3.3.2 Natural Environment

(1) Topography and Geology

The city of Maputo is situated in the southern part of Mozambique at 26° southern latitude and 32°-35°eastern longitude. It is divided into two geomorphologic areas: the coastal plain area (lower regions) and a higher area with inland dunes. The city seats on a platform of Pleistocene red sand alternating with alluvial soils of poor structure in the lower regions. The Pleistocene sands rest on the formations of red sandstone that are found on the verge of Polana and Maxaquene.

The city originated from this embankment in areas that until the beginning of this century were dominantly Pans with hydromorphic soils typical of machangos, with deposits of clay-quartz rich in organic materials.

Initial the city occupied just a line of sand of about 1200 meters, in the area which extends from the fortress to the chancellate of Eduardo Mondlane University.

Before Land filling and the construction of the protective wall to contain the sea, the lower area of the city, suffered directly from the effects of tides.

The action of the sea is due to the vertical cut of "arribas" of Tertiary and the formation of the beaches of white sand to the Northwest of current level.

After the complex operations of land filling and sanitation the city developed climbing the embankment on the southeast and extending south, in a flat plane of about 40 to 50 meters.

After the sedimentation of the rock formations of the Tertiary period, a series of regressions and transgression characterized the quaternary in the south region of Mozambique. The periods of regressions corresponded to the formation of the littoral dunes that in the whole of the region are oriented from south to north, and this corresponds winds that dominated the region then.

(2) Soil Erosion

The expansion of city has drastically changed the natural situation. Due to the vegetation was removed for construction of houses and agricultural purposes, the soil became exposed to water.

In the 80's a drainage system was constructed. However, neglected maintenance of the system led to the destruction of almost all of it. In 1989 small ravines are formed between the plateau and the coastal area, and these became more and more developed after each heavy rain.

In 1998 the erosion damages were very significant due to the heavy rain. Av. Julius Nyerere was cut and a lot of houses were destroyed. Especially, in February 2000, the intense and continuous rains caused an enormous increase to the craters.

(3) Superficial Water

Maputo city is located in Maputo bay, at the confluence of three rivers – Maputo, Umbeluzi and Incomati. All of them are important rives, shared with upstream countries. Umbeluzi River supplies Maputo city with the drinking water. In a lower scale there are also small coastal basins that drain directly into the ocean.

In Maputo city, superficial water is mainly drained by the natural drainage and artificial drainage. The artificial drainage water system comprises pipes and ditches. It is very important to the storm-water drainage. The drainage water system pass the unpaved areas, thus, cleaning and maintenance procedures must be done periodically, almost after each intense rain. Unfortunately these procedures have not been carried out, affecting drastically the drainage system.

(4) Ground Water

The study area seats on a dune belt which develops along the entire coastal south of the Save (a river which divides the southern region of the country with the central). The porous eolian sands form a phreatic aquifer with fresh water. The permeability decreases from the coast inland, as a consequence of the increase in clay content.

The geological formation of Maputo city plateau is characterized by the occurrence of ground water between 7 and 15 meters depth.(MUCHANGOS, 1994).

The ground water quality can be recognized in the study area:

a) Chloride Concentration

Since the study area is on a coastal aquifer, the salinity of the groundwater is generally the most important chemical parameter regarding drinking water purposes. WHO (World Health Organization) standards mention recommendable chloride concentrations of 200mg/l and maximum allowable concentration of 600 mg/l. From the previous study, the larger area of the site in consideration has got chloride concentrations well below the maximum permissible concentrations.

In average the study area has chloride concentrations of 254.01 mg/l, which makes the groundwater of the study area adequate for drinking purposes as it is commensurate with the WHO standards. The concentration of chloride ions is higher on the coastal plain and it also decreases until inland and well before the Infulene Valley in which the shallow aquifer presents higher chloride concentrations due to the sea water intrusion with this layer.

b) Sulphate concentration

The sulphate concentrations of the shallow groundwater varies between 4 to 253mg/l .This concentration is within the acceptable range , as the internationally recommendable range for drinking water < 250-400 mg/l. The relatively high values are found in brackish water areas like Infulene Valley.

c) Magnesium concentration

The concentration of magnesium in fresh water generally shows values below 40mg/l. The magnesium concentration in the study area varies between 0.4 and 70mg/l with few exceptions where higher values are encountered. It can be said that the water quality is within the international standards (max 125mg/l).

d) Potability

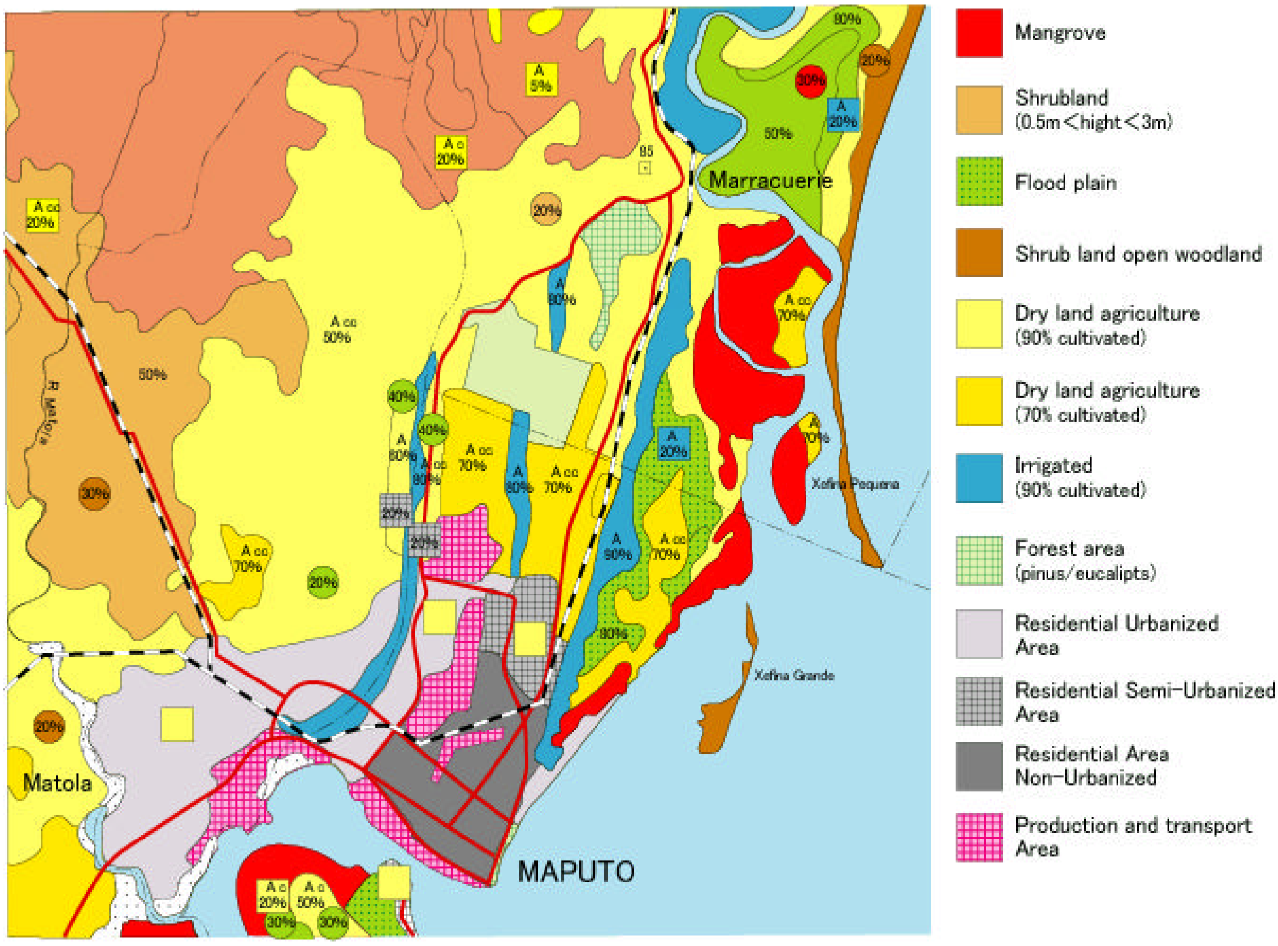
The quality of the groundwater should generally be in agreement with the international standards with respect to physical chemical and biological properties. From the chemical properties treated above, the groundwater in the study area meets the standards.

