative routes of Av. J. Nyerere, and then the road network with the best alternative route of Av. J. Nyerere shall be the final set of the F/S projects.

The two alternative routes of Av. J. Nyerere are described in Figure 21.3.1.



Source: JICA Study Team

Figure 21.3.1 Alternative routes of Av. J. Nyerere

One alternative named "On-line" is rehabilitation of the original route of Av. J. Nyerere (Plan 4), while the other is called "Off-line" which construct a number of detours to compensate the missing links (Master Plan Route).

The two alternative routes of Av. J. Nyerere have been thoroughly described in the chapter (18), thus here is just presenting the costs and benefits accrued from the two alternatives with different routes of Av. J. Nyerere as shown in Table 21.3.1.

Table 21.3.1 Comparison of Two Alternative Routes (Year: 2021)

Alternatives	Construction Cost for J.N. Road	Total Cost	IRR	B/C	NPV
JN. Off-Line	5.05 mil. USD	35.5 mil. USD	29.8%	2.97	54.6 mil. USD
JN. On-Line	15.8 mil. USD	48.4 mil. USD	27.4%	2.70	63.6 mil. USD

Source: JICA study team

It is obvious that the Off-Line is the better alternative route, because the initial cost is cheaper than On-line. Although NPV of Off-Line is less than On-line, IRR and B/C is much better than On-Line. Furthermore the construction of On-Line is very difficult for drainage work and slope protection against heavy rain such as February 2000. Therefore the favorite route of the missing link of Av. J. Nyerere should select Off-Line.

21.3.2 Project Packaging

In order to implement the construction works practically for the road rehabilitation and the road related facilities, a drainage work becomes one of the key elements of the project implementation.

Based on the proposed drainage systems for each storm water basin, those have been studied in Chapter 12 and 18 Clause 12.2 and 18.7, each component of the Feasibility Study Projects has been combined into Packages.

As the results, the Project has been categorized following four (4) items and the location is shown in Figure 21.3.2:

- **Package A: Road and Public Transportation Projects in Polana-Canico area (total length=19.6km)**

This package consists of the new construction of the missing link of Av. J. Nyerere(L=5.6 km), the improvement of Av. V. Lenine, the Improvement of Av. Acordos Lusaka (L=2.8km), the construction of the Bus terminal at the Combatentes Plaza and the rehabilitation of pavement and drainage on District 3 Area Roads (total length =9.5 km).

- **Package B: Road, Public Transportation and Traffic Management Projects in Maxaquene, Malhangalene, Mahalala, Urbanizacao, Munhuana, Xipamanine,**

Chamanculo and Central area (total length=16.5km)

This package consists of the Widening of Av. Guerra Popular (L=0.7km), the Improvement of Av. Angola (L=3.1km) and Rua S. Cabral/Largo de Deta (L=0.6km), the Improvement and widening of Av. Marien Ngouabi (L=1.9km), the rehabilitation of pavement and drainage on District 2 Area Roads (total length = 10.2 km) and the Improvement of Intersections in the CBD (14 intersections).

- **Package C: Road and Public Transportation Projects in Altmae, Central, Polana-Cimento, Coop and Sommerschield area (total length=18.6km)**

This package consists of the rehabilitation of pavement and drainage on Industrial and Commercial Area Roads (total length= 6.03 km), Port Area Roads (total length =3.9 km), District 1 Area Roads (total length = 8.7 km) and the Improvement of Bus Bays and Bus terminal (23 numbers).

- **Package D for Structure Strengthening of Road Maintenance Organization**

21.4 CONSTRUCTION PERIOD OF EACH PROJECT PACKAGING

The construction period for each project package was estimated taking into account the work volume, site conditions, weather conditions, right-of-way situation, etc. The roads have been divided into five categories, described as follows:

1. **Package A: Road and Public Transportation Projects in Polana-Canico area (total length=19.6km)**

   These consist of the new construction of the missing link of Av. J. Nyerere, the improvement of Av. V. Lenine, the improvement of Av. Acordos Lusaka, the construction of the Bus terminal at the Combatentes Plaza and the rehabilitation of pavement and drainage on District 3 Area Roads having a total length of approximate 19.6 km. The estimated construction period for this work is 2 years.

2. **Package B: Road, Public Transportation and Traffic Management Projects in Maxaquene, Malhangalene, Mahalala, Urbanizacao, Munhuana, Xipamanine, Chamanculo and Central area (total length=16.5km)**

   This package consists of the Widening of Av. Guerra Popular, the Improvement of Av. Angola and Rua S. Cabral/Largo de Deta the Improvement and widening of Av.

Marien Ngouabi, the rehabilitation of pavement and drainage on District 2 Area Roads and the Improvement of Intersections in the CBD having total length of 16.5 km. The estimated construction period for this work is 1.5 years.

3. **Package C: Road and Public Transportation Projects in Altmae, Central, Polana-Cimento, Coop and Sommerschield area (total length=18.6km)**:
   This package consists of the rehabilitation of pavement and drainage on Industrial and Commercial Area Roads, Port Area Roads, District 1 Area Roads and the Improvement of Bus Bays and Bus terminal having a total length of 18.6 km. The estimated construction period for this work is 1 year.

4. **Package D for Structure Strengthening of Road Maintenance Organization**
   This package consists of the training and guidance of the new road maintenance system, the procurements of training and maintenance equipments and the construction of training room. The period of the training and the guidance will be 2 years during the implementation of the project packages.

21.5 PREPARATORY WORKS

The preparatory work is the required works to be implemented before the commencement of the project packages consisting of the land acquisition, the house compensation, the relocation utilities and the Engineering services. The required period of this works is 1.5 year.

21.6 IMPLEMENTATION SCHEDULE

The implementation schedule was set up taking into consideration the construction period estimated above for each project package, annual project cost, ease of implementation from the viewpoint of land/house acquisition, etc.

The recommended overall implementation schedule for each package as follow:

Package A: Road and Public Transportation Projects in Polana-Canico area (total length=17.1km)

- **2 years**

Package B: Road, Public Transportation and Traffic Management Projects in Maxaquene, Malhangalene, Mahalala, Urbanizacao, Munhuana, Xipamanine, Chamanculo and Central area (total length=16.5km)

- **1.5 years**

Package C: Road and Public Transportation Projects in Altmae, Central, Polana-Cimento, Coop and Sommerschield area (total length=18.6km)

- **1 year**

Package D: Structure Strengthening of Road Maintenance Organization

- **2 years**

The recommended implementation schedule is presented in Figure 21.6.1

21.7 INVESTMENT PROGRAMME

The investment program of the Project has been made on the basis of the implementation schedule. Table 21.7.1 shows the tentative investment program for the proposed road, traffic management, public transportation and structural strengthening projects.

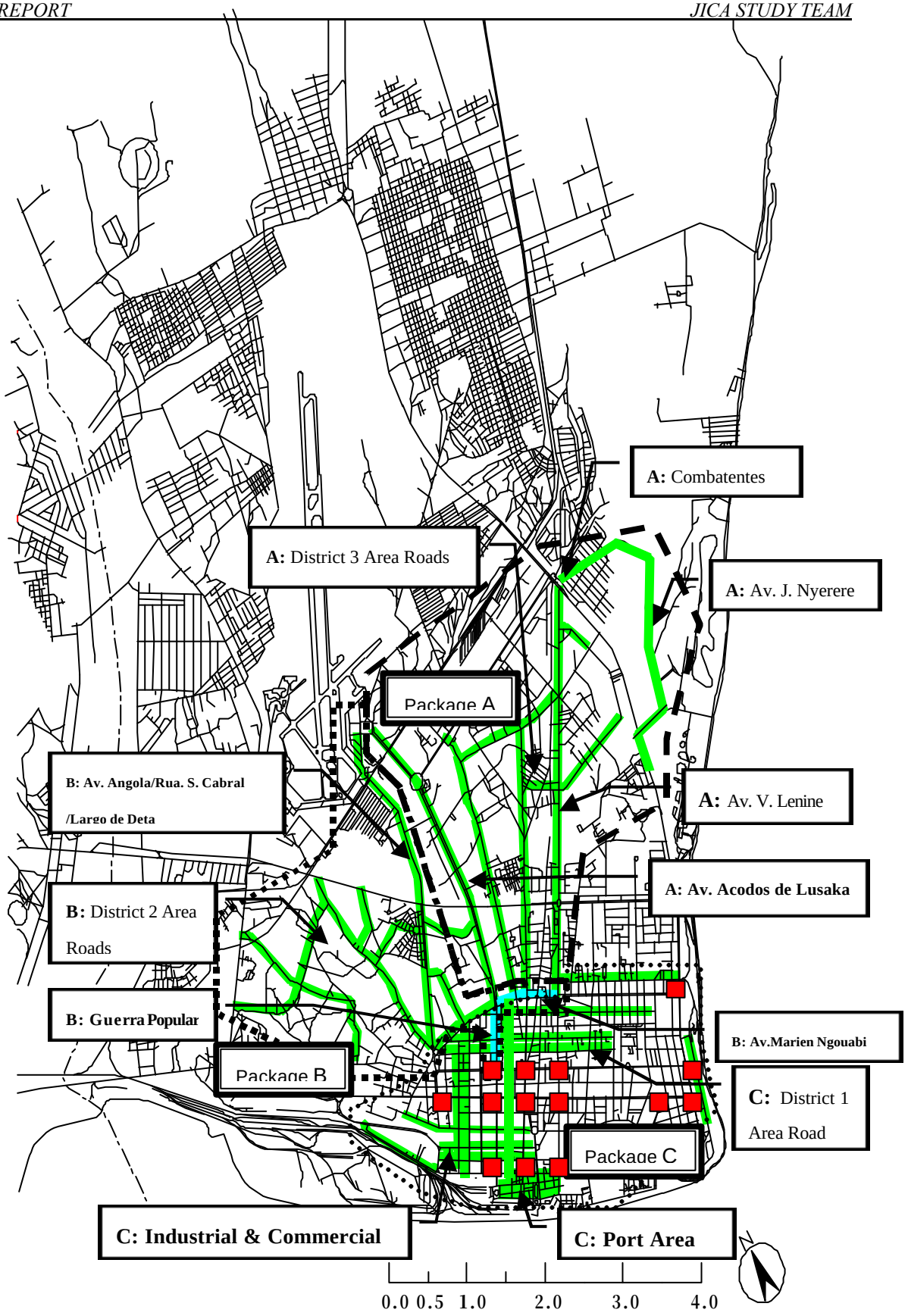


Figure 21.7.1 Project Packaging

Package No.	Proposed Facilities to be Implemented	Project Road Length (km)	High Priority Projects to be implemented in the Short-term Plan					
			1 st. year	2nd. year	3rd. Year	4th. Year	5th. year	
			2002	2003	2004	2005	2006	2007
Preparatory Works	Land Acquisition, House Compensation, Relocation of Utilities, Engineering Services	----						
Package A	Road and Public transportation Projects in Polana-Canico area	19.6						
Package B	Road, Public Transportation and Traffic Management Projects in Altmae, Central, Polana-Cimento, Coop and Sommerschield area	16.5						
Package C	Road and Public transportation Projects in Altomae and Polana-Cimento area	18.6						
Package D	Structure Strengthening of Road Maintenance Organization	----						

Figure 21.7.2 Proposed Implementation Schedule of High Priority Project

Table 21.7.1 Tentative Investment Programme of High Priority Projects

Unit:mil.US$

Phase	Project Road Length (km)	1 st. year 2002		2 nd. Year 2003		3 rd. year 2004		4 th. Year 2005		5 th. Year 2006		**Grand Total**	
		C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C
(1) Construction Cost													
- Package A	17.1	0.00	0.38	0.00	0.38	8.98	0.00	2.24	0.00	0.00	0.00	11.22	0.75
- Package B	16.5	0.00	0.00	0.00	0.31	0.00	0.31	3.96	0.00	5.94	0.00	9.90	0.62
- Package C	18.6	0.00	0.14	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.14
Sub Total (a		**0.00**	**0.51**	**8.00**	**0.69**	**8.98**	**0.31**	**6.20**	**0.00**	**5.94**	**0.00**	**29.12**	**1.51**
(2) Structural Strengthening Cost		0.00	---	0.00	---	0.28	---	0.28	---	0.00	---	0.56	---
Sub Total (b		**0.00**	**---**	**0.00**	**---**	**0.28**	**---**	**0.28**	**---**	**0.00**	**---**	**0.56**	**---**
Total Construction Cost (a)+(b)		**0.00**	**0.51**	**8.00**	**0.69**	**9.26**	**0.31**	**6.48**	**0.00**	**5.94**	**0.00**	**29.68**	**1.51**
(3) Consultant Fee (DD/SV=10% of Construction Cost)		0.20	---	1.13	---	0.79	---	0.48	---	0.32	---	2.91	---
(4) Contingency for Price Escalation and Physical Change (10% of Construction Cost)		0.00	---	0.80	---	0.90	---	0.62	---	0.59	---	2.91	---
(5) Administration Cost of Mozambique Government (1% of Construction Cost)		---	0.12	---	0.06	---	0.06	---	0.03	---	0.03	---	0.29
Sub Total (6) = (3) + (4) + (5		**0.20**	**0.12**	**1.93**	**0.06**	**1.69**	**0.06**	**1.10**	**0.03**	**0.91**	**0.03**	**5.82**	**0.29**
Total (1) + (2) + (6		**0.20**	**0.63**	**9.92**	**0.74**	**10.94**	**0.37**	**7.58**	**0.03**	**6.85**	**0.03**	**35.50**	**1.80**

C/C: Construction Cost H/C: House Compensation including relocation of utilities

Exchange Rate 1 US$ = 22,000 Mts = ¥125.00 (July 2001), or 1 Mts = ¥0.00568

CHAPTER 22

PROJECT EVALUATION

CHAPTER 22 : PROJECT EVALUATION

22.1 GENERAL

In this chapter, project evaluation is conducted on the F/S (feasibility study) projects. Project evaluation of this chapter consists of economic analysis, non-economic benefit analysis, and financial analysis.

