ANALYSIS OF TRANSPORT ROUTE DEVELOPMENT IN ABUJA F.C.T. USING MULTI-TEMPORAL REMOTE SENSING TECHNIQUES

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CERTIFICATION

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ABSTRACT

Abuja the Nigeria's new Federal Capital came into being as a result of the promulgation of decree number 6 of 1976 cited as territory act. There was the urgent need to shift the Federal Capital from Lagos as it was playing the dual role of both State and Federal Capital. This has contributed to its many problems like lack of land for expansion increasing crime rate and traffic congestion that is almost to a stand still during peak hours.

In planning the new city therefore, road transport network was given the most prominent role as it has been described as the major structural element in the Master Plan attracting heavy government spending.

Remote Sensing is the best way of monitoring dynamic changes occurring in the metropolis and the best tool for continuos city planning if there is periodic coverage by photograph.

This study seeks to analyse the development of transport route in Abuja by means of multi temporal Remote sensing data. Aerial photographs of 1982 and 1988 and satellite image of 1996 were used for the analysis. Laboratory analysis was carried out from National Remote Sensing Centre at Jos to compliment visual interpretation carried out with the aid of 15X magnification. A combination of these steps generated the Abuja road maps for the period under review. The roads were classified according to the classification in the Master Plan document and analysed.

It was discovered that local streets development was the highest while the expressways have not witnessed much changes. This is due to the demand level for them and the attendant heavy investment it may require. Road accessibility within the Federal Capital Territory is very good but there are residential development in adjacent land areas were road construction has not taken place. If these houses are not coordinated it may result into social and political crises in the future when demolition must be carried out to give way to planned roads.

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some physical parameters like mountains and plateaus as well as the vegetation for their economic and agricultural potentials.

It was observed that when the railway reaches Kano, groundnut production increased two hundred (200) times while cocoa increased thirty (30) times in the South-West forest zone and tin production increased twelve (12) times on the Jos Plateau. (Ogunsanya 1983). The existing land transportation system in Nigeria constitutes a constraint on utilization of resources as many roads are subject to total closure during the rainy season with adverse consequences on export crops and distribution of manufactured goods.

The present North-South alignment of railway is a bottleneck in the development of the nation. Future land transportation in Nigeria must link two economically complimentary areas and increase area flexibility.

1.0.2 TRANSPORTATION AND AGRICULTURAL DEVELOPMENT

There has been sustained emphasis on rural development as a basis for agricultural development and growth in the economy. Agricultural development is synonymous with rural development. Transportation, which is so vital to both rural and agricultural development, is highly inefficient or virtually non-available in the rural areas.

Any government policy directed at rural and agricultural development must integrate approach at urban and rural transport development planning starting from center to periphery to highway development and the necessary linkages.

Transportation is a necessary but not sufficient condition for development. It is so vital that any meaningful agricultural development plan must be simultaneously with transportation planning.

1.0.3 TRANSPORT PLANNING

Transport planning started with the work of Mitchell and Raplain in 1954 titled Urban Transport – a function of landuse" They noted that different types of landuse generate different types of transportation in terms of volume, composition and duration depending on three major uses, residential, industrial and commercial.

Transport planning must therefore make some important assumptions that:

(a) Traffic is stable and predictable and the demand is related to movement and intensity of landuse.

(b) The demand, traffic stability and landuse intensity help to predict future events as transportation leads to development and vice versa.

(c) Other areas have their own impact as the urban centres.

Transport should be part of urban planning and that transport planning must be continuous. For transport planning to be adequate there is need for data on population distribution and density by zones, data on landuse pattern, (segment by segment) as well as income and traffic pattern. These help to accurately forecast develop a good network and analyse alternatives and be able to evaluate the efficiency of such alternatives.

There are many traffic survey needed for planning purposes of different types such as:

(i) Origin – Destination survey

(ii) Cordan survey i.e. zone to zone using pneumatic counter

(iii) House –travel pattern survey

(iv) Car/vehicle occupancy survey

(v) Commercial vehicle survey

(vi) Parking survey

(vii) Pedestrian survey – which include foot walk or side walk, zebra crossing, pelican crossing, fort bridge/tunnel and pedestrian mall and precinct.

1.0.4 URBAN AND RURAL TRANSPORT PROBLEMS

Urban transport system has its own problems which includes congestion, air pollution, noise pollution, public transport problems and aesthetic and social constraints. Traffic congestion may result from the nature of the roads, the type of vehicles or human behaviour.

The roads may be inadequate, narrow, poorly aligned and poor surfacing with no pedestrian walkway or sidewalk. Vehicles may cause congestion when the size, width,

height, number and weight are out of tune with the design of the roads. The age of the vehicles and their roadworthiness were major contributing factors.

The human factor in traffic congestion has to do with human behaviour in respect of parking of vehicles and obedience to traffic laws and regulations.

Urban traffic problems comes also in the form of air pollution through gaseous exhaust containing Carbon Monoxide (CO), Lead (Pb) and Carbon Dioxide (CO_2) to the atmosphere which leads to higher temperature with its attendant environmental problems like global warming and the depletion of the ozone layer. Pollution may also be in terms of noise especially from motorbikes and aircraft. Others are lack of accessibility unprofitable public transport or its non-availability and aesthetic and social constraints.