(5) Flora and Fauna

For the ecological analysis the study area could be divided into two main areas: the Maputo plateau and the coastal plain. According to the record of some documents, the plateau was occupied by an open forest and then it became to a savanna by anthropogenic action. At present, more of the areas become a residential area.

The coastal plain that is located at the south limit of the Incomati Estuary, characterized by a dune cordon along the coast, establishing a linkage with an interior wet area. At this wet area there are some of the dune vegetation and flood plain communities (mangroves, salt marshes and reed beds). Vegetation in Maputo bay and surroundings is shown in Figure 3.3.4

Mangroves near Maputo have been almost devastated. In Costa do Sol only a vestige area remains. The cause that mangroves were destroyed is the expansion of residential areas, fuel-wood collection, changes in salt water composition, water contamination by domestic waste water and solid waste disposal. Recently a proposal which classify the existing wet area as a protected area where no construction will be allowed was propounded to the Municipality. If this plan was sustained, the mangroves will have a chance to survive.



Source: Scope Assessment and Preliminary Design Study of Repair of Avenida Julius Nyerere, Maputo, Mozambique (SAPDSRAJNMM), 2000

Figure 3.3.4 Vegetation in Maputo Bay and Surroundings

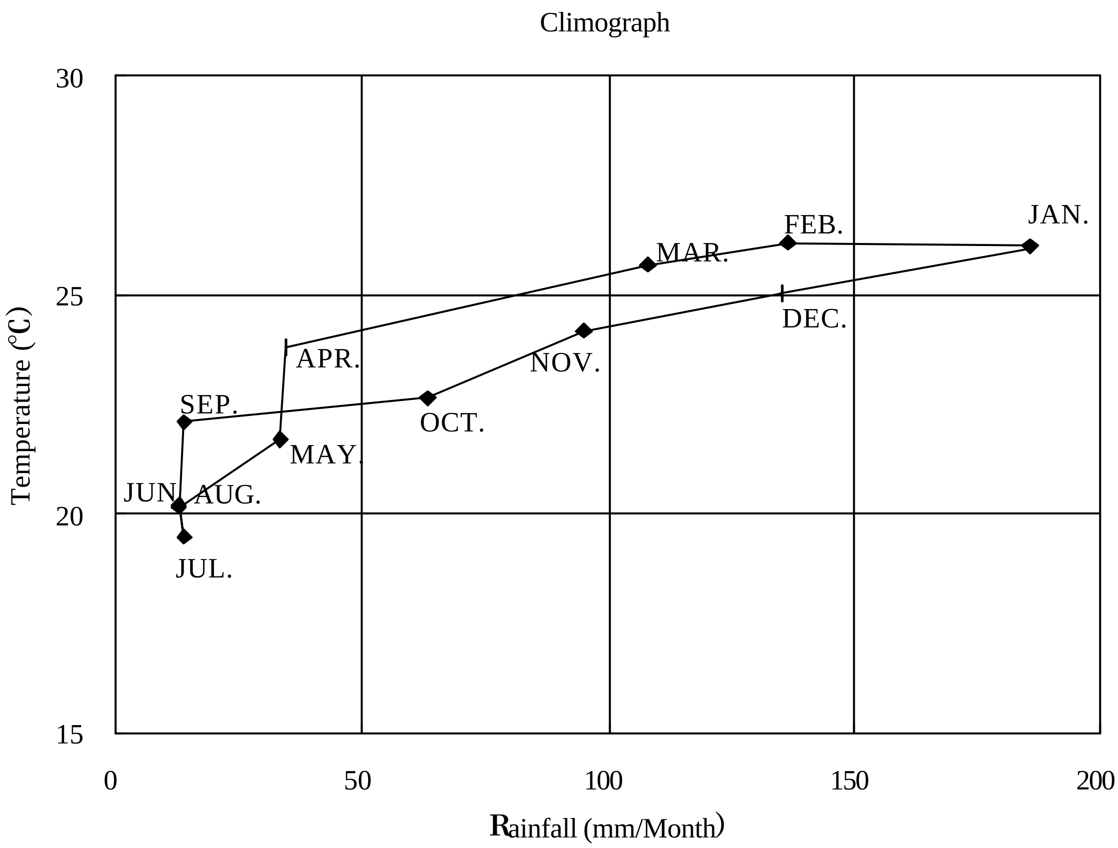
(6) Meteorology

Maputo is characterized by a tropical humid climate, with two distinct seasons – hot and rainy

(October – March) and cool with little precipitation (April– September).

The average annual temperature, between 1990 and 2000, was 23℃, since the ocean influence the thermic amplitude is low.

Figure 3.3.5 shows the average mensal temperature and rainfall for the period between 1990 and 2000. For this period (exclude 1993) the mean annual rainfall is 819mm. Intense rainfalls occur usually in months between December and March.



Source: National Meteorology Institute, 2000

Figure 3.3.5 Climograph of Maputo (1990-2000)

Another fundamental climatic characteristic necessary in the present study, is the direction of winds, as they're of paramount importance in the analysis of Air pollutants settlement.

Table3.3.3 below shows the predominant wind directions in Maputo city for the period between 1990 and 2000. From the table it can be seen that in summer winds are predominantly south-east and north-east during rain season.

Table 3.3.3 Wind directions in Maputo city (1990 – 2000)

Month	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Wind Direction	SE	SE	SE	SE	SW	SW	SW	S	NE	E	NE	NE

Source: National Meteorology Institute, 2000

3.3.3 Environmental Pollution

There are not any existing data of air pollution, noise and vibration in Maputo at present. Thus, in order to collect the basic data for consideration of scope of EIA, a series of environmental survey was carried out with help of local consultants.
The survey items are as follows:

- Air Pollution
- Noise
- Vibration

Locations of survey points are indicated in Figure 3.3.6.

(1) Air Pollution

a) Standard on air quality

Mozambique has not established own standard on air quality. The air quality standard is generally referred to “world-standards” by the WHO (World Health Organization) (the World Bank were adopted the WHO Guidelines values for Bank’s projects). A summary of relevant WHO guidelines is given in Table 3.3.4.