The first section is the economic analysis of the projects, and the objectives are two-folds.

Firstly it is to evaluate the economic viability of the project. Since previous economic evaluation on the M/P (master plan) has shown that the M/P is highly recommendable in terms of economic efficiency, the F/S projects which are the short-term program of the M/P are naturally expected to produce the same favour results. However, the detailed contents of the program have been modified in the F/S study, then it arouses the necessity to make a reconfirmation of the economic viability of the F/S projects.

The second objective of the economic analysis is to examine economic validity of each project within the programme. Since the costs of F/S projects are various in its size, it is necessary to identify individual economic validity of each project. By comparing individual economic indicators of the projects, it can lead to a prioritisation of the projects so that it is expected to provide the useful indication for the planner when the rearranging of the implementation schedule is needed in case of financial difficulty.

In addition to the above conventional evaluation, other "non-economic" benefits are considered. The evaluation of a road project has been traditionally performed with economic values for national economy, however, the road development will certainly accrue other benefits which are difficult to be quantified in economic values. The primal objective of road development is not aiming to produce economic values by saving VOC, rather it aims to improve people's life. Although there is no standardized method to calibrate such benefits, this chapter will contribute some attempts to examine such non-economic benefits.

The final section of this chapter is presented for financial analysis of the programme implementation with conducting financial arrangement simulation. By using the financial review results of M/P study, the financial arrangement is prepared to implement the projects with a risk analysis.

22.2 ECONOMIC ANALYSIS

22.2.1 Estimation of Benefits

The method is being used in this F/S analysis is the same as being used in the M/P study. Details can be referred in the relevant section of the chapter 12. The benefit of the road development maintenance is calculated as saving in VOC including time cost of passengers.

Table 22.2.1 List of Costs related to Running of a Vehicle

Vehicle	Time	Overhead
Fuel cost Tire cost Oil / Lubricant cost Maintenance cost Depreciation cost	Values of Passenger's time Driver's time Crew's time	Insurance cost Administration cost

Source: JICA study team

The VOC model being used is the VOC model from the M/P study. The VOC model is consistent with the HNMS-VOC model currently used as a de-facto model in ANE (Administration of National Roads) in Mozambique. It is structured in a matrix according to vehicle speeds and IRI (International Roughness Index). Traffic assignments for evaluation cases are carried out to calculate matrices by speed and IRI, and then multiplied by the VOC matrices to output the total VOC.

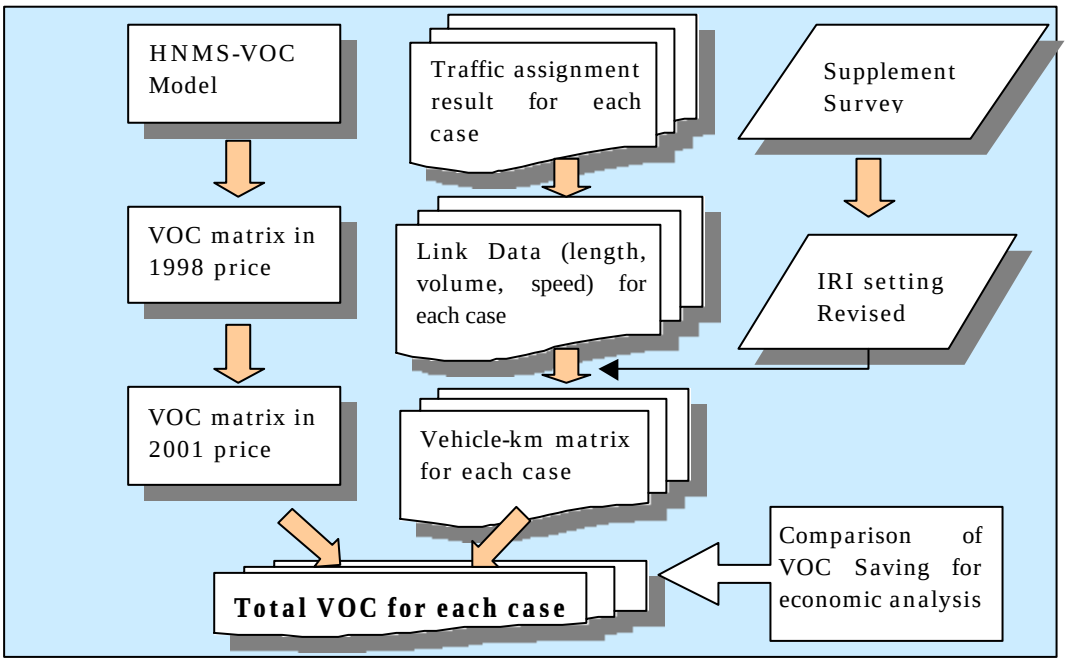


Figure 22.2.1 Procedure of the VOC calculation

For economic analysis of F/S program including all project packages, benefit is calculated by subtracting the VOC of the target case from "the base case". The base case is assumed that minimum maintenance works are carried out on roads, i.e. "Do-minimum" case.

For economic analysis of individual projects, benefit is calculated from a benefit loss by cancelling the target project from the whole F/S projects. In other words, the benefit of the individual project is said to be a gain of VOC from "With Project" to "Without Project", since VOC is increased somehow by cancelling any project. For details of traffic assignment methods and results, please refer the chapter 18.3.

The benefits of all projects and individual projects are calculated as follows. (VOC Saving of P-12 is not calculated since traffic assignment data is not available.)

Table 22.2.2 Benefits of F/S Project in Year 2005

No.	Project Name	Annual VOC Saving (Million USD)
ALL	**All Projects**	**13.62**
P-1	Construction of missing link on Av. Julius Nyerere	2.49
P-2	Improvement of Av. Vladinir Lenine	0.07
P-3	Rehabilitation and Improvement of Av. Acordos de Lusaka	1.28
P-4	Rehabilitation and Improvement of Av. Angola	0.29
P-5	Rehabilitation and Improvement of Av. Marien Ngouabi	0.48
P-6	Rehabilitation of Industrial and Commercial Area Roads	0.53
P-7	Rehabilitation of Port Area Roads	0.50
P-8	Rehabilitation of District 1 Area Roads	0.57
P-9	Rehabilitation of District 2 Area Roads	0.69
P-10	Rehabilitation of District 3 Area Roads	1.50
P-11	Rehabilitation of Improvement of Traffic Management	0.55

Source: JICA Study Team

22.2.2 Estimation of Costs

Cost is calculated from the cost estimation made in the previous chapter. The conversion of financial cost to economic cost is carried out by applying the different conversion factors to respective cost items. The rationale to use such conversion factors is described in the chapter of the M/P's economic evaluation. It is briefly explained by that financial (or market) price contains several price disturbances such as tax or subsidies which disturb the function of the

price qualifying the real value of items. In order to measure the real loss of the value, i.e. economic cost, such disturbances should be subtracted from the financial price of costs. Conversion factors are calculated as follows.

Table 22.2.3 Conversion Factors for Each Cost Item

Materials	Component	C F	Comp x CF
Land	20%	1.00	0.20
Machine (rent)	35%	1.00	0.35
Fuel/Oil	5%	0.85	0.04
Skilled Labour	5%	1.00	0.05
Unskilled Labour	15%	0.48	0.07
Licence/ Tax	5%	0.00	0.00
Others	15%	1.00	0.15
		CF for Materials =	**0.86**

Construction Works	Component	C F	Comp x CF
Materials	20%	0.86	0.17
Machine (rent)	30%	1.00	0.30
Fuel/ Oil	10%	0.85	0.09
Skilled Labour	10%	1.00	0.10
Unskiled Labour	10%	0.48	0.05
Licence/ Tax	5%	0.00	0.00
Imported Material	10%	0.95	0.10
Others	5%	1.00	0.05
		CF for Construction =	**0.85**

Maintenance Works	Component	C F	Comp x CF
Materials	15%	0.86	0.13
Machine (rent)	20%	1.00	0.20
Fuel/ Oil	5%	0.85	0.04
Skilled Labour	10%	1.00	0.10
Unskiled Labour	40%	0.48	0.19
Licence/ Tax	5%	0.00	0.00
Others	5%	1.00	0.05
		CF for Maintenance =	**0.71**

Source: JICA study team

Each component of the works is determined by discussion within JICA study team members by keeping the consistency with the cost estimation of the F/S projects.

There are assumptions as follows.

- ✓ For Fuel/ Oil, conversion factor is 0.85 since 15% of the price is assumed as fuel tax.
- ✓ For Unskilled labour, conversion factor is 0.48, which is extracted from the VOC model of ANE (National Road Administration of Mozambique) and calculated from a production loss of agricultural goods by unskilled labour.
- ✓ For imported materials which are asphalt and steel bars, 0.95 of conversion factor is set according to the rate of average import tax of these material.
- ✓ For machine and skilled labour, conversion factor is 1.00 due to the scarcity of these items in Mozambique.
- ✓ For tax and license, conversion factor is 0.0 because they are just financially transferred to the government.

In addition, conversion factor of house compensation (or land acquisition cost) is set to be 1.00 because it is assumed that any part of the urbanized city has a potential to be productive so that resettlement accrues the cost of losing such potentials and the price of house compensation reflects such loss. Meanwhile, facility reallocation is considered as construction, thus the conversion factor of 0.85 is applied.

The cost comparison in financial and economic prices is described as follows.

Table 22.2.4 Financial and Economic Costs of F/S projects

Unit: Million USD

Project Name / Phase	Financial Cost						Economicl Cost						Ratio
	Year1 2002	Year2 2003	Year3 2004	Year4 2005	Year5 2006	Grand Total	Year1 2002	Year2 2003	Year3 2004	Year4 2005	Year5 2006	Grand Total	
- Av. J. Nyerere	0.30	0.28	4.93	1.23	0.00	6.75	0.30	0.28	4.32	1.08	0.00	5.98	0.89
- Av. V. Lenine	0.02	0.00	0.13	0.03	0.00	0.17	0.02	0.00	0.11	0.03	0.00	0.15	0.89
- Av. A. Lusaka	0.02	0.00	1.72	0.43	0.00	2.16	0.02	0.00	1.51	0.38	0.00	1.90	0.88
- Av. Angola	0.02	0.00	0.00	1.00	1.42	2.44	0.02	0.00	0.00	0.88	1.24	2.13	0.87
- Av. M. Nugouabi	0.02	0.06	0.06	0.70	0.99	1.83	0.02	0.05	0.05	0.61	0.86	1.59	0.87
- Industrial/ Commercial Area	0.02	2.85	0.00	0.00	0.00	2.86	0.02	2.50	0.00	0.00	0.00	2.52	0.88
- Port Area	0.02	1.90	0.00	0.00	0.00	1.92	0.02	1.67	0.00	0.00	0.00	1.69	0.88
- District 1 Roads	0.02	4.48	0.00	0.00	0.00	4.49	0.02	3.94	0.00	0.00	0.00	3.95	0.88
- District 2 Roads	0.02	0.21	0.29	1.77	2.51	4.79	0.02	0.18	0.26	1.55	2.18	4.18	0.87
- District 3 Roads	0.08	0.12	4.18	1.05	0.00	5.42	0.07	0.11	3.66	0.92	0.00	4.76	0.88
- Traffic Management Facilities	0.02	0.00	0.00	1.37	1.93	3.32	0.02	0.00	0.00	1.20	1.68	2.90	0.87
- Bus Stops and terminals	0.15	0.70	0.00	0.00	0.00	0.85	0.15	0.61	0.00	0.00	0.00	0.77	0.90
Total	0.69	10.60	11.29	7.58	6.85	37.01	0.68	9.34	9.91	6.65	5.96	32.54	0.88

Source: JICA Study Team

22.2.3 Evaluation settings

The project life is assumed to be 20 years from year 2002 at which the construction is due to be commenced.

According to the implementation plan, the construction of F/S projects is finished at the end of year 2006; therefore the benefit is accrued from year 2007. Since the traffic assignment is conducted for year 2010 and 2005, benefits are calculated primarily for year 2010 and year 2005, and then the difference of benefits between year 2010 and year 2005 is used to calculate the growth rate of the benefits. Benefit of year 2007 is extrapolated from a time series of such benefits between year 2005 and year 2010.

Although some projects are completed before year 2007, it is assumed that benefit is borne only after year 2007 because it considers some negative effects influencing on traffic flows during construction periods. The benefit of year 2007 is assumed to be half of the original size since it is common that it takes 1 year of adjustment time for the network to be fully functional.

IRRs of the project roads are reduced by level 1 at year 2010 compared to year 2007 because of the deterioration effects on roads by traffic, i.e., IRI tends to be worse year by year at growing the number of traffics.

It is remarked that the base case "Do minimum" is assumed at minimum level of maintenance and it needs some amount of maintenance cost. Thus, the net cost of the project case is calculated by subtracting the cost of "Do minimum" maintenance.

In some economic analysis, sunk cost and salvage value are considered. Sunk costs are costs that are not necessary to start the project but they had been actually used before the project's commencement. For this road project, the roads in Maputo have already existed before the F/S projects and the construction cost of such base roads is not included as the costs for this analysis in spite of the fact that the benefits of rehabilitation of the roads can not be achieved without the base roads. In this case, the additional cost would be counted as costs as "sunk cost". On the other side, the salvage value is the value that remains at the end of the project. For this road project, the rehabilitated roads will exists more than the project life of 20 years, so that these roads may well be producing the benefit even after the project life. In this case, the additional value would be counted as benefits remaining. Sunk cost and salvage value are, however, theoretical and difficult to be quantified indeed. Therefore, in this analysis, both sunk costs and salvage values are assumed to be offset against each other, therefore, neither additional cost nor benefit is counted from this point of view.

22.2.4 Economic Evaluation of the F/S projects as a whole

With a method described in the previous section, a cost-benefit analysis of the F/S projects is conducted as follows.

Table 22.2.5 Cost Benefit Analysis in Stream

Discout rate = 12.0% Unit: million USD

	2001 price Cost	2001 price Benefit	2001 price Profit	Discount Rate	Discounted Cost	Discounted Benefit	Discounted Profit
2002	0.7	0.0	-0.7	89.3%	0.6	0.0	-0.6
2003	9.3	0.0	-9.3	79.7%	7.4	0.0	-7.4
2004	9.9	0.0	-9.9	71.2%	7.1	0.0	-7.1
2005	6.6	0.0	-6.6	63.6%	4.2	0.0	-4.2
2006	6.0	0.0	-6.0	56.7%	3.4	0.0	-3.4
2007	0.2	7.4	7.2	50.7%	0.1	3.7	3.6
2008	0.2	15.4	15.2	45.2%	0.1	7.0	6.9
2009	0.2	16.0	15.8	40.4%	0.1	6.5	6.4
2010	0.2	16.7	16.5	36.1%	0.1	6.0	5.9
2011	0.2	17.3	17.0	32.2%	0.1	5.6	5.5
2012	0.2	17.9	17.6	28.7%	0.1	5.1	5.1
2013	0.2	18.5	18.2	25.7%	0.1	4.7	4.7
2014	0.2	19.1	18.9	22.9%	0.1	4.4	4.3
2015	0.2	19.7	19.5	20.5%	0.0	4.0	4.0
2016	2.7	20.4	17.7	18.3%	0.5	3.7	3.2
2017	0.2	21.1	20.9	16.3%	0.0	3.4	3.4
2018	0.2	21.8	21.6	14.6%	0.0	3.2	3.1
2019	0.2	22.6	22.3	13.0%	0.0	2.9	2.9
2020	0.2	23.3	23.1	11.6%	0.0	2.7	2.7
2021	0.2	24.1	23.9	10.4%	0.0	2.5	2.5
Total	38.4	281.4	243.0	-	24.0	65.6	41.5

B/C	NPV	IRR
2.7	41.5 mil.USD	27.9%

(B/C=Benefit Cost Ratio, NPV=Net Present Value, IRR=Internal Rate of Return)

Source: JICA Study Team

Since all economic indicators show very much positive results (B/C=2.7, NPV=41.5 mil. USD, and IRR=27.9%), it is obvious that the F/S projects as a whole is very feasible from the economic point of view.

22.2.5 Economic Evaluation of Each F/S Project

For economic analysis of each individual project, "With" and "Without" analysis is applied. "With" case is the same as the whole F/S projects (full projects). For calculating the VOC of "Without" case of each project, a network without upgrading the project-related link(s) is constructed and traffic assignment is conducted. Benefit of the project is calculated from the "benefit loss" which is a difference of VOC savings between "With " case and "Without" case. VOC saving of "With project" case is the same as of the whole F/S projects.

The following table summarizes the results of each economic analysis.

Table 22.2.6 Summary of Economic Analysis Results of Each Project

No.	Project Name	Discounted Benefit (mil. USD)	Discounted Cost (mil. USD)	B/C Ratio	Net Present Value (mil. USD)	Internal Rate of Return
P-1	Construction of missing link on Av. Julius Nyerere	13.4	4.5	3.0	9.0	32.0%
P-2	Improvement of Av. Vladinir Lenine	0.4	0.1	3.4	0.3	34.6%
P-3	Rehabilitation and Improvement of Av. Acordos de Lusaka	6.9	1.4	4.9	5.5	46.7%
P-4	Rehabilitation and Improvement of Av. Angola	1.4	1.4	1.0	0.0	12.4%
P-5	Rehabilitation and Improvement of Av. Marien Ngouabi	2.3	1.0	2.2	1.3	27.2%
P-6	Rehabilitation of Industrial and Commertial Area Roads	3.5	2.1	1.7	1.4	21.0%
P-7	Rehabilitation of Port Area Roads	3.4	1.4	2.4	1.9	28.9%
P-8	Rehabilitation of District 1 Area Roads	3.8	3.3	1.2	0.5	14.3%
P-9	Rehabilitation of District 2 Area Roads	3.3	2.7	1.2	0.6	15.3%
P-10	Rehabilitation of District 3 Area Roads	8.1	3.5	2.3	4.6	26.6%
P-11	Rehabilitation of Improvement of Traffic Management	2.7	1.9	1.4	0.8	18.4%
P-12	Improvement of Bus Stops and Terminals	N/A	0.7	-	-	-
	TOTAL / AVERAGE	49.2	23.4	2.2	26.0	25.2%

Source: JICA Study Team

According to the results in the table, all projects seem to be feasible because no project in the table is lower than the critical point of B/C (equals to one) or IRR (12%) while the degrees of feasibility are various from 46.7% to 12.4% of IRR.

This kind of listing is prone to mislead a reader to consider that only high economic-return projects shall be implemented. This listing is, however, not for selection of the projects for

implementation. This is because that the F/S projects are organized into a complete network which has a systematic mechanism to deal with traffics. This issue is rather suitable for traffic engineers not economists, but it can also be explained in the economic analysis with the total NPV (Net Present Value). The summed value of NPV of the all independent projects is 26.0 mil. USD, which is lower than the value of NPV of the whole projects (41.5 mil. USD). It indicates that projects are utmost effective only when they are implemented as a whole network, not by being implemented individually.

Therefore, the listing of economic analysis results should be read to explain the different impacts of the various F/S projects, and in practice, this list will be treated as a guide for the planner in future for amending the implementation schedule in case of financial difficulty.

22.2.6 Sensitivity Analysis of Economic Evaluation Result

In order to confirm to the above favourite result, sensitivity analysis is conducted.

This is firstly done by changing the value of benefit and cost by +10% and –10%.

Table 22.2.7 Sensitivity Analysis of the F/S projects

Scenario	Best Case			Medium			Worst		
Benefit Change	10%	0%	-10%	10%	0%	-10%	10%	0%	-10%
Cost Change	-10%	-10%	-10%	0%	0%	0%	10%	10%	10%
B/C	3.4	3.1	2.8	3.0	2.7	2.5	2.8	2.5	2.3
NPV	49.0	43.2	37.4	47.3	41.5	35.8	45.7	40.0	34.2
IRR	31.5%	29.8%	27.9%	29.6%	27.9%	26.2%	27.9%	26.3%	24.6%

Source: JICA Study Team

It is obvious that even at the worst scenario (10% down of benefit and 10% increase of cost), the indicators are positive to show the project's feasibility (IRR=24.6%).

In addition, switching value index of benefit and cost are calculated in order to analyse the robustness of the results. Switching value rates are a changed value of cost (or benefit) at which IRR of the target project is equal to the discount rate. When the IRR is less than the discount rate, the project is thought no longer feasible. Thus, the switching value is treated as a critical border at which the project turns to be unfeasible.

Table 22.2.8 Switching Values of Cost and Benefit

Discount rate= 12%

	Original	SVI	Change Rate
Cost	38.4 mil. USD	104.7 mil. USD	174.2%
Benefit	281.4 mil. USD	102.6 mil. USD	△63.5%

SVI= Switching Value Index Source: JICA Study Team

From the above table, it can be said that the F/S projects are unfeasible when cost is increased at 174% or benefit is decreased by 64%. Since such situation is quite unrealistic, the economic feasibility of the projects is guaranteed as robust.

The same method of sensitivity analysis is conducted for each project as follows.

Table 22.2.9 Results of Sensitivity Analysis of Each Project

No.	Project Name	Change of IRR			Swtching Value Index	
		IRR in Original	IRR in Worst Case	IRR in Best Case	Change Rate of Benefit	Change Rate of
P-1	Construction of missing link on Av. Julius Nyerere	32.0%	27.9%	36.5%	△60.9%	259.0%
P-2	Improvement of Av. Vladinir Lenine	34.6%	30.2%	39.3%	△69.6%	264.0%
P-3	Rehabilitation and Improvement of Av. Acordos de Lusaka	46.7%	40.8%	53.2%	△77.6%	424.1%
P-4	Rehabilitation and Improvement of Av. Angola	12.4%	9.5%	15.5%	△11.5%	12.9%
P-5	Rehabilitation and Improvement of Av. Marien Ngouabi	27.2%	23.1%	31.7%	△55.6%	141.4%
P-6	Rehabilitation of Industrial and Commertial Area Roads	21.0%	17.4%	25.1%	△42.4%	78.0%
P-7	Rehabilitation of Port Area Roads	28.9%	24.3%	34.1%	△58.3%	151.8%
P-8	Rehabilitation of District 1 Area Roads	14.3%	11.4%	17.5%	△19.3%	24.3%
P-9	Rehabilitation of District 2 Area Roads	15.3%	12.3%	18.6%	△25.1%	34.9%
P-10	Rehabilitation of District 3 Area Roads	26.6%	22.7%	30.8%	△52.6%	120.8%
P-11	Rehabilitation of Improvement of Traffic Management	18.4%	15.0%	22.1%	△34.1%	54.1%

Source: JICA Study Team

The sensitivity analysis of each project shows that feasibility of projects of Av. Lusaka, Av. Julius Nyerere, Av. Lenin is highly guaranteed, while projects of Av. Angola, District 1 Area Roads, and District 2 Area Roads shows some vulnerability in its robustness of feasibility from the economic point of view.

22.3 NON-ECONOMIC EVALUATION

One of the criticisms of the economic analysis of road development is its base rationale that benefits from road development are mainly VOC savings for national economy. In practice, however, none of traffic engineers or politicians devotes themselves to develop roads in order to reduce "VOC" for national economy. Rather, in reality, roads are developed to improve people's life.

From this comprehensive point of view, this section considers some important benefits that are not quantifiable into money term, such as "transport benefits for low-income people", "accessibility improvement", "job creation effect", "flood protection", and "emission reduction effect".

22.3.1 Transport Benefit for Low-Income People

This road development program is not aiming to produce the economic benefits for national economy, rather the main purpose is to bring benefits to "people" in Maputo. Especially, this study of road development in Maputo has been implemented in the international cooperation scheme of Japan and one of the key issues of the cooperation is to improvement of the people's life in poor condition. Thus, the project evaluation should consider how much benefit the project would bring to such poor people.

It is very known that most of the low-income people in Maputo use buses for their daily transport. Therefore, bus time saving can be thought as a direct benefit to the low-income people in Maputo.

Figure 22.3.1 Buses as a main transport mode for people

In a normal economic analysis, however, bus passenger benefits are treated as little as that the bus passenger time related cost accounts only about 1% of total VOC in the last economic analysis. This is due to the rationale of economic analysis to evaluate the project from the point view of national economy, where low-income people's value of time is discounted by assuming that low-income people's time is not as much productive as the high-income people.

With an analysis of such rationale, it is highly probable that the economic analysis underestimates the value of the projects for the people in Maputo in reality. Thus, it is worthwhile to extract the bus passenger time saving as an indicator for positive impact for low-income people.

By using the traffic assignment data, the bus passenger time saving is calculated. The following table describes the benefits of bus passengers of the F/S projects.