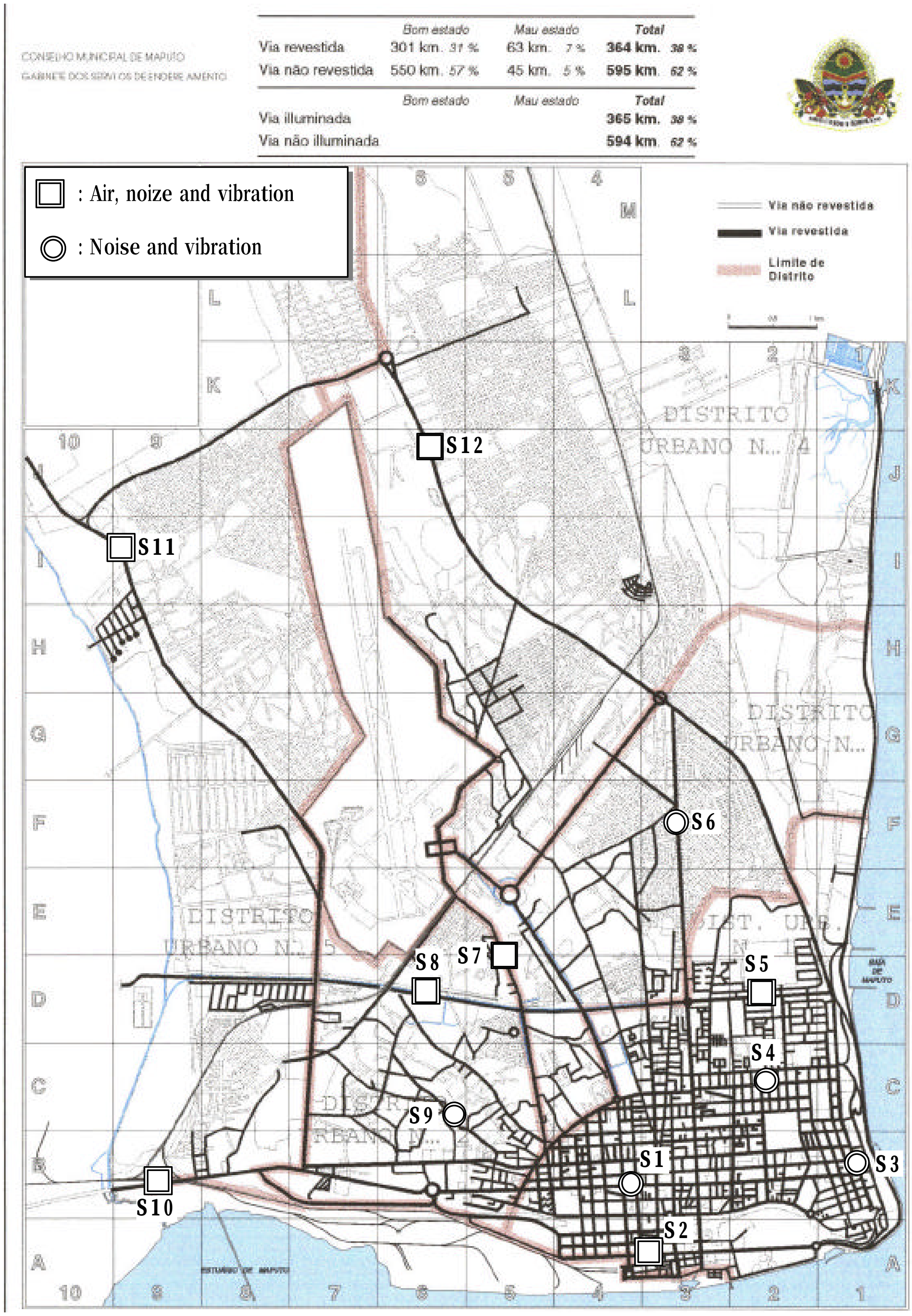


Figure 3.3.6. Environmental pollution survey sites

Table 3.3.4 WHO Guideline values and limits for air quality

Substance	Guidelines value	
	Time-weighted average concentration (per m^3)	Averagin time
SO_2 (Sulphur dioxide)	350 μg	1hour
	125 μg	24hours
	50 μg	1year
NO_2 (Nitrogen dioxide)	400 μg	1hour
	150 μg	24hours
CO (Carbon monoxide)	60mg	30minutes
	30mg	1hour
	10mg	8hours
TSP (Total suspended particulates)	120 μg	24hours
Pb(Lead)	0.5-1.0 μg	1year

b) Existing air quality

Air quality survey was carried out at 7 sites (shown in Figure 3.3.6.) in January 2001 by colorimetric method that measures in changing of color in the chromair, using comparator that direct to read the concentration in ppm.

The details of the analysis of samples collected at the above mentioned sites are summarized in Table 3.3.5. and Table 3.3.6. Concentration of NO_2 (Nitrogen Dioxide), SO_2 (Sulphur Dioxide) and CO (Carbon Monoxide) on weekdays and holidays is lower than the WHO guideline values.

Table 3.3.5 Summary Results of Air Pollutant Survey (Weekday)

¹	Location		Substance (Averagin time: 1hour)		
			NO_2 (Nitrogen Dioxide)	SO_2 (Sulphur Dioxide)	CO (Carbon Monoxide)
			ì gm^3	ì gm^3	mg/m^3
1	Av. 25 de Setembro	S2	307.5	285.6	21.5
2	Av. Kenneth Kaunda	S5	255.0	220.7	17.3
3	Avenlda de Angola	S7	311.7	300.2	22.8
4	Rua 2.500	S8	266.5	257.0	19.2
5	Av. da Namaacha	S10	246.0	171.3	16.3
6	Av. de Mocamblque	S11	225.5	165.0	17.0
7	Av. Julius Nyerere	S12	215.2	157.0	14.4
	WHO Guideline Values		400	350	30

Table 3.3.6 Summary Results of Air Pollutant Survey (Holiday)

¹	Location		Substance (Averagin time: 1hour)		
			NO2 (Nitrogen Dioxide)	SO2 (Sulphur Dioxide)	CO (Carbon Monoxide)
			ì gm³	ì gm³	mg/m³
1	Av. 25 de Setembro	S2	287.1	265.0	19.3
2	Av. Kenneth Kaunda	S5	240.5	220.8	17.0
3	Avenlda de Angola	S7	300.6	292.7	20.4
4	Rua 2.500	S8	255.0	250.5	17.5
5	Av. da Namaacha	S10	248.2	170.0	17.2
6	Av. de Mocamblque	S11	220.0	162.4	16.5
7	Av. Julius Nyerere	S12	210.2	150.5	14.0
	WHO Guideline Values		400	350	30

(2) Water pollution

In Maputo city, there are some low-income residential areas, semi-infrastructured or even without any infrastructure. Polana-Canico is one of the areas, where the houses usually have latrines and in some cases septic tanks. In both situations, the groundwater and the superficial water are contaminated by organic and bacteriologic wastewater. The scatter solid waste disposal is also an important pollution source to be considered in this area.

Thus, the superficial aquifers have high levels of Escherichia coli, as a high level of nitrates from domestic waste, exceeding in some cases 200 mg/l. The saline intrusion affects also the groundwater near the coast. In Maputo city, the water from the deep wells is usually potable, except in the surroundings of the waste disposal site in Hulene (PROL, 1999).

(3) Noise and Vibration

a) Standard on noise and vibration

In Mozambique, which does not have own established standards on noise and on vibration, the World Bank's noise guideline is applied and it's values are shown in Table 3.3.7. Regarding vibration, the World Bank has not any standard. Thus, vibration regulation limit for road areas in Japan is applied.

Table 3.3.7 The World Bank's Guideline Values for Noise

Maximum Allowable L_{eq}(hourly), in dB(A)		
Classification of District	Daytime (07:00-22:00)	Nighttime (22:00-07:00)
Residential Districts Institutional Districts Educational Districts	55	45
Industrial Districts Commercial Districts	70	70

Table 3.3.8 Vibration Request Limit for Road Side Areas in Japan

Classification of District	Daytime (07:00-22:00)	Nighttime (22:00-07:00)
Residential Districts Non-Zoning Areas	65	60
Commercial Districts Quasi-industrial Districts Industrial Districts	70	65

b) Existing noise and vibration level

Noise and vibration survey was carried out at 12 sites along the proposed roads (shown in Figure 3.3.6.) in January 2001. During 10 minutes (continuously from per two hours) noise and vibration were measured using SL-4001 sound level meter and VM-52A vibration level meter. The survey were carried out on weekdays and holidays, during day and night times.

The details of the analysis of survey implemented at the above mentioned sites are summarized in Table 3.3.9. and Table 3.3.10. Traffic noise level L_{eq} (the equivalent continuous A-weighted sound pressure level) and Traffic vibration level L_{10} (the highest value of 80% range of vibration level) are for buildings that are located along the roads. The noise level during day and night times is lower than The World Bank's guideline values, and the vibration level during day and night times is lower than vibration regulation limit for road areas in Japan.

Table 3.3.9 Summary of Road Traffic Noise Level Leq (dB)

1	Location		Category of Areas	Daytime (07:00～22:00)			Nightime (22:00～07:00)		
				Weekday	Holiday	Guideline Values	Weekday	Holiday	Guideline Values
1	Av. 24 de Julho	S1	Commercial Districts	66.4	63.0	70	52.5	51.4	70
2	Av. 25 de Setembro	S2		65.6	62.2		52.7	50.3	
3	Av. Julius Nyerere	S3		60.2	57.9		51.5	49.6	
4	Av. Mao Tse Tung	S4		53.5	51.6		43.0	42.0	
5	Av. Kenneth Kaunda	S5	Residential and Institution Districts	53.3	52.0	55	42.0	41.2	45
6	Avenida Vladimir Lenine	S6	Residential Districts	54.1	52.8		43.4	42.3	
7	Avenlda de Angola	S7	Industrial Districts	66.2	64.5	70	53.8	51.7	70
8	Rua 2.500	S8	Residential Districts	52.2	51.0	55	41.5	40.2	45
9	R. Dr. Lacerda	S9		51.4	50.8		40.8	40.6	
10	Av. da Namaacha	S10	Agricultural Districts	53.8	52.7	55	43.1	42.4	45
11	Av. de Mocamblque	S11	Residential Districts	54.0	53.3	55	39.2	37.8	45
12	Av. Julius Nyerere	S12		52.6	50.3		43.2	41.0	

Table 3.3.10 Summary of Road Traffic Vibration Level L_{10} (dB)

1	Location		Category of Areas	Daytime (07:00～22:00)			Nightime (22:00～07:00)		
				Weekday	Holiday	Request Limit	Weekday	Holiday	Request Limit
1	Av. 24 de Julho	S1	Commercial Districts	40.4	38.5	70	37.0	35.8	65
2	Av. 25 de Setembro	S2		38.5	37.1		35.5	33.2	
3	Av. Julius Nyerere	S3		38.4	35.6		35.2	33.3	
4	Av. Mao Tse Tung	S4		34.0	32.5		31.6	31.2	
5	Av. Kenneth Kaunda	S5	Residential and Institution Districts	33.1	32.8	65	30.8	30.1	60
6	Avenida Vladimir Lenine	S6	Residential Districts	36.6	35.3		34.2	31.7	
7	Avenlda de Angola	S7	Industrial Districts	38.9	38.2	70	36.6	36.0	65
8	Rua 2.500	S8	Residential Districts	34.5	32.8	65	31.9	30.8	60
9	R. Dr. Lacerda	S9		32.6	31.8		30.3	30.2	
10	Av. da Namaacha	S10	Agricultural Districts	35.5	33.8	65	32.6	31.7	60
11	Av. de Mocamblque	S11	Residential Districts	35.0	34.2	65	31.2	31.0	60
12	Av. Julius Nyerere	S12		33.8	32.8		31.5	30.8	

CHAPTER 4

PRESENT ROAD NETWORK SYSTEM

CHAPTER 4 : PRESENT ROAD NETWORK SYSTEM

4.1 GENERAL

The total road length in Maputo City is 830km, of which some 190km (23%) are paved, leaving a total 77% of unpaved roads. Almost of District 1 Roads are paved, but the other roads in District 2 to 5, except Trunk roads, are unpaved as shown in Table 4.1.1.

Among the total roads in Maputo, there are only tow roads, such as Av. de Namaacha (No.2) and Av. de Mocambique (No.1), maintained by the National Road Agency and the others are maintained by the Maputo City.

Table 4.1.1 Road Lengths of Maputo City Roads

District	Road Length (km)	Road No.	Paved (km)	Unpaved (km)
District 1	152.2	423	96.7 (63.5%)	55.5 (36.5%)
District 2	77.9	216	28.1 (36.1%)	49.8 (63.9%)
District 3	163.7	543	19.2 (11.9%)	144.3 (88.1%)
District 4	236.2	547	19.6 (8.3%)	216.6 (91.7%)
District 5	200.2	511	26.3 (13.1%)	173.9 (86.9%)
Total	830.2	2,240	190.1 (22.9%)	640.1 (77.1%)

The national roads are classified into three categories according to the National Road Agency's (ANE) information and the jurisdiction as primary, secondary and tertiary roads.

As ANE stated that the above road classification is applied only to the national road system and as such does not cover the urban roads. It is therefore necessary to clarify the classification of the urban road network system in Maputo as well as its functions.

4.2 RECOMMENDABLE ROAD CLASSIFICATIONS AND URBAN ROAD STANDARD

4.2.1 Recommendable Road Classification

In order to clarify the classification system to be applied to the urban roads in Maputo, a new road network system has been proposed by the study team based on ANE's classification as well as the trunk road classification recommended by the structure plan of metropolitan Maputo.

The main point of the newly proposed road network system is as follows:

- Road function is classified into four categories: Primary trunk roads, trunk roads, collector roads and local area roads.
- Full access control should be introduced to high-class roads with heavy and high-speed traffic. On the other hand, low class roads should be limited low speed and low traffic with introduction safety and better environment.

Table 4.2.1 and Figure 4.2.1 show the recommendable road classification to be applied for the urban road network system in Maputo.

Primary trunk road will be the only national road No.1 (Av. Mocanmbique) and No.2 (Av. de Namaacha)/ AV. 24 de Julho which are the intra or inter-national highways connecting with national and regional capitals with the full or partial access control and the following arterial roads are selected as the trunk roads by their functions.

- North-South roads
  - -Rue 5.751
  - -Julius Nyerere Av.
  - -Marginal Av.
  - -Vladimir Lenine Av.
  - -FPLM Av.
  - -Acordos de Lusaka Av.
  - -Angola Av.
- west-east roads
  - -Rue 5.750.
  - -Gago coutinho Rd.
  - -Rue 2.520/2.500/3.032/3.250/Kenneth kaunda Av.
  - -Mao Tse Tung Av/Marien Ngouabi Av/Joao Albasini Rd./Tanzania Av.
  - -Trabalho Av./Eduardo Mondlane Av.
  - -United Nation Av./Pauliho Santos Gill Rd./25 de Setembro Av.

This trunk road network is functioning their requirement and carrying amount of traffic smoothly except some bottleneck sections.

Regarding accessibility to community facilities, this trunk road network directly service to post offices, polices offices, hospitals, market, above secondary schools and primary schools with it's direct access ratio of 92%, 84%, 78%, 50%, 67% and 25% respectively as shown in Figure 4.2.2-4.2.6. On the standing point of traffic safety for children, less cutting rate of school zone is recommendable.

Therefore, 19% of the less cutting rate could be obtained by the re-arrangement of school zones as shown in Figure4.2.7. Other safety measures such as safety pedestrian pass and pedestrian signal crossing could also be considerable in order to increase children's safety on the trunk road network.

As the result of the classification, almost all of the primary trunk and the trunk roads in the city of Maputo is paved road but the problem is that the only 43% of the collector roads, which should function as the important road in each community, are paved and the remains are almost un0passable.

Furthermore, there can be pointed the discrepancy that the collector roads in District 1 and 2 are 100% paved and approximately 50% paved respectively but the collector roads in District 3 to 5 are unpaved and difficult to fulfil the required function well as shown in Table 4.2.2 and Fig. 4.2.8.

4.2.2 Recommendable Urban Road Standard.

As mentioned before, there is no road classification and no road design standard for the urban roads being established in Maputo.

In order to clarify the urban road designing to be applied to this study, a new design standard width and a new geometric design stand have also been proposed by the study team based on ANE's design standard as well as SATCC design standard.

The main point of the newly proposed standards is as follows:

- Standard width is classified by four classifications of roads, two types of roads where the roads are passing and by numbers of lone.
- Standard width is showing each component of typical cross-sectionas and recommended right of way.
- Geometric design standard is classified by design speed and is consisting of horizontal and vertical alignment.

Table 4.2.3 and 4.2.4 shows the components of the proposed standard width and the geometric design standard to be applied for the study of urban roads in Maputo.

The existing urban streets in the District 1 and major urban trunk roads have a carriageway, a parking lane, drainage and a mounted pedestrian way. While the others have a carriageway and a shoulder.

Regarding the Carriageway of the Trunk Roads, the existing width of the single carriageway is almost acceptable compare with the proposed urban standard.