Table 22.3.1a Bus Passenger Time Saving of the F/S projects

Base Year: 2007

No.	Project Names	Annual Bus Passenger Time Saving (hour) (A)	Total Cost ('000 USD) (B)	Efficiency Ratio (A)/(B)
ALL	**All Projects**	4,567,512	31,278	146.0
P-1	Construction of missing link on Av. Julius Nyerere	736,214	4,731	155.6
P-2	Improvement of Av. Vladinir Lenine	103,031	155	662.8
P-3	Rehabilitation and Improvement of Av. Acordos de Lusaka	993,236	1,910	520.0
P-4	Rehabilitation and Improvement of Av. Angola	92,468	2,129	43.4
P-5	Rehabilitation and Improvement of Av. Marien Ngouabi	170,328	1,591	107.1
P-6	Rehabilitation of Industrial and Commertial Area Roads	34,253	2,511	13.6
P-7	Rehabilitation of Port Area Roads	512,827	1,684	304.5
P-8	Rehabilitation of District 1 Area Roads	634,373	3,942	160.9
P-9	Rehabilitation of District 2 Area Roads	10,534	4,179	2.5
P-10	Rehabilitation of District 3 Area Roads	802,045	4,785	167.6

Source: JICA Study Team

According to the results in the above table, the projects which have significant impacts on bus passengers are not only trunk road such as Av. Lusaka or Av. Lenin, but also some area road projects such as projects of Port Area Roads, District 3 Area Roads, District 1 Area Roads.

It is interesting to see that the area roads projects, which tend to be evaluated less than trunk roads in economic analysis, have competitive effects on bus passengers' travels.

VOC saving is also an important indicator in the sense that a high VOC including fuel consumption is anticipated to push up bus fares in long run and it surely affects especially the low-income people. Thus, VOC saving can be regarded as one of indirect benefits for the low-income people in Maputo.

Table 22.3.1b Bus VOC Saving of the F/S projects

Base Year: 2007

No.	Project Names	Annual Bus VOC Saving ('000 USD) (A)	Total Cost (Mil. USD) (B)	Efficiency Ratio (A)/(B)
ALL	**All Projects**	791.9	31.3	25.3
P-1	Construction of missing link on Av. Julius Nyerere	292.0	4.7	61.7
P-2	Improvement of Av. Vladinir Lenine	91.8	0.2	590.5
P-3	Rehabilitation and Improvement of Av. Acordos de Lusaka	314.7	1.9	164.8
P-4	Rehabilitation and Improvement of Av. Angola	101.5	2.1	47.7
P-5	Rehabilitation and Improvement of Av. Marien Ngouabi	47.1	1.6	29.6
P-6	Rehabilitation of Industrial and Commertial Area Roads	168.7	2.5	67.2
P-7	Rehabilitation of Port Area Roads	270.0	1.7	160.3
P-8	Rehabilitation of District 1 Area Roads	91.7	3.9	23.3
P-9	Rehabilitation of District 2 Area Roads	15.8	4.2	3.8
P-10	Rehabilitation of District 3 Area Roads	241.1	4.8	50.4

Source: JICA Study Team

This table is also indicating that area road projects such as port area roads have competitive impact on saving VOC of Bus against major trunk road projects.

This competitive importance of area road projects tends to be underestimated in conventional economic analysis, even though its impact is much more related to the low-income people in Maputo, which should be a main target group of the development project.

Therefore, it indicates that area roads development should be paid the same respect as the benefits for common people in Maputo.

22.3.2 Accessibility Improvement

1) Benefited Population

Road development surely improves the accessibility of the population embedded with road sides. The influenced population who will receive the benefits is calculated by a formula as;

Benefited Population = (Project Road Length x Accessible Area to Bus Stop) x Population Density

The results are shown in the following table.

Table 22.3.2 Influenced Population in Accessibility Improvement

Name of Road		Project Road Length(km)	Accessible area to bus stops(m)	Influenced areas (m2)	Population density (person/ha.)	Population (person)	P / Cost (000' USD)
Trunk Roads	1.Link with AV. Julius Nyerere	6.7	300	4,038,000	169	68,242	11,403.7
	2.AV.Vladimir Lenine	3.3	300	1,980,000	169	33,462	216,338.4
	3.AV. Acordos de Lusaka and Av. Guerra Popular	2.8	300	1,680,000	169	28,392	14,945.8
	4.AV. Angola and Rua S. Cabral/Largo de Deta	3.7	300	2,220,000	169	37,518	17,600.6
	5.AV. Marien Ngouabi	2.6	300	1,560,000	113	17,628	11,059.4
Collector Roads	1.Industrial and Commercial Area Roads	6.0	300	3,600,000	234	84,240	33,449.8
	2.Port Area Roads	3.9	300	2,340,000	113	26,442	15,653.4
Residential Area Roads	1.District 1 Area Roads	8.7	300	5,220,000	113	58,986	14,921.4
	2.District 2 Area Roads	10.2	300	6,120,000	234	143,208	34,222.6
	3.District 3 Area Roads	9.5	300	5,700,000	169	96,330	20,238.1

Source: JICA Study Team

It is remarkable to see the highly influential projects are projects of Area Roads, especially District 2 Area Roads project is the highest project in terms of benefited population size.

2) Accessibility of Public Facilities

Accessibility improvement of public facilities is a key indicator of what road development upgrades people's welfare in society. Following illustrations are describing the accessibility improvement of hospitals, police stations, and fire stations by the F/S projects.

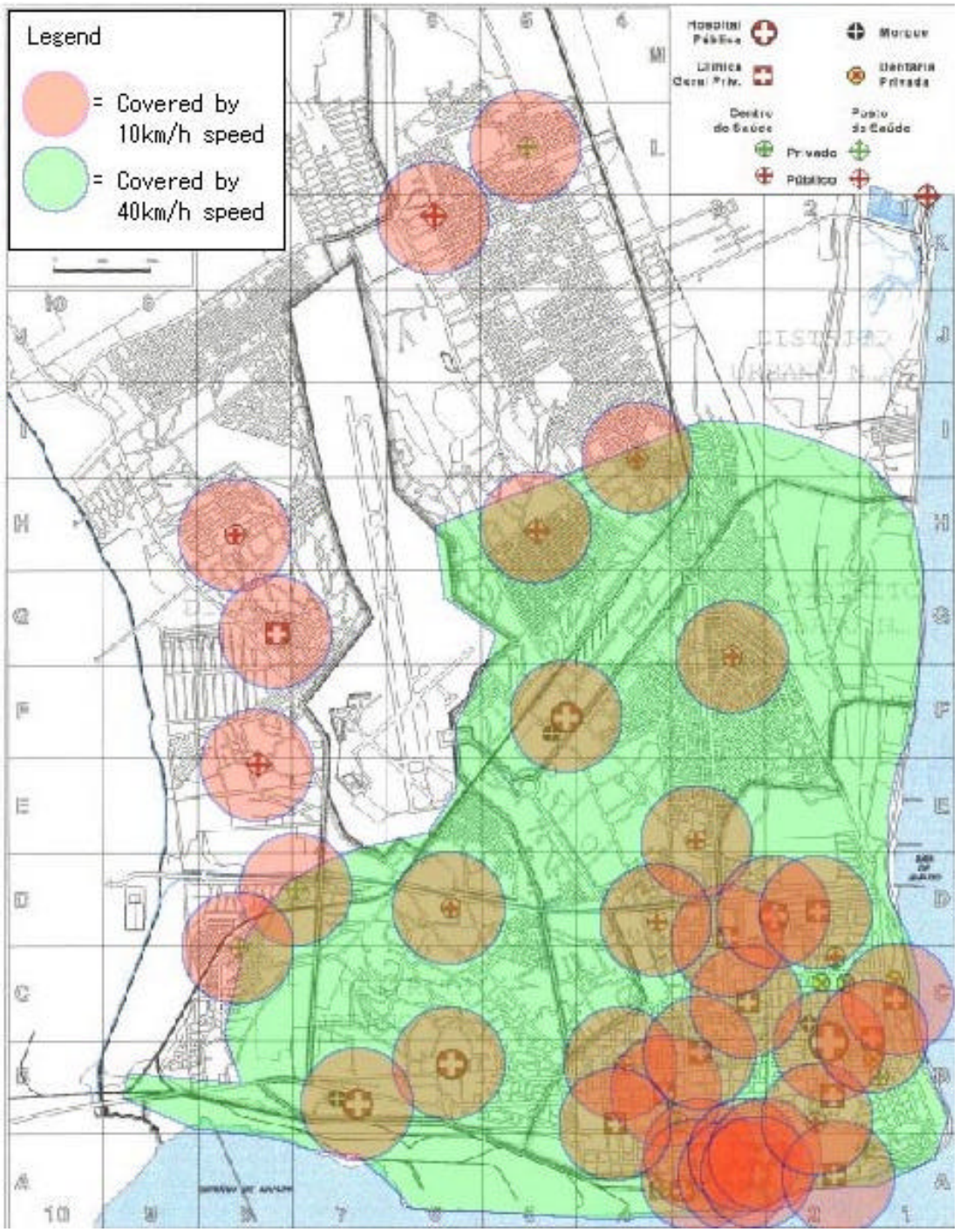


Figure 22.3.2 Improved Covered Area of 5 Minutes Vehicle Transport from Hospitals

Red circles indicate the current covered area in which hospitals vehicles can reach within 5 minutes at speed of 10 km/h, thus the area out of red circles is the area of which people can not receive emergency medical service. By the road widths widening and other rehabilitation, the speed is expected to increase to 40km/h. The green zone indicates a new covered area of medical service with such improvement.

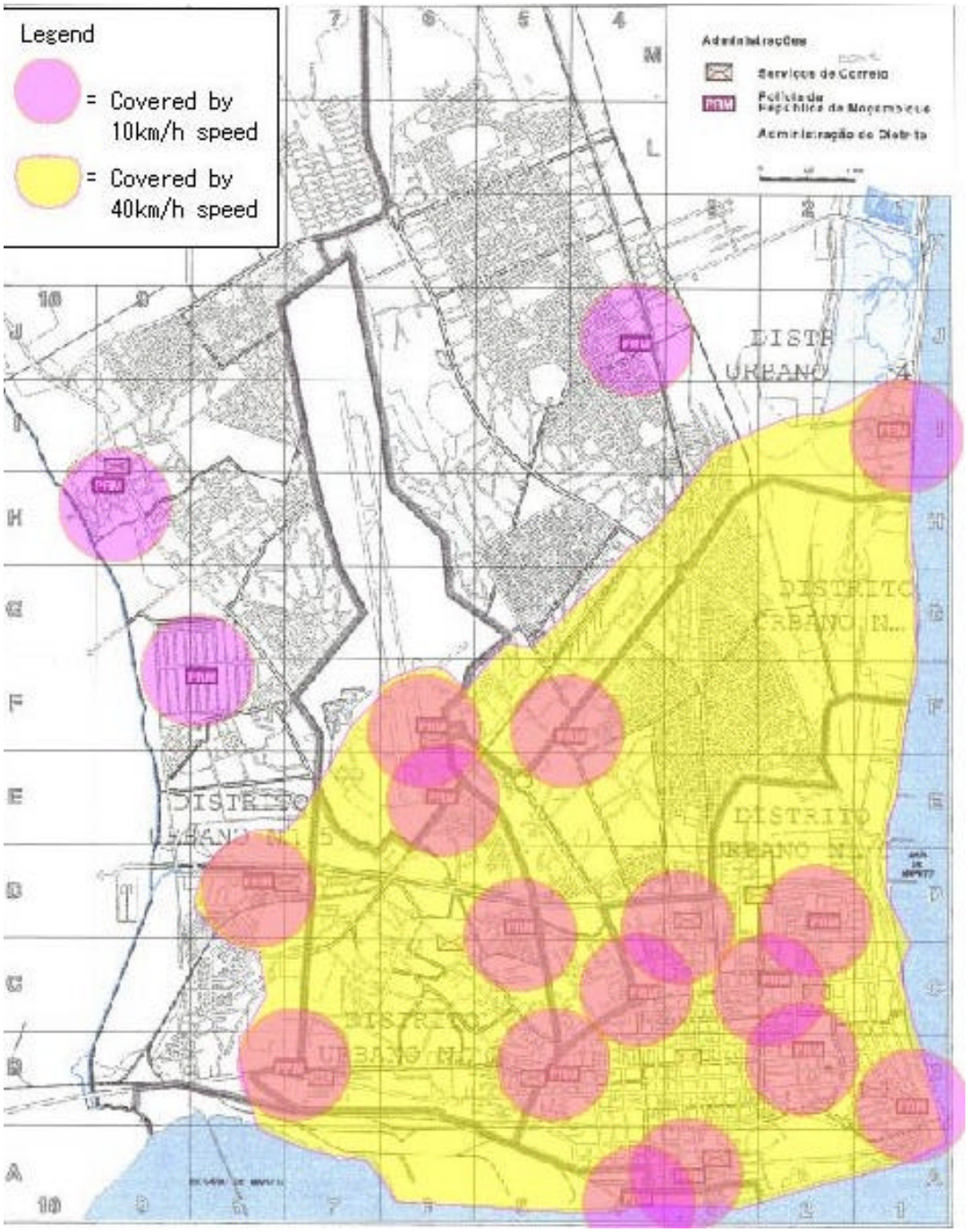


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Figure 22.3.3 Improved Covered Area of 5 Minutes Vehicle Transport from Police Stations

The same method is applied to illustrate the accessibility improvement of police station by the F/S projects. Out of the circles indicate the area in which the police can not reach within 5 minutes in the current situation (the speed is 10 km/h). The yellow area is the new accessible areas of the police by the F/S projects.