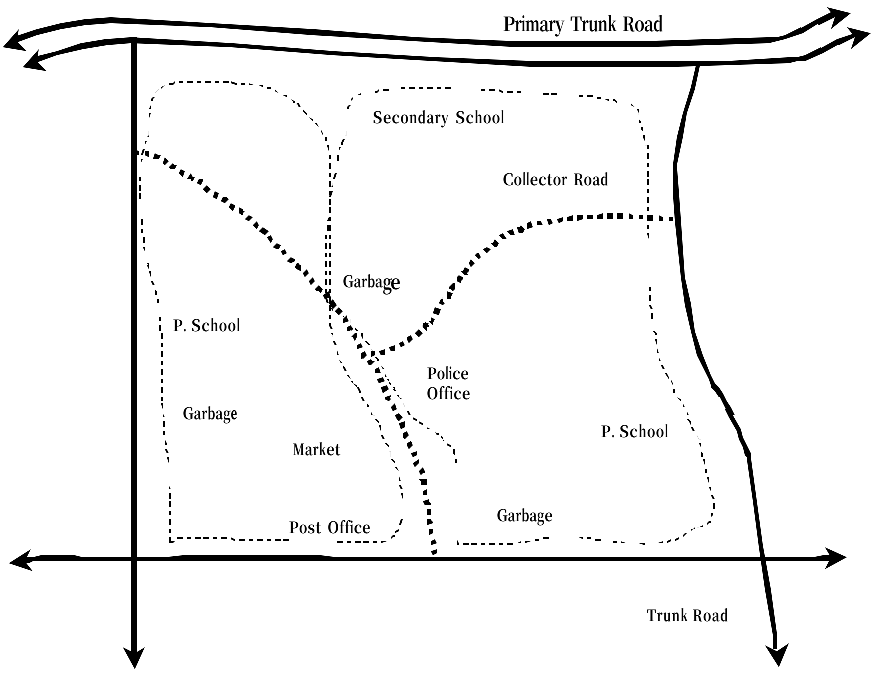
But, there is a problem of the traffic capacity and the connecting condition the dual carriageway network of the Trunk Road as shown in Figure 4.2.9. The major problems are shown as follows and cause the major traffic congestion:

- Missing of Dual Carriageway between Av. Acordos de Lusaka and Av. Guera Popular.
- Missing of Dual Carriageway between Av Mao Tse Tung and Av. da Tanzania
- Missing of either dual or single carriageway on the middle section of Av. Julius Nyerere.
- Missing of Dual Carriageway on Machava road from Av. Kenneth Kaunda.

Regarding the widening of the Machava road to be a dual carriageway, the Government has committed the implementation of the project and the detailed design of the project has already started. The others are only in the consideration and need to be improved in a early stage.

Table 4.2.1 Urban Road Classification

Function \ Road Case			Primary Trunk Road	Trunk Road	Collector Road	Local Area Road
Roads to be Connected	Inter/Inter National Highway		○	○	–	–
	Primary Trunk Road		○	○	△	–
	Trunk Road		○	○	○	△
	Collector Road		△	○	○	○
	Local Area Road		–	△	○	○
City/Center to be Access	National Capital		○	△	–	–
	Regional Capital		○	○	–	–
	District Center		△	○	△	–
	Community Center		–	△	○	○
	Each Housing		–	–	○	○
Access to Community Facilities	School	Primary	– 25% → 6%	△	○ 5% → 94%	○
		above Primary	△ 67%	○	○ 33%	△
	Market		△ 50%	△	○ 50%	○
	Hospital		△ 78%	○	○ 22%	△
	Police office		△ 84%	○	○ 16%	△
	Post Office		△ 92%	○	○ 8%	△
Trip Length			Very Long	Long	Medium	Small
Traffic Volume			Large	Large	Medium	Small
design Speed		Urban	60-80km/h	60-80km/h	30-50km/h	20-40km/h
		Rural	80-100km/h	80-100km/h	60-80km/h	50-70km/h