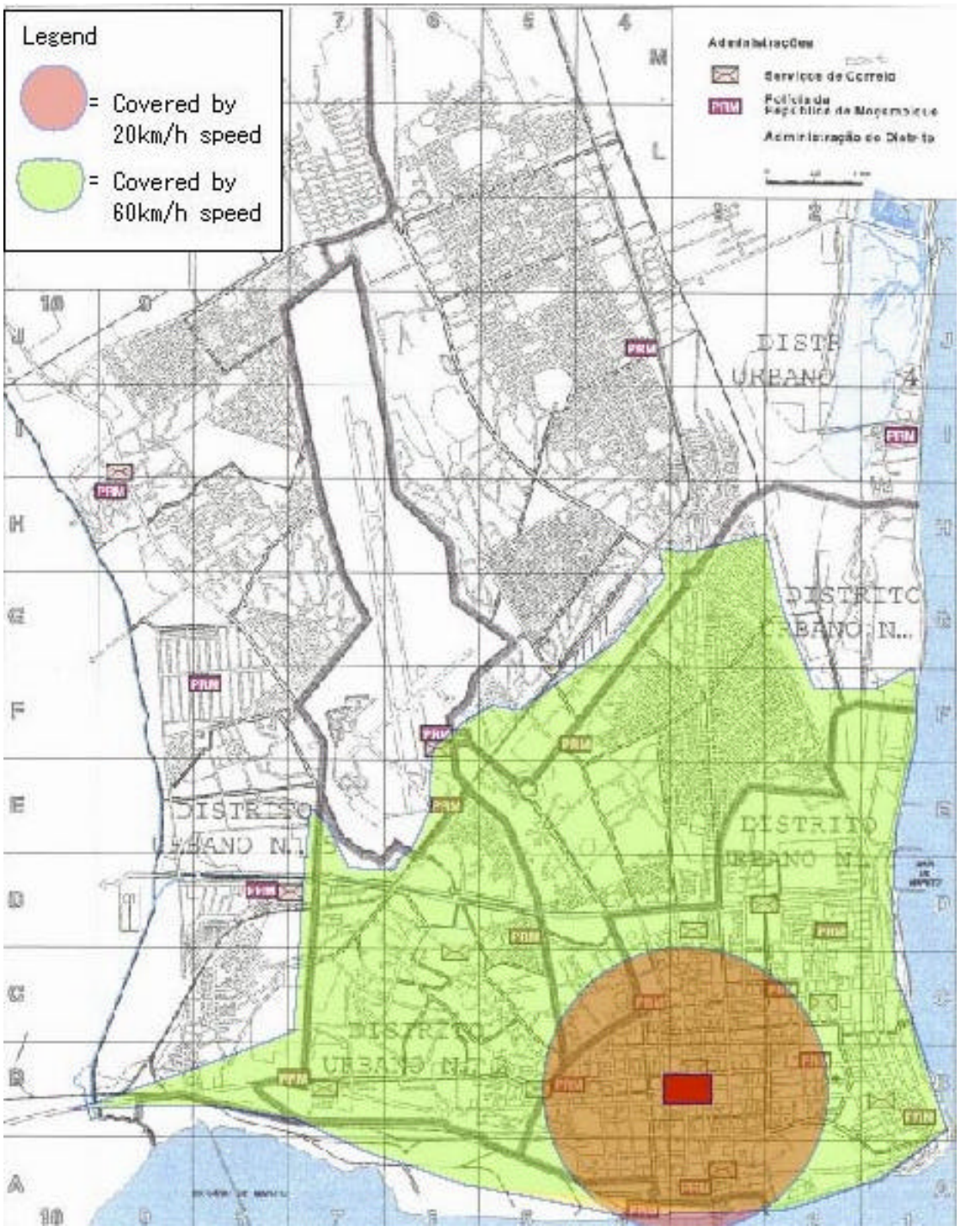

Figure 22.3.4 Improved Covered Area of 7 Minutes Vehicle Transport from Fire Station

Currently there is only one fire station in Maputo. With the same method to calculate the accessible zone, it can be said that the fire engine vehicles can reach the most of the inner city area within 7 minutes, as indicated in green zone, after the F/S projects are implemented.

22.3.3 Job Creation Effect with Construction and Maintenance

The F/S projects implementation has to employ skilled and unskilled workers in Maputo. With high unemployment rates of nearly 20% (it may be 50% among low-income population who are mostly unskilled), the job creation effect with the construction of the F/S projects must have a significant impact on their life.

Here is an estimate of the number of workers required to commence the F/S projects.

Table 22.3.3 Job Creation Effect of the F/S Projects

Project	Superviser	Skilled Woker	Unskilled Worker	Total
- Link with Av. J. Nyerere	2,322	36,306	48,105	86,733
- Av. V. Lenine	69	423	816	1,307
- Av. A. Lusaka	946	5,765	11,126	17,837
- Av. Angola	1,102	6,722	12,972	20,796
- Av. M. Ugouabi	770	4,694	9,059	14,523
- Industrial/ Commercial Area	5,533	40,219	57,189	102,941
- Port Area	895	4,101	12,146	17,142
- District 1 Roads	1,184	6,352	15,165	22,701
- District 2 Roads	2,387	24,954	35,752	63,093
- District 3 Roads	2,357	43,214	62,285	107,856
- Traffic Management Facilitie	2,409	7,266	3,354	13,029
Total	19,974	180,015	267,969	467,958

Source: JICA Study Team

The most significant projects with job creation effect are among Area Road projects such as District 3 Roads project, Industrial/ Commercial Area Roads project, etc.

More attention should be given to the category of "Unskilled Worker", because most of the low-income people tend to be unskilled.

Other additional effect from this job creation effect is to improve the skills of such unskilled workers. It is anticipated that workers without any special skill will acquire some practical skills related to road works through the projects.

22.3.4 Flood Protection

In the rainy season, flood problems are frequently witnessed in Maputo. The main factor of the flood problem is the inadequate facility of drainage system. The F/S projects contain the road-side drainage facility to deal with floodwater and it surely improves the situation.

Estimation of benefits of such flood prevention is hard to do since most of damages by flood are difficult to be quantified. They are deterioration of property including house and facilities, obstruction of business, spreading of water-related diseases, causation of heavy erosions, etc.

It may be argued that area road projects such as district road development projects and the commercial area roads project will play a more important role than trunk roads projects in flood protection, because the influenced people size beside roads can be a proxy indicator of protected population directly by the drainage facility of the project roads. It is, however, very difficult to conclude in such a way, since the water flow of flooding has to be calibrated to estimate the exact effect, and it is out of issues treatable in this chapter.

Besides, the flood surely affects the transport. The flood on roads obstructs the traffic flow and it incurs unnecessary detour or reduction of speeds that results in an increase of VOC (Vehicle Operation Cost). The phenomenon is similar to the traffic congestion by decreasing of road width and speed limit. If the road network with a proper drainage can prevent the flood and improve the traffic flow, the benefit can be traced by calculating the VOC.

Traffic assignment is conducted with "a rainy day" network, of which the condition of links is modified, for "with drainage" and "without drainage". With the same method in economic analysis applied, the benefits are calculated as follows.

Table 22.3.4 Road User's Benefit by Drainage System of the F/S Projects

Base Year : 2007

PCU-km Saving	PCU-hour Saving	VOC Saving (USD)
21,260	9,953	9,029

Source: JICA Study Team

Even though the benefit should be treated as a special case in the sense that this benefit is accrued only in a rainy day and a few days to follow, the VOC saving effect of drainage facility with roads is as high as about 9 thousands USD for a rainy day

22.3.5 Emission Reduction

Reduction of travel distance and increase of travel speed by the F/S projects will contribute to alleviate the emission from vehicle, which contains some poisonous substances such as carbon oxide (CO), nitrogen oxides (NOx) and carbon dioxides (CO2).

The estimated reduction level of emission by the F/S projects is described as follows.

Table 22.3.5 Emission Reduction by the F/S Projects

Unit: tons

Substances	Annual Saving in Year 2007	Annual Saving in Year 2010
CO	239.9	325.0
NO	17.2	18.9
CO2	135.4	173.6

Source: JICA Study Team

There are some studies to estimate the economic cost of the air pollution and to calculate the benefit, however the unit price of the pollutants are varied very much among such studies and it is not possible to conduct a consistent economic evaluation with such immature figures at this moment.

Rather, this issue should be considered at a broader context in the global concern on environment. Currently, global warming is a serious concern addressed in a lot of international and national conferences. It is well known that CO2 is a key factor of global warming, and every country including Japan is now obliged to make every effort to alleviate the problem. As the F/S projects certainly improve the emission level of CO2, this project is no longer a simple plan of transport improvement, rather it can be one of the tangible means to stop the global warming for long run.

22.4 FINANCIAL ANALYSIS

22.4.1 Financial Capability of the MCM

According to the financial reviews of the MCM, the financial capability of the M/P has been estimated as follows.

Table22.4.1 Estimation of Financial Capability of the MCM

Base Year:2000

Scale	Amount (Mil. USD)
The whole budget of the MCM	8.0
Budget Allocation for 7 road-related institutions	5.5
Investment Budget of 7 road-related institutions	3.0
Investment Budget of 2 road-related institutions	1.6
Executed projects related to urban road	0.4

Source: "Budget report 1999", "Plan 2000" and "2nd Revision of Plan 2000"

The financial capability for the road development and maintenance is estimated roughly around1.8 million USD (including the salary budget). It is, however, too optimistic in practice to assume all of this capable fund can be used for the project, because this is an estimated number on the budget plan. In addition, the pessimistic estimation of the road budgets which account only costs of the actually executed project, shows less than 0.5 million USD. (Details can be learned in Chapter 2.4.)

Moreover, it is noted that this estimation is based on the average exchange rate of year 2000, which is 15,237 Meticas for 1 USD. Currently, the average exchange rate is worsen to around 20,000 Meticas for 1 USD. By taking the effect of exchange rate into account, the financial capability of the MCM would be much lower than estimated.

Currently, the MCM is in the course of establishing a more reasonable budgetary system, and no reliable financial data more than the data used in Chapter 2.4 does not exist. According to the series of discussions with the MCM's financial officers, however, it is assured that around **0.5** million USD at the price level of year 2001 (around 10 billion Meticas) would be available for the project implementation that seems to be plausible from the table.

22.4.2 Financial Requirement of the Project Implementation

Cash flow of cost requirement of the project implementation is formed as follows.

Table 22.4.2 Cash flow of cost requirement of the projects

Unit: Million USD at Year 2001 Price

Code	Category	TOTAL	2002	2003	2004	2005	2006
A1-1	Construction Cost	**29.1**	0.0	8.0	9.0	6.2	5.9
A1-2	Structural Strengthening Cost	**0.6**	0.0	0.0	0.3	0.3	0.0
A1-3	Compensation Cost	**0.8**	0.4	0.3	0.1	0.0	0.0
A1-4	Relocation Cost	**0.7**	0.1	0.4	0.3	0.0	0.0
A1-5	Engineering Cost	**2.9**	0.2	1.1	0.8	0.5	0.3
A1-6	Contingency Cost	**2.9**	0.0	0.8	0.9	0.6	0.6
A1-7	Administration Cost	**0.3**	0.1	0.1	0.1	0.0	0.0
A1	*Sub-Total of Construction*	***37.3***	*0.8*	*10.7*	*11.4*	*7.6*	*6.9*
A2	*Routine Maintenance Cost*	***1.0***	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
A3-1	VAT for Materials	**1.0**	0.3	0.3	0.2	0.2	0.0
A3-2	VAT for Fuel and Oil	**0.5**	0.1	0.2	0.1	0.1	0.0
A3	*Sub-Total of VAT*	***1.5***	*0.4*	*0.5*	*0.3*	*0.3*	*0.0*
	Grand Total (A1+A2+A3)	**39.8**	**1.4**	**11.3**	**11.9**	**8.1**	**7.1**

Source: JICA Study Team

Regarding the total cost requirement compared with the available budgets (0.5 million USD), it is apparent that the MCM has to find other funding source.

Currently, the average interest rate of the banks for lending has been set as high as around 37%. It is unrealistic to expect any form of loan applied to implement the projects for the MCM, which is still suffering from the lack of funds and the lack of capacity on handling financial arrangement even in routine projects.

Therefore, since the road project in the growing capital city is a key factor for national development of Mozambique, this project can expect the international funding sources. In consideration of forms of funding, the grant scheme must be mostly favorable rather than a loan scheme by regarding the current financial situation of the MCM, which does not have any reliable source of funding like fuel tax.

Even though a main portion of costs such as construction cost is expected to be funded by external sources such as a grant, it is common that some parts of costs especially resettlement related costs, maintenance cost, and VAT costs are covered by the local government.

By taking the shares of financial responsibility stated above, the cost that the MCM has to finance is calculated as follows.

Table 22.4.3 Cash Flow of the MCM's Financial Responsibility.

Unit: Million USD at Year 2001 Price

Responsibility of the	Code	Category	**TOTAL**	2002	2003	2004	2005	2006
	A1-1	Construction Cost	**29.1**	0.0	8.0	9.0	6.2	5.9
	A1-2	Structural Strengthening Cost	**0.6**	0.0	0.0	0.3	0.3	0.0
○	A1-3	Compensation Cost	**0.8**	0.4	0.3	0.1	0.0	0.0
○	A1-4	Relocation Cost	**0.7**	0.1	0.4	0.3	0.0	0.0
	A1-5	Engineering Cost	**2.9**	0.2	1.1	0.8	0.5	0.3
	A1-6	Contingency Cost	**2.9**	0.0	0.8	0.9	0.6	0.6
○	A1-7	Administration Cost	**0.3**	0.1	0.1	0.1	0.0	0.0
	A1	*Sub-Total of Construction*	***37.3***	*0.8*	*10.7*	*11.4*	*7.6*	*6.9*
○	*A2*	*Routine Maintenance Cost*	***1.0***	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
○	A3-1	VAT for Materials	**1.0**	0.3	0.3	0.2	0.2	0.0
○	A3-2	VAT for Fuel and Oil	**0.5**	0.1	0.2	0.1	0.1	0.0
	A3	*Sub-Total of VAT*	***1.5***	*0.4*	*0.5*	*0.3*	*0.3*	*0.0*
		Grand Total (A1+A2+A3)	**39.8**	**1.4**	**11.3**	**11.9**	**8.1**	**7.1**

Cost Requirement for the MCM

Responsibility of the	Code	Category	**TOTAL**	2002	2003	2004	2005	2006
○	A1-3	Compensation Cost	**0.8**	0.4	0.3	0.1	0.0	0.0
○	A1-4	Relocation Cost	**0.7**	0.1	0.4	0.3	0.0	0.0
○	A1-7	Administration Cost	**0.3**	0.1	0.1	0.1	0.0	0.0
○	A2	Routine Maintenance Cost	**1.0**	0.2	0.2	0.2	0.2	0.2
○	A3-1	VAT for Materials	**1.0**	0.3	0.3	0.2	0.2	0.0
○	A3-2	VAT for Fuel and Oil	**0.5**	0.1	0.2	0.1	0.1	0.0
		Total for the MCM's Responsibility	**4.3**	1.2	1.4	0.9	0.5	0.2
		Rate in Grand Total	11%	86%	12%	8%	7%	3%

Source: JICA Study Team

It is estimated that the MCM has to prepare around 1 million USD (worth around 20 billion Meticas at year 2001 price level) for the project implementation in every year.

22.4.3 Financial Arrangement

According to the cash flow analysis above, it is obvious that there is still a shortage of own funding to cover the required costs by the MCM's road budget. In order to fulfill the lack of funding, the MCM should request the return of the fuel tax paid by vehicle drivers in Maputo. According to the financial review, it is estimated that roughly 22 million USD worth of fuel tax would have been paid by the drivers in Maputo in year 2000. Even thought the fuel tax revenue from Maputo's drivers counts more than 30% of the total, the fuel tax revenue has not been used for the city road development of Maputo.

It is learned that currently the MCM is starting to negotiate the fuel tax refund with the national government and the progress is highly expected according to the discussion with the Mayor of Maputo. Therefore, the financial arrangement considers the fuel tax revenue is available as one of financial sources.

Financial arrangement of the F/S projects is formulated as follows.

Table 22.4.4 Financial Arrangement (at fixed price level of year 2001).

Unit: mil. USD

Year	2002	2003	2004	2005	2006	TOTAL
Cost Required from the MCM	1.2	1.4	0.9	0.5	0.2	**4.3**
From the MCM's own budget	0.5	0.5	0.5	0.5	0.2	**2.2**
From Fuel Tax Refund	0.7	0.9	0.4	0.0	0.0	**2.1**
Other Source of Finance (International grant)	0.2	9.9	10.9	7.6	6.9	**35.5**

Source: JICA Study Team

It is remarked that year 2002 is the critical year for feasibility of the project implementation, since the MCM has to prepare 1.2 million USD but the negotiation of the fuel tax refund would take a long time to make a deal. In general, the international grant scheme does not support financially for filling such gap for house compensation, maintenance costs, etc. Thus, the MCM has to make their utmost effort to prepare the fund of 1.2 million by their own with limit of time. It is strongly recommended that the MCM should take a prompt action by all means for the preparation of the required fund of year 2002.

22.4.4 Risks and Minimizing Measures for Financial Arrangement

There are always risks to obstruct the progress of projects especially in financial issues. Not a few plans to be thought as good have been abolished because of failure of financial arrangement. In order to mitigate such risks, a risk analysis is conducted and mitigation actions are stated.

Risks considered are;

1. Financing from the MCM is not enough (or not available) especially at the first year.
2. Negotiation with ANE is not successful and fuel tax refund is not possible to cover the gap.
3. Financing from the international grant is not available or delayed.

For these risks, the MCM is responsible to prepare for risk minimizing measures as follows.

1. Establish a special financial management unit for the project, for which an exclusive full-time manager is appointed to plan and monitor the financial arrangement efforts stated below.
2. Scrutinize the MCM's budget to grasp the available budget for the project.
3. Hold a series of intensive meetings with ANE and other related organizations to ensure the fuel tax refund.
4. Establish formal and informal connections with foreign embassies and international organizations to assure various alternatives for international funding.
5. Establish formal and informal connections with related national level departments for enabling an international donation to be smoothly administered.
6. Start to consider other sources of funding such as urban tax surcharge, a subsidy from the national government, and establishment of Road Fund.
7. Be prepared to rearrange the implementation schedule of the project to seek a possible best solution in case of a substantial lack of funding.

As soon as the special financial management unit is formed, the MCM should start to "act" for ensuring the project implementation without any delay.

CHAPTER 23

MANAGEMENT SYSTEM AND OPERATIONS

CHAPTER 23: MANAGEMENT SYSTEM AND OPERATIONS

23.1 GENERAL

While the Directorate of Roads and Bridges (hereinafter the DRB) has made every effort to improve and repair the deteriorated roads, it is difficult to maintain all roads in Maputo. As a result of the study in Maputo, the Study Team recommended the improvement of Road Maintenance Management System.

In the field of the road maintenance and repair, the MCM should intend to establish a new road maintenance policy introducing a privatisation in order to accelerate the effective and the efficient daily, routine and periodic maintenance of the road as well as maximization of the national resources.

The one of the components of this project includes the structural strengthening of the following fields in order to meet the required functions of the new DRB of the MCM for to introduce the privatisation to the road maintenance.

The Objectives for Improvement of the Road Maintenance System are shown as follows.

- To establish a Sustainable Road Maintenance System
- To introduce Privatisation for efficient road maintenance
- To strengthen road maintenance capability

23.2 ORGANIZATION OF NEW ROAD DEPARTMENT

23.2.1 Required Road Maintenance

In consideration of the defective conditions of the Roads in Maputo City, the required maintenance activities to be covered under routine, periodic and emergency maintenance are as follows.

- Routine Maintenance:
Required continuously on every road
Maintenance Activities:
Road facilities installation, Road Markings, grass cutting, open ditch cleaning, gravel patching, dragging, pothole patching and grading

- Periodic Maintenance:

After road rehabilitation, the serviceability of the pavement surface will be down. Periodic Maintenance will be done periodically.

Maintenance Activities:

Re-graveling, repairing rut dragging, repairing shoulders, resealing cracks, surface dressing.

- Emergency Maintenance:

If the roads will be deteriorated by disasters or traffic accidents, etc, the Emergency Maintenance should be done earlier preventing to increase the damage.

Maintenance Activities caused by disasters

Removal of soils that cover the road by a landslide

Embankment of soils at eroded section by a landslide, etc.

Maintenance Activities caused by Traffic Accidents

Repair of Guard Rails, Traffic Signals, Kerb Stones, Traffic Signs, Street Lights and other road facilities etc.

23.2.2 Introduction of New Road Department

a) Existing Problem of the Implementation Agency

In the present condition, major road rehabilitations as the periodic maintenance are done by the private companies that made a contract with the DRB. But the road rehabilitations except major rehabilitations are done by the direct force of the DRB. However, the road maintenance by the DRB has not done as well because of lack of staffs, availability of the maintenance equipments and the maintenance budget.

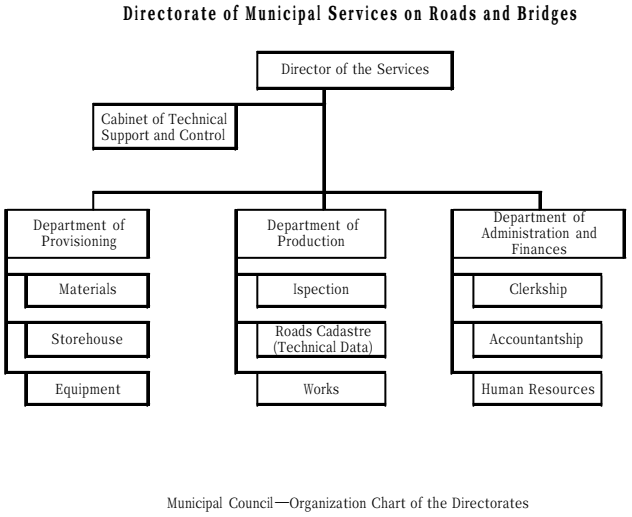

Figure 23.2.1 Existing Organization Chart of the DRB

b) Proposed Organization of New Road Department

The study team recommended the desirable organization of the DRB.
The DRB should attend to the following items;

- Establishment of the Road Development Plan
- Evaluation of the Road Design
- Management

The final target for the road maintenance system is showing as follows;
Routine/Periodic maintenance should be done by the private enterprise.
The DRB should concentrate to manage and supervise the maintenance activities done by the private enterprises.
Before the introduction of privatisation, the DRB execute the routine/periodic.

As described in Figure 12.1.1 and 12.1.2 in Section 12.1.1, Chapter 12, Part A: Master Plan Study, the recommendable organization of the DRB have been proposed.

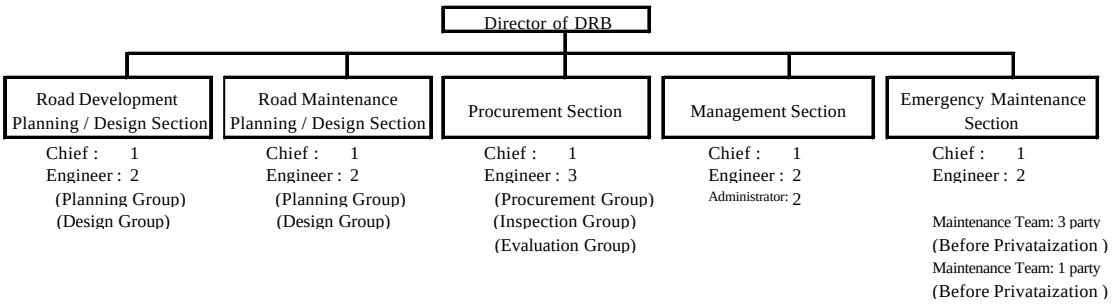

Figure 23.2.2 Proposed Organization of the DRB

b)-1 Introduction of Planning Section

- Stock of Road Inventory Data and utilization of Road Inventory Data
- Establishment of Road Development Programme
- Establishment of Road Maintenance Programme
- Regulation with the municipal directorate of construction and urbanization

b)-2 Introduction of Design Section

- Preparation of Design Standard
- Evaluation of Road Design
- Regulation with the Agencies of the Public Utilities

b)-3 Introduction of Procurement Section

- Preparation of Construction Unit Prices
- Database for Specification and Contract documents
- Preparation of short list of contractors and consultants
- Procurement of construction services
- Inspection of the construction service
- Evaluation of the construction services

b)-4 Introduction of Management Section

- Budget Allocation
- Administration
- Regulation of the other municipal

b)-5 Introduction of Emergency Maintenance Section

- Maintenance Patrol
- Emergency maintenance
- Maintenance of equipments

c) Required Periodic Maintenance

The Maputo city, which consists of 7 Districts, has 2,240 roads (excluding Inhaca) with a total length of 830 km (excluding Inhaca) It consists of 190km(23%) of paved roads and 640km(77%) of unpaved roads.

40km of existing paved road that were selected the short term programme will be improved or rehabilitated under this project, whereas the length of the roads subject to the maintenance programme is estimated at approximately 150km of paved roads.

The estimated volume of periodic maintenance is shown as follows.

In accordance with the result of the PSI survey, the volume of the routine maintenance for pothole patching is estimated approximately 5.0% area for the total road area of 150km for the periodic maintenance.