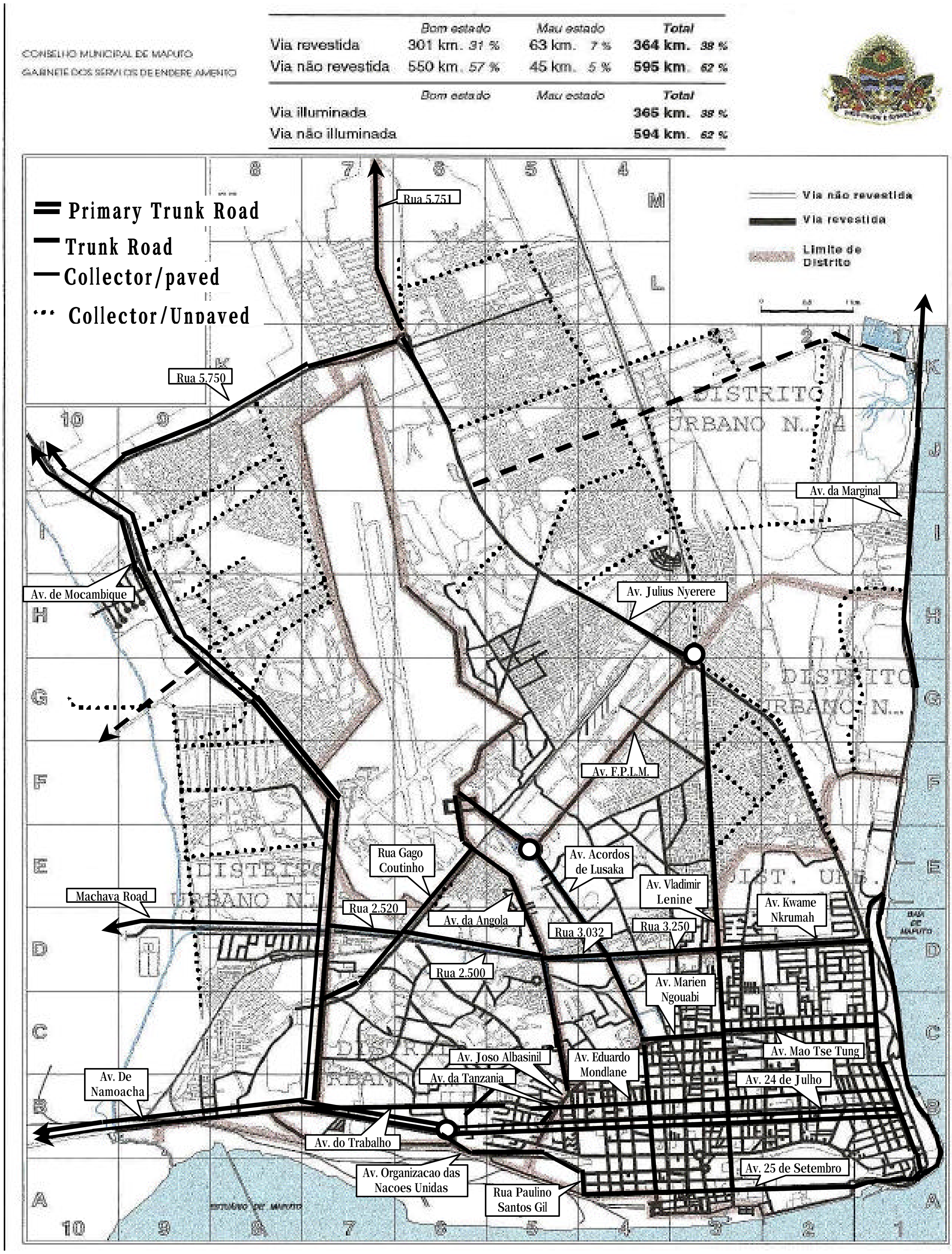


Figure 4.2.1 Existing Road Network Classification

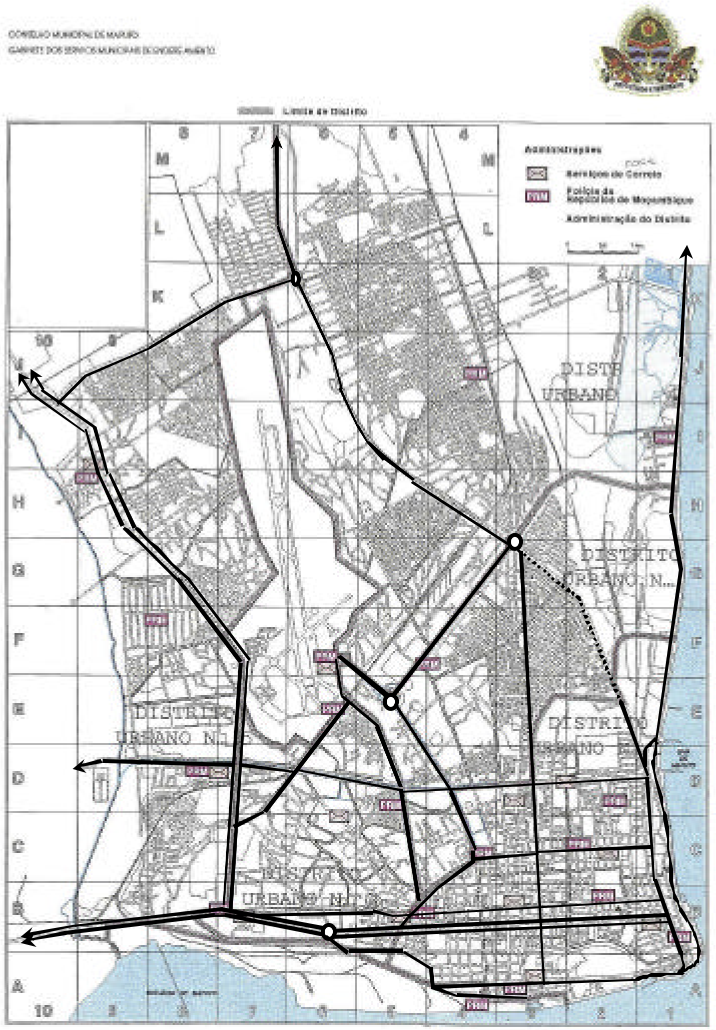


Figure 4.2.2 Accessibility to Administrative Services By Trunk Road Network

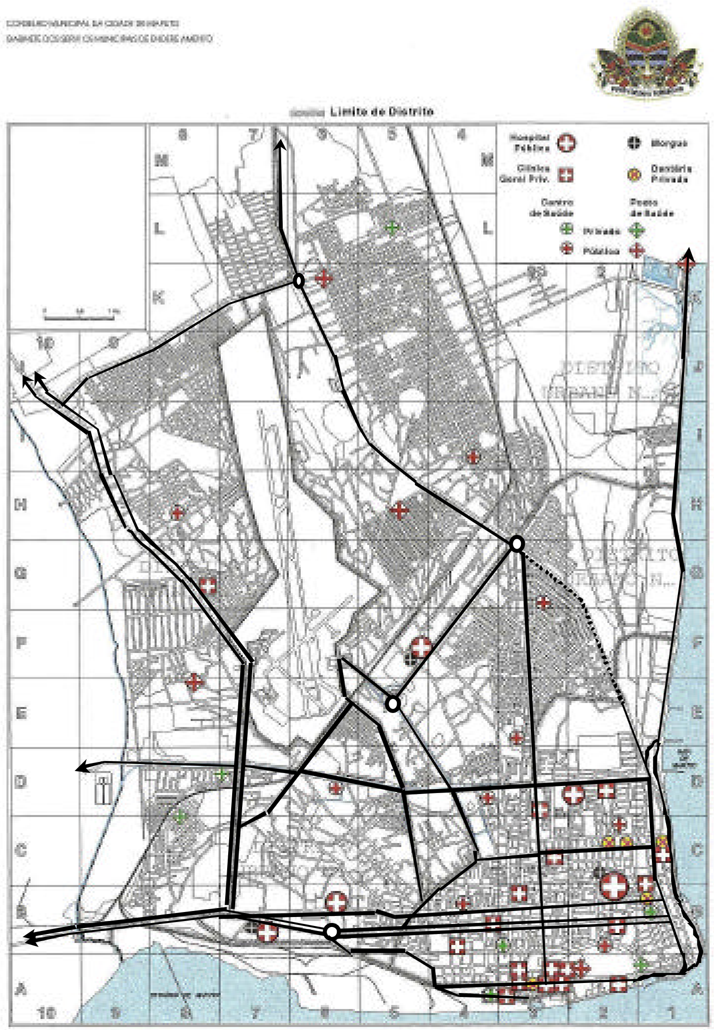


Figure 4.2.3 Accessibility to Hospitals by Trunk Road Network

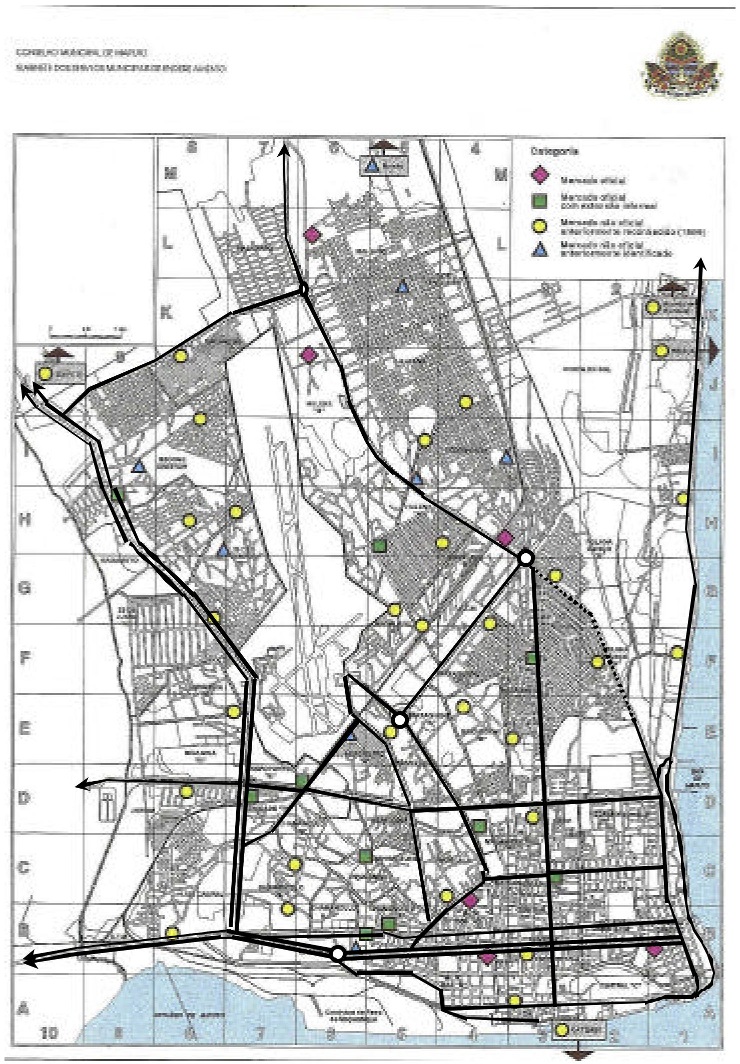


Figure 4.2.4 Accessibility to Markets by Trunk Road Network

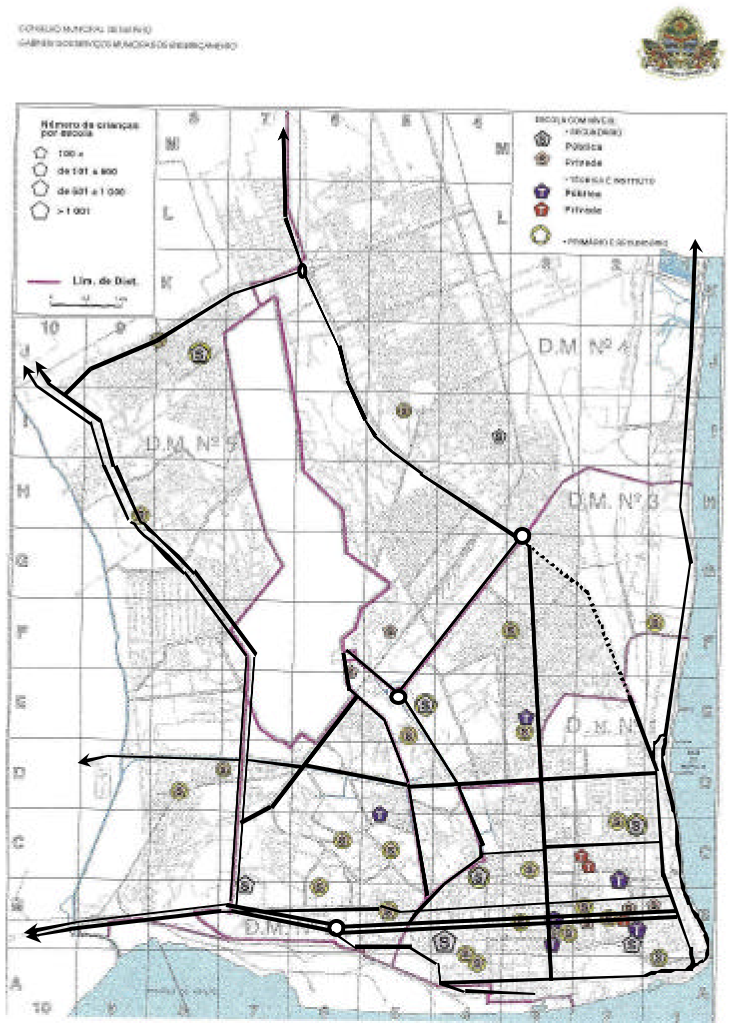


Figure 4.2.5 Accessibility to High Education by Trunk Road Network

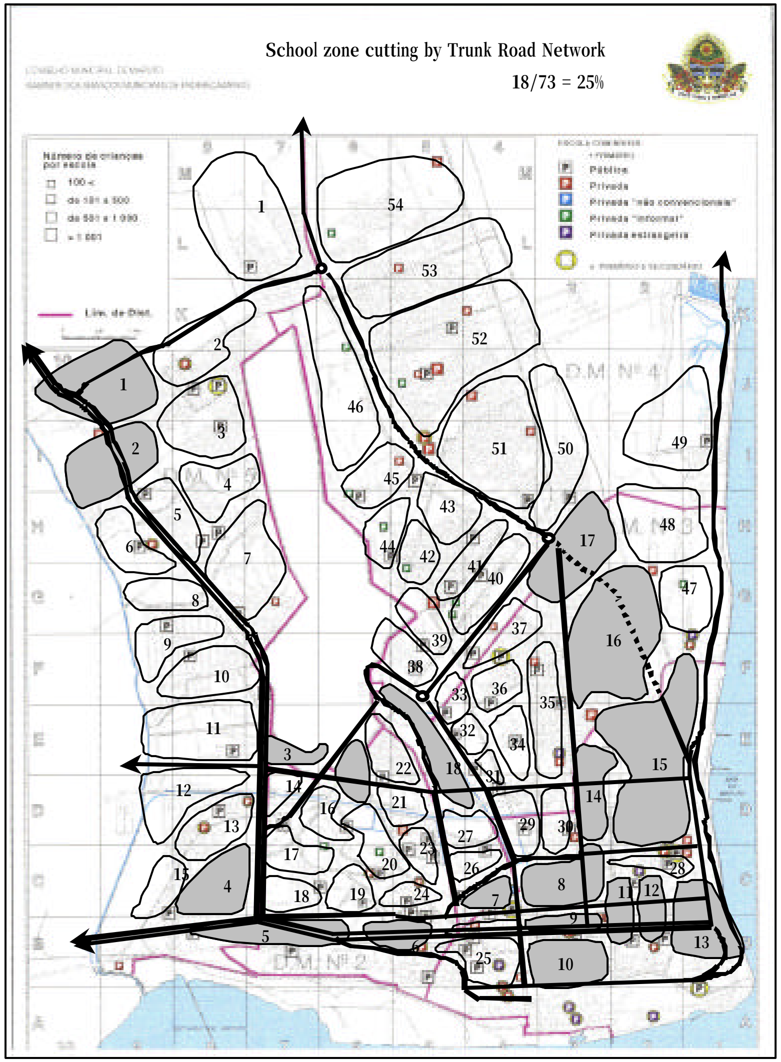


Figure 4.2.6 School Zone Cutting by Trunk Road Network

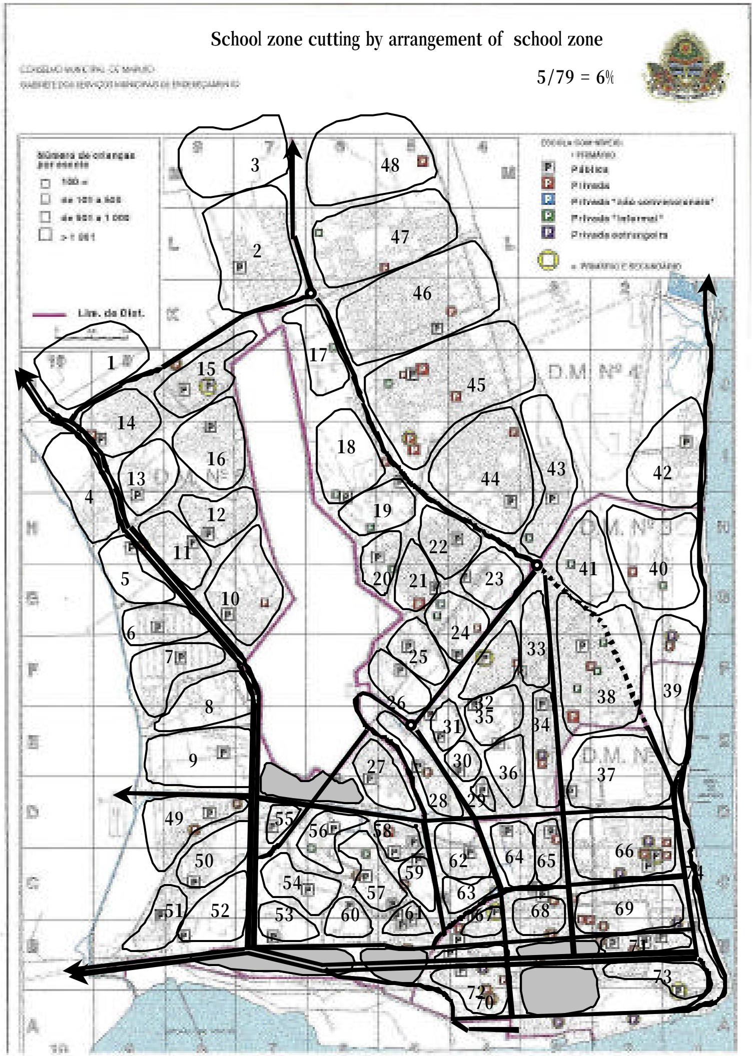


Figure 4.2.7 School Zone cutting by Arrangement of School Zone

Table 4.2.2 Pavement Proportion by Classification

	Paved/Unpaved	Paved(km)		Unpaved(km)		Total(km)	
District 1	Primary Trunk Road	0.0	-	0.0	-	0.0	-
	Trunk roads	31.6	100%	0.0	0%	31.6	100%
	Collector Roads	26.5	100%	0.0	0%	26.5	100%
	Local Area Roads	38.6	41%	55.5	59%	94.1	100%
	District 1 Total(km)	96.7	64%	55.5	36%	152.2	100%
District 2	Primary Trunk Road	0.0	-	0.0	-	0.0	-