Table 23.2.1 Estimated Pavement Area of Each Road Classifications

Road Classification	Length(km)	Average Width(m)*	Paved Area(m2)
Trunk Roads	76.4	16.0	1,222,400
Collector Roads	24.2	11.0	266,200
Local Area Roads	47.1	10.5	494,550
Total	147.7		1,983,150

*Remark: Average Road Width is calculated based on the Road Inventory Data.

Required total area for periodic maintenance is estimated at 99,160m2.

(1,983,150m2 x 5%)

Requirement units are based on an average output of 30m2/day, 6 hours work/day, 200days work/year are estimated respectively with the assumption of 7 years term.
99,160 / (30 x 200 x 7) = 2.4 units.

Therefore, it is proposed that there will be 3 units for carrying out bitumen patching for pot holes in short term.

The summary of required equipments for periodic maintenance is shown as follows.

Table 23.2.2 Summary of required equipments for periodic maintenance

Equipments	Quantity	Remarks
(a) Equipments		
Tipper Track	3	
Bitumen Sprayer	2	
Asphalt Cutter	2	
Compressor	1	
Roller	2	
Pick up track	2	Supervisory vehicle
(b) Materials		
Chipping	600 m3	
Bitumen	60,000 lts.	
Diesel	64,000 lts	
Oil/Lubrication	1,000 lts	
(c) Staffs		
Inspector	1	
Foreman	2	
Drivers/Operators	8	
Helpers	8	
Labours	10	

d) Requirement of Routine Maintenance

Activities to be covered under routine maintenance include:

a) Road Facilities Installation

Installation of Traffic Signs, Road Markings and Traffic Lights, etc

b) Open Ditch Cleaning

Open ditch cleaning is done manually or shovel car and involves excavation back to original invert level of ditches which have been become silted up during rain.

c) Pipe culvert Cleaning

Cleaning and Flushing of existing pipe drainage by water jet.

d) Gravel Patching

Patching the pothole involves the replacement of gravel in worn and eroded area of surface and shoulder of gravel and earth roads.

e) Grading

Grading is the most expensive routine maintenance activity. Light grading is carried out when the road surface is dry and preferably, heavy grading is done after rain. In determining the frequency of grading, taking into account traffic and surface type, grading will be two times a year.

In dry season, water tanker will be used for spraying water on the roads being improving with grader and rollers for the purpose of earth consolidation.

The summary of required equipments for routine maintenance is shown as follows.

Table 23.2.3 Summary of required equipments for routine maintenance

Equipments	Quantity	Remarks
(a) Equipments		
Tipper Track	1	Pothole patching
Water Tanker	2	
Pump	1	
Water Jet	1	Flushing and cleaning of the pipe drain
Grader	1	Grading
Shovel car	2	Cleaning of open ditch
Dump track	2	
Pick up track	2	Supervisory vehicle
(b) Materials		
Diesel	61,00 lts	
Gasoline	18,000 lts	
(c) Staffs		
Inspector	1	
Foreman	1	
Drivers/Operators	9	
Helpers	9	
Labours	16	

23.3 ESTABLISHMENT OF MAINTENANCE PROGRAMME

23.3.1 Required Road Maintenance Cycle

The project roads will need the routine maintenance and the periodic maintenance after 10 years from the completion of the project.
The other roads except the project roads will need the routine maintenance and the periodic maintenance each 7 years.

The required road maintenance cycle is shown as Figure 23.3.1

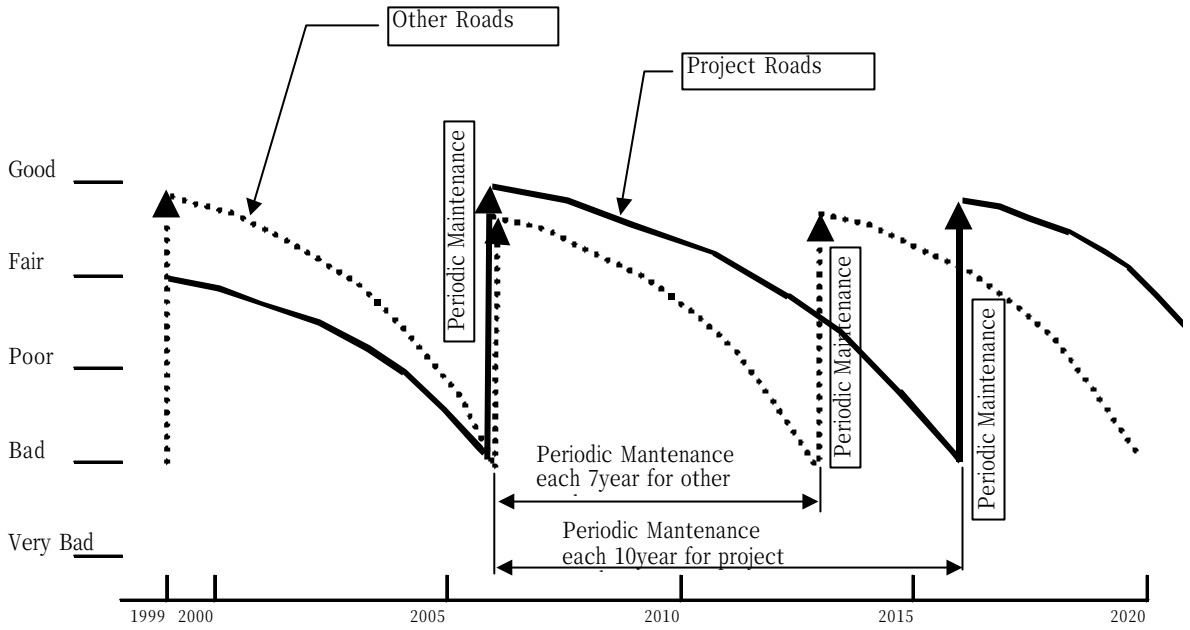

Figure 23.3.1 Required Road Maintenance Cycle

Maintenance Cost

Normally routine maintenance cost is estimated as follows,

Table 23.3.1 Maintenance Cost

	Routine maintenance	Periodic maintenance	
	Maintenance cost	Maintenance cost	Maintenance cycle
Project roads	annual 1.5% of the construction cost	10% of the construction cost	10year
Urban roads except project roads	1,200USD/km/year (equivalent to 5% annual of the construction cost)	3,600USD/km/7year (equivalent to 30% of the construction cost)	7year
Semi urban roads except project roads	600USD/km/year (equivalent to 10% annual of the construction cost)	1,800USD/km/7year (equivalent to 15% of the construction cost)	7year

The DRB should make the maintenance programme by considering the above maintenance cycle and maintenance cost.

23.4 PROCURMENT AND INSPECTION METHOD OF MAINTENANCE WORK

The DRB should prepare the following items for execute the maintenance by the private enterprise.

23.4. 1 Preparation of standard unit price for each work items

In the present condition, the DRB does not have the standard unit price for each work items so that it is impossible to make an annual maintenance programme by the DRB.
The DRB should prepare the standard unit price for each work items for themselves.
The standard unit prices should be updated in consideration of the condition of work items.

23.4.2 Preparation of Standard Specification and Contract Documents

The DRB should prepare of the standard specification and contract documents due to manage the road maintenance efficiency. The data of them should be stocked into the computer.

23.4.3 Preparation of Short List of the Contractors and the Consultants

The DRB should evaluate of the contractors/consultants and prepare of the short list of them due to vitalise of the economic activity. The total cost of the road maintenance will be reduced, but the quality of the road maintenance will be increase by competition of the each private enterprises.

23.5 TECHNICAL ISSUE OF MAINTENANCE WORK

23.5.1 Confirmation of the difference between previous road development plan and existing condition of roads and traffic volume

It is important to check whether the existing road and traffic condition is adjusted to the previous development plan or not. The road development planning section of the DRB should survey the existing road condition and traffic volume.
If it is identified the difference between the existing road and traffic condition based on the previous development plan, the DRB should revise the road development plan.

23.5.2 Design

The DRB has not have the road design standard for urban roads so that it is impossible to require keeping the design quality to the consultants.
The road design standard for urban roads should be established by the DRB due to keep the quality of the design outputs.

23.5.3 Future Traffic Forecast and Economic Analysis

The future traffic demand will be forecasted using the JICA STRADA model for the target year on the result of the pavement condition survey and traffic survey.
The economic and financial analysis will be done based on the revised traffic forecast.
In order to run the new road maintenance system effectively, it will be necessary a provision of budgetary fund of expenditure.

23.6 OTHERS

23.6.1 Construction of the Training Room

The DRB should have the maintenance training room due to strengthen road maintenance capability.
The required structural strengthening of the fields is shown as follows.

- Training of operation for upgrading data on road maintenance and planning
- Training of theory and practical operation on road maintenance
- Training of administrative and supervise staff for maintenance works
- Training of mechanics and operators and technical staffs

There is enough space to construct the training room at the property of the existing DRB.
The space of the proposed training room is necessary approximately 200 m^2.

23.6.2 Dispatch of the Expert for the Road Maintenance

In consideration of the scarcity of adequate inland trainers, some experts would be invited to the DRB.
Following five experts expatriates consisting of 1 long term expert and 4 short term experts for about two years.

(1) Long term expert for road maintenance

The long-term expert shall assist the DRB staffs in identifying a general work plan for strengthening of the road maintenance efficiency of the DRB. The proposed scope of work includes;

a) Work programme, setting out method, management and operation of construction equipment, labour force requirement, arrangement of construction materials, quality control, expenditure control of works and cash flow planning consisting with the most efficient allocation of resources.
b) Establishment of a training programme based on the manpower requirement and implementation of an effective on the job training.

(2) Short term expert

The following fields are required for strengthening road maintenance capability of the DRB.

- Road maintenance method
- Construction method for rehabilitation
- Maintenance programme
- Traffic forecast

23.6.3 Installation of the Training Equipments

The DRB has not enough equipment for management so that it is necessary to install the following equipments for maintenance training.

The installations of the computers are necessary at each section of the DRB.
Stock of databases for the followings is very important to manage the road maintenance efficiency by the DRB.

- Database of the road inventory
- Database of specification and contract documents
- Registration of the contractors and consultants
- Database of the traffic data
- Database of the Public Utilities
- Database of the Progress Records

The above-mentioned databases will be updated when the data will be changed.

Table 23.6.1 Required Equipments for Maintenance Training

Descriptions	Quantity	Remarks
(a) Equipments		
Desk top computer	5	Each section
Server	1	
Plotter	3	
Printer	5	
Projector	1	
Video Camera	1	Progress records
(b) Software		
Office tool software	5	
Cad software	5	

23.6.4 On the Job Training for road maintenance

The capability of the evaluation for a rehabilitation done by the private enterprises should be strengthen to manage the road maintenance efficiency.
Training of the actual maintenance should be implemented by on the job training by the contractor. Main training theme is Quality control, Flow control and Quantity control for the rehabilitation.

23.7 Recommendation

1) Establishment of New Road Department

The new road department (DRB) should be established as soon as possible due to introduce a privatisation to accelerate the effective and the efficient daily, routine and periodic maintenance of the road as well as maximization of the national resources.
The new road department should concentrate to manage and supervise the maintenance activities.

The MCM should introduce the new financial support to the road maintenance cost showing as follows.

- Introduction of new tax (city planning tax for District 1, fuel tax, on street parking charge, subsidy to off-street parking)

2) Technical Support for Road Maintenance

2)-1 Supply of Road Maintenance Equipments and Training Equipments

It is necessary to supply the road maintenance equipments and training equipments recommended by this study for the structure strengthening the DRB to introduce the privatisation to the road maintenance.

2)-2 Dispatch of the Expert for the Road Maintenance

Dispatch of the experts for the road maintenance is necessary to strengthen the road maintenance capability of the DRB. The DRB should acquire the following items.

- Theory and practical operation on road maintenance
- Operation for upgrading data on road maintenance and planning
- Administrative and supervise staff for maintenance works

The training room should be constructed in the property of the DRB.

CHAPTER 24

CONCLUSION AND RECOMMENDATIONS

CHAPTER 24 : CONCLUSION AND RECOMMENDATIONS

24.1 CONCLUSION

The feasibility study proved that project roads of Package A, B and C are technically, economically and environmentally feasible having a high economic internal rate of return of 38.6 %, 20.5 % and 23.0 % with a average respectively.

Therefore the projects should be realized within the earliest possible time, in the following priority order taking into consideration the functions of the involved roads, especially early linking of the missing link of Av. J. Nyerere on trunk road is important and is necessary to increase the surround economic, to reduce the traffic congestion of other trunk road. However it is necessary to arrange house compensations, relocation of utilities and so on. Therefore the priority order of the project road should be considered through all factors.