	Trunk roads	12.0	100%	0.0	0%	12.0	100%
	Collector Roads	1.3	23%	4.3	77%	5.6	100%
	Local Area Roads	12.1	21%	45.5	79%	57.6	100%
	District 2 Total(km)	25.4	34%	49.8	66%	75.2	100%
District 3	Primary Trunk Road	0.0	-	0.0	-	0.0	-
	Trunk roads	14.9	94%	1.0	6%	15.9	100%
	Collector Roads	0.8	5%	14.2	95%	15.0	100%
	Local Area Roads	3.5	3%	129.1	97%	132.6	100%
	District 3 Total(km)	19.2	12%	144.3	88%	163.5	100%
District 4	Primary Trunk Road	0.0	-	0.0	-	0.0	-
	Trunk roads	13.8	79%	3.7	21%	17.5	100%
	Collector Roads	1.6	15%	9.3	85%	10.9	100%
	Local Area Roads	4.2	2%	204.2	98%	208.4	100%
	District 4 Total(km)	19.7	8%	217.2	92%	236.9	100%
District 5	Primary Trunk Road	10.5	100%	0.0	0%	10.5	100%
	Trunk roads	6.4	100%	0.0	0%	6.4	100%
	Collector Roads	2.5	12%	19.2	88%	21.8	100%
	Local Area Roads	6.9	4%	154.7	96%	161.6	100%
	District 5 Total(km)	26.3	13%	173.9	87%	200.3	100%
Total	Primary Trunk Road	10.5	100%	0.0	0%	10.5	100%
	Trunk roads	78.8	94%	4.7	6%	83.4	100%
	Collector Roads	32.7	41%	47.0	59%	79.7	100%
	Local Area Roads	65.3	10%	589.1	90%	654.4	100%
	District 1- 5 Total(km)	187.3	23%	640.8	77%	828.1	100%