Priority	Proposed Roads
1 st (Package C).	- Rehabilitation of pavement and drainage on Industrial and Commercial Area Roads (L = 6.03 km)
	- Rehabilitation of pavement and drainage on Port Area Roads (L = 3.9 km)
	- Rehabilitation of pavement and drainage on District 1 Area roads (total length = 8.7 km)
	- Improvement of Bus Bays and Bus terminal (23 numbers)
2 nd. (Package A)	- New construction of the missing link of Av. J. Nyerere (L = 5.6 km)
	- Improvement of Av. V. Lenine
	- Improvement of Av. A. Lusaka (L = 2.8 km)
	- Construction of the Bus terminal at the Combatentes Plaza
	- Rehabilitation of pavement and drainage on District 3 Area Roads (total length = 9.5 km)
3 rd. (Package B)	- Widening of Av. G. Popular (L = 0.7 km)
	- Improvement of Av. Angola (L = 3.1 km) and S. Cabral/Largo de Deta (L = 0.6 km)
	- Improvement and widening of Av. M. Ngouabi (L = 1.9 km)
	- Rehabilitation of pavement and drainage on District 2 Area Roads (total length = 8.7 km)
	- Improvement of Intersections in the CBD (14 intersections)

Table 24.1.1 shows the summary of the project feature for the above roads.

It is noted the following major benefits and effects are expected to accrue from the implementation of the Projects.

1) Improvement of Traffic Congestion on the Trunk Roads Network

Due to the high rate of the city's expansion as well as the recent remarkable increase of traffic demand accompanying the economic recovery in Maputo area, the traffic flow on the city roads has greatly increased and caused serious traffic congestion on the trunk roads which have insufficient traffic capacity due to having only 2 lanes for the unsuitable road structure and the deterioration of pavement surfaces.

The Widening of Av. Marien Ngouabi and Av. Guerra Popular from 2 to 4 lanes and the improvement of Av. Angola and Av. Acordos Lusaka will solve chronic traffic congestion on the roads in the city. Accordingly, it will improve not only economic and social activities but also the daily life of the people in the city.

2) Improved PRSP through Rehabilitation of Local Area Roads

Area roads in District 2 and District 3 are almost unpaved and narrow road. Therefore most of local area roads are impossible to pass smoothly due to lack of drainage system in rainy season. Such road environment is caused to delay the development and economic growth of community area.

In order to create a better environment and to enhance economical effect in the existing Community Area as well as create good access to public community facilities in the community area, local area roads should be rehabilitated for improving PRSP.

Table 24.1.1 Summary of Project Feature

Project Road			Design Speed (km/h)	Carriageway Width (m)	Shoulder/ Parking Lane Width (m)	Sidewalk Width (m)	Utility Space (m)	Median Strip (m)	Total Width (m)	Drainage Type	House compensation
Package A	trunk roads	Av. J. Nyerere	60	3.25	1.25	4.00	2.00	-	22(40)	V	required
		Av. V. Lenine	50	3.50	0.50	2.00	2.00	-	16	L	required
		Av. A. Lusaka	60	3.00	2.00	4.00	1.00	2.00	28	L/V	None
	District 3 area roads	Rua da Goa	40	3.00	-	1.50	0.50	-	10	LU	required
		Rua da Lixera	40	3.00	-	1.50	0.50	-	10	LU	required
		Av. Milagre Mbote	40	3.0(5.0)	-	1.50	0.50	-	8～10	LU	required
		Av. da Malhangalene	40	3.0(5.0)	-	1.50	0.50	-	8～12	LU/V/U	required
		Rua 1 de Maio	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3306	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3523	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3576	40	3.00	-	2.00	1.00	-	14	V/U	required
Package B	Collector roads	Av. G. Popular	50	3.00	0.50	3.50	-	-	20	L	required
		Av. Angola	50	3.50	2.50	4.00	-	-	20	L	None
		Rua S. Cabral/Largo de Deta	50	3.50	2.50	4.00	-	-	20	L	None
		Av. Marien Ngouabi(4 lane)	50	3.00	0.50	3.50	-	-	20	L	required
			50	3.50	2.50	4.00	-	-	20	L	None
	Ddistrict 2 area roads	Rua 2282/2265	40	3.0(5.0)	-	2.00	0.5～1.0	-	8～14	LU/V/U	required
		Rua 2275	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua de Xipamanine	40	3.00	-	1.50	0.5～1.0	-	10～14	LU/V/U	required
		Rua dos Imaos Roby	40	3.00	1.50	1.50		-	12	V/U	required
		Rua 2315/2313	40	3.00	-	1.5～2.0	0.5～1.0	-	10～14	LU/V/U	required
		Rua 2309/2324	40	3.00	-	2.00	1.00	-	14	V/U	required
		Av. das Estancias	40	3.00	-	1.50	0.50	-	12	V/U	required
Package C	I/C area roads	Av. J. Michel	40	3.00	1.00	4.00	-	-	16	L	None
		Av. F. de Magalhaes	40	3.00	3.00	4.00	-	-	20	L	None
		Av. Z. Magalhaela	40	3.00	3.00	4.00	-	-	20	L	None
		Av. M. Siad Barre	40	3.00	2.00	3.00	-	-	16	L	None
		Av. Romao Fernandes	40	3.00	1.00	4.00	-	-	16	L	None
		Rue 1229	40	3.00	3.00	3.00	-	-	16	L	None
		Av. As Estancias	40	3.00	1.00	3.00	-	-	12	L	None
	Port area roads	Rue Consigglieri Pedroso	30	3.00	1.00	2.50	-	-	13	L	None
		Rue Joaquim Lapa	30	3.00	1.00	3.00	-	-	14	L	None
		Rue do Bagamayo	30	3.00	0.00	3.00	-	-	12	L	None
		Rue de Timor Leste	30	3.00	1.50	2.00	-	-	13	L	None
		Av. Martires de Inhaminga	30	3.00	4.00	2.50	-	-	19	L	None
		Other 6 roads	30	3.00	0.00	2.00	-	-	10	L	None
	District 1 area roads	Av. Milargre Mabote	40	3.00	1.50	3.50	-	-	16	L	None
		Av. da Malhangalene	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Para O Parmar	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Kaweme Nkrumah	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Paulo Samuei Kankhomba	40	3.00	1.00	6.00	-	-	20	L	None
		Av. Emilia Dausse	40	3.00	1.00	6.00	-	-	20	L	None
		Av. de Maguiguana	40	3.00	1.00	6.00	-	-	20	L	None
		Av. Filipe Samuel Magaia	40	3.00	3.00	4.00	-	-	20	L	None
		Av. Friendrich Engels	40	3.00	1.00	2.00	-	-	12	L	None

V: Open ditch type, L: L-shaped type, LU: L-shaped lid and U-shaped type, U: U-shaped type

3) Improvement of Intersections in the CBD

In order to increase the traffic capacity on intersection in CBD, some intersections of the trunk roads should be improved to keep the smooth traffic flow. The following measures should be established to the major intersections.

<Establishment of Right-turn Lane>
The right-turn lane should be constructed to the major intersections on Av. Mao Tue Tung, Av. Eduardo Mondlane, Av. 24 de Julho and Av. 25 de Setembro for Av. J. Nyerere, R. dos Lusiadas, Av. Vladimir Lenine, Av. Karl Marx, Av. Guera Popular and Av. da Zambia.

<Improvement of Traffic Signals>
Signal pattern timing should be adequately adjusted according to the traffic movement. Furthermore, traffic signals should be established to the un-signaled intersections where the bus routes cross with the trunk roads.

4) Improvement of Public Transport Services

Based on the future traffic estimation, future demand of bus traffic would grow rapidly. In order to enhance the future bus traffic efficiency, the development concepts are as follows.

<Completion of public transport services>
In order to open the public transport services to un-served area, branch bus routes on collector roads and local area, which should be improved.

<Smoothly bus operation>
In order to operate smoothly buses, it needs to adopt bus lanes on the dual carriageway road such as Av. Eduardo Mondlane.

<Completion of bus information>
In order to use easily buses for passengers, bus information system should be improved and information board should be installed at bus stops.

5) Improvement of Bus Bays and Bus Terminals

Bus stopping on carriageway causes traffic congestion problem at Bus Stops due to shortage of proper bus bay space of the main carriageway. Therefore, construction of properly sized Bus Stop with bus bays and shelters should be needed.

Existing problem at bus terminals are caused by lack of proper spaces for buses, taxis and trucks, and market activities. Therefore, existing bus terminals should be equipped with proper stopping and moving spaces for buses, taxis, trucks and market spaces.

6) Improvement of Roadsides Environment

The population and the traffic volume are steadily increasing every year in Maputo city. Therefore, in order to reduce the aggravation of environment caused by traffic congestion, the implementation of the high priority project will bring many beneficial effects on socio-economic, natural environment and social environment as described below.

- Establishment a rule of Resettlement

The new construction of the missing link of Av. J. Nyerere and the widening of Av. M. Ngouabi and Av. G. popular will certainly require the resettlement of houses.
It is concluded that the mitigation measures should include appropriate house compensation for resettlement, securing places for persons to move to, and to settle various problems associated with the resettlement.

- Prevention of Air pollution

Unless the existing road conditions and road network are improved, the air pollution will become much worse due to an increase of the traffic condition.
It is concluded that the air pollution can be reduce to the level of a national standard, since the unpaved roads and the traffic congestion will improve and reduce respectively.

- Prevention of Noise and Vibration

Unless the existing road surface conditions are improved, the noise and vibration to the houses along the roads will become much worse due to the traffic volume increase.
It is concluded that the noise and the vibration will be reduce to the level of a national standard, since the deteriorated road surfaces will improve.

- Prevention of Flood Hazard

Overflow of water on the roads including flooded water has been observed in many places due to damaged roads and insufficient drainage condition.

It is concluded that the drainage system will be eliminated by improvement of the project implementation

24.2 RECOMMENDATIONS

In order to materialize the projects, the Study team recommends that MCM takes the following actions.

1) Financial Measure Required

According to the cash flow analysis for the projects in Chapter 22, the financial situation of the MCM is not wealthy enough. In order to conduct surely the projects, the MCM should consider the following financial resources:

- To ensure the MCM own budgets and the return of the fuel tax during projects activities,
- To ensure the foreign budget for the periodic and routine maintenance, and
- To establish the Road Fund account in the MCM.

2) Allocation of Local Budget for House Compensation

It is recommended to allocate the necessary amount of local funds for house compensation and utilities relocation which might be necessary for implementation if the Projects. House compensation and utilities relocation should be conducted according to the project implementation schedule as follows:

Year	Schedule of H/C and U/L
1 st. year (2002)	House compensation on missing link of Av. J Nyerere and District 3 local area roads and Utilities relocation of on Av. J. Nyerere and Bus Stops and Terminals
2 nd. year (2003)	House compensation on missing link of Av. J. Nyerere, Av. M. Ngouabi, Av. G. Populae, District 2 and 3 local area roads and Utilities relocation of Av. J. Nyerere, District 2 and 3 local area roads
3 rd. year (2004)	House compensation on Av. M. Ngouabi, Av. G. Popular and District 2 local area roads and Utilities relocation of District 2 local area roads

Furthermore, it is recommended that the land required for the road development should be controlled by the MCM until the actual development takes place.

3) Forming a Suitable Resettlement Plan

Resettlement of the residents and workers along the project roads will be required before the implementation of the projects is started. In order to prevent social, economic and environmental impacts of the resettlement on the residents in advance, it is recommended that a suitable resettlement plan should be established paying due attention to the following items:

- Funding the resettlement compensation,
- Securing places to move the persons to be resettled,
- Ensuring the living standards in the places to move into, and
- Holding discussions with the residents to be resettled to reach a mutual consent.

4) Improvement of Storm Drainage System

The flooding damage of existing Av. J.Nyerere was almost caused by the defectiveness of drainage system in February 2000. Because the type of drainage was the pipe culvert and the lack of maintenance against accumulated sand and solid waste. From such viewpoints, the following measure should be conducted.

(1) Recommendable Road Drainage System

Road drainage systems of project roads should be considered the following methods.

- U-shaped drain with cover, which can remove for cleaning inside the drainage and can load directly vehicles, should be used in urbanized area and local area road in narrow ROW. Its width is narrow and easy to cover with concrete lid shaped flat type or L type. Pre-cast concrete type will be more preferable for repair.
- V-shaped open drain is made from concrete or stone pitching. The former should be used to trunk roads in sub-urban area. And the latter should be used to trunk roads and local area roads.
- K or L-shaped drain is made from concrete blocks or stabilized soil. The former should be used local area roads for temporary construction. The latter should be used to local area roads in narrow ROW.

(2) Routine Maintenance of Roadside Drainage by MCM and Resident People

Routine / periodic maintenance of drainage facilities, consisting cleaning, repair and reconstruction of drainage facilities, should be conducted by the new road department of MCM.

In addition, easy maintenance such as cleaning, dredging, prevention of garbage dumping

etc., should be done by the resident people. Therefore, enlightenment of such action should be initiated by district offices in cooperation with the new road department of MCM.

(3) Improvement of Area Drainage System by MCM

Project for improvement / restoration of local area drainage system should be conducted by relevant department of MCM. Such improvement project should be proceeded in parallel with the progress of the road development projects.

5) Establishment of DRB Maintenance System

In order to function effectively the DRB by the implementation of the high priority project, the Study Team recommends to the MCM to establish the following new road department.

- Planning Section
- Design Section
- Procurement Section
- Management Section
- Emergency Maintenance Section