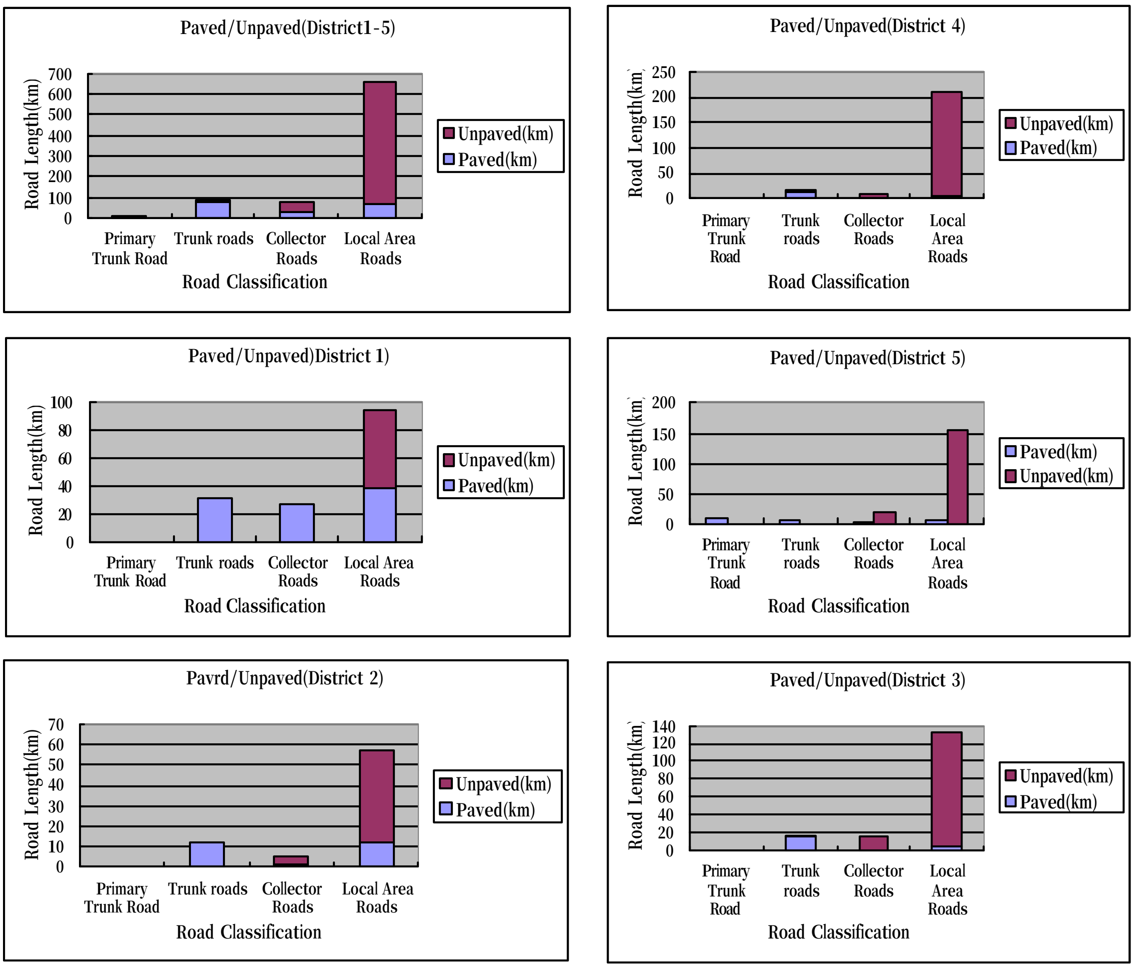


Figure 4.2.8 Pavement Proportion by Classification

Table 4.2.3 Proposed Standard Width for New Construction

Road Classification	Land-use Pattern	Road Type	Lane No.	Design Traffic Volume (pcu/day)	Design Speed (km/hr)	Lane width (m)	Carriage-way Width(m)	Shoulder (m)		Paking Lane both side(m)	Central Strip (m)	Sidewalk both side (m)	Drainage System	Utility Space both side (m)	Total Road Width (m)	Recommended Right of way (m)	Pavement Type	
								Left side	Right side								Recommend	Alternative
Primary Trunk Road	Urban Area	Street	4	<40,000	60-80	3.25	13.00	0.50	0.25	2.50	6.00	3.00	L,U	3.00	37.50	40	AC	-
			2	<10,000	60-80	3.25	6.50	0.50	-	2.50	-	3.00	L,U	3.00	24.50	40(25)	AC	-
	Semi-urban /Rural	Road	4	<80,000	60-80	3.50	14.00	1.25	0.25	-	6.00	1.50	OD	5.00	40.00	40	AC	-
			2	<13,000	60-80	3.50	7.00	1.25	-	-	-	1.50	OD	5.00	27.50	40	AC	DBST
Trunk Road	Urban Area	Street	4	<40,000	50-70	3.25	13.00	0.50	0.25	2.50	6.00	3.00	L,U	3.00	37.50	40	AC	-
			2	<10,000	50-70	3.25	6.50	0.50	-	2.50	-	3.00	L,U	3.00	24.50	40(25)	AC	-
	Semi-urban /Rural	Road	4	<80,000	50-70	3.25	13.00	0.75	0.25	-	6.00	1.50	OD	3.00	35.00	40	AC	DBST
			2	<13,000	50-70	3.25	6.50	0.75	-	-	-	1.50	OD	3.00	22.00	40(25)	AC	DBST
Collector Road	Urban Area	Street	2	<8,000	40-50	3.00	6.00	0.50	-	-	-	2.00	OD/LU	1.00	13-20	13-20	AC	Concrete Block /DBST
	Semi-urban /Rural	Road	2	<8,000	40-50	3.00	6.00	0.50	-	-	-	1.50	OD	(1.5)	13-20	13-20	AC	DBST/Stab.M
Local Area Road	Urban/Semi urban/Rural Area	Street	2	<3,000	20-40	3.00	6.00	-	-	-	-	-	OD	2.00	10.00	10	AC	Concrete Block /DBST
			1		20-40	4.00	4.00	-	-	-	-	-	OD	2.00	6.00	6	AC	DBST/Stab.M

L,U: L-side ditch , U-Shaped drain(W=0m, both side)
OD : Open Drain (W=2.0m,both side/ except Local Area)
OD : Open Drain (W=1.5m,Local Area Road 2lane-both sode, 1 lane-one side))

Table 4.2.4 Proposed Geometric Design Standard

Classification	Design Speed (km/h)	Horizontal Alignment		Vertical Alignment		
		Minimum Radius Curve (m)	Minimum Radius Curve without superelavation (m)	Maximum Gradient (%)	Minimum Vertical Curve (m)	
					Crest	Sag
Primary Trunk Road	80	280	3,500	4	4,500	3,000
	70	210	2,600			
	60	150	2,000	5	2,000	1,500
Trunk Road	70	210	2,600			
	60	150	2,000	5	2,000	1,500
	50	100	1,300	6	1,200	1,000
Collector Road	50	100	1,300	6	1,200	1,000
	40	60	800	7	700	700
Local Area Road	40	60	800	7	700	700
	30	30	500	8	400	400
	20	15	200	9	200	200

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Classification	Design Speed (km/h)	Horizontal Alignment		Vertical Alignment		
		Minimum Radius Curve (m)	Minimum Radius Curve without superelavation (m)	Maximum Gradient (%)	Minimum Vertical Curve (m)	
					Crest	Sag
Primary Trunk Road	80	250	3,500	5	4,500	3,000
	70	190	2,600			
	60	140	2,000	6	2,000	1,500
Trunk Road	70	190	2,600			
	60	140	2,000	6	2,000	1,500
	50	90	1,300	6	1,200	1,000
Collector Road	50	90	1,300	6	1,200	1,000
	40	60	800	7	700	700
Local Area Road	40	60	800	7	700	700
	30	30	500	8	400	400
	20	15	200	9	200	200