Some of these problems may be solved by construction of access roads and flyovers where necessary, improved telephone services, improved traffic control system, the use of helicopters to detect areas of traffic congestion and traffic restraints. Some other measures include provision of mass transit like buses and subways, decentralisation of landuse and banning of goods vehicles during the daytime.

Rural transport problem stern mainly from lack of or poor linkages which makes integration difficult. The roads where they exist, are seasonal and difficult to ply when most needed in the raining season to evacuate raw materials and food to the urban centres.

Considering the fact that about eighty percent (80%) of Nigerians live in the rural areas, transport policies must address the need of the rural populace.

1.0.5 TRANSPORT POLICIES

The government as a matter of urgency should have transport policies geared towards;

(i) Opening up the rural areas for increase productivity

(ii) Provision of adequate public transport services

(iii) Diversification of available transport systems

(iv) Provision of transport infrastructure and maintenance of the existing ones.

(v) Development of transport industry.

(vi) Control and regulation of traffic

(vii) Promotion of safety education

(viii) Conservation of energy and diversification of energy sources.

(ix) Promotion of research and

(x) Pollution control.

It is mandatory for all levels of government to devote the greater part of their resources to transport development as the material development of Africa may be summed up in the one word " Transport" Lugard (1923)

1.1.0 AIM

The aim of this study is to investigate the rate of transport route development in Abuja using a multi-temporal Remote sensing technique.

1.2.0 OBJECTIVES

The main objectives of this study are:

(i) to determine the rate of highway development in the Federal Capital City

(ii) to generate road maps of the study area for the three time periods of the study.

(iii) To determine area, of intra urban road transport need using accessibility indices.

1.3.0 JUSTIFICATION OF THE STUDY

A new Federal Capital Territory for Nigeria located at a central place that is easily accessible to all parts of the country was the recommendation of the Honourable Justice T. Akinola Aguda panel set up by the Federal Military Government under the leadership of late General Murtala Muhammad in 1975.

The Federal Government on The 5th of February 1976 approved the recommendation. Decree number 6 cited as Territory Act was also promulgated. The Act vested the ownership of all land in the area on the Federal Government. The Federal Capital Development Authority (F.C.D.A) was established to handle the design, planning and construction of the Federal Capital Territory.

Shifting the Federal Capital Territory from Lagos was informed by a number of problems that have bedeviled it such as lack of land for expansion, lack of suitable accommodation and attendant high cost of living coupled with the rising crime rate. Perhaps the most important of these factors is the congestion in traffic which is almost to a standstill during peak hours. This tends to paralyse government business and made life unbearable for the inhabitants. The continuous heavy investment in the highway sub sector in Lagos was no longer justifiable as the maximum landspace allotted to transportation by transport planners has been exceeded and the returns in terms of traffic decongestion was on the decline.

Abuja is planned to be developed in three phases at the end of the third phase it should accommodate about three million inhabitants. Transport planning which is an integral part of any master plan and urban-change detection system is highly essential and of paramount importance. Transport problems are beginning to rear their heads in Abuja with traffic congestion along some major highways. Passengers are usually stranded for hours in the satellite towns seeking for means of getting to their work place in the metropolis. (Abuja Star Newspaper 1999)

Abuja the emerging Federal Capital of Nigeria is currently the fastest growing city in Africa. There is need to investigate if transport facilities are developing at the same pace with other physical structures and if this development is adequate for the future of the city. Abuja presently has a good network of roads, which is expected of an emerging planned city.

According to Bowden (1975), cities are dynamic and they require regular coverage for continuous city planning. "Periodic photograph reveals dynamic changes constantly occurring in the metropolis area, municipalities and different urban distinct.

According to Adams (1981), "new roads railways, airports, shopping centres, new towns and other major building developments can and must be planned on the assumption of general car ownership". The highways occupies a relatively more important position due to its flexibility and efficiency in the movement of goods and people. The automobiles through the highway have changed the morphology of the cities from a tightly knit concentric structure to an exploded multinuclei type" Bolade (1991). The highways have reduced spatial gaps between areas of different specifications and their network has the greatest impact on the social and economic development of Nigeria since independence.

It is a general conviction among transport planners that urban traffic problems are bad and they are likely to get worse because all cities are expecting continued growth in physical and personal income hence increase in car ownership.

Thomson (1981) opined that ":adequate planning and necessary government policies must be put in place to resist the undesirable trend inherent in motorized societies, yet these cities are richer, older, with extensive rail system and enormous freeways networks than the best of any third world country. Bowden (1975) concluded that cities are dynamic and they require regular coverage for continuous city planing. "periodic photograph reveals dynamic changes constantly occurring in the metropolis area, municipalities and different urban district.

Studying Nigeria's Federal Capital City by means of aerial photograph will help in ameliorating the present transport problems and providing the framework for solving envisaged future problems. Any effort in this direction is expected to contribute in no small measure to our national development.

1.4.0 THE SCOPE AND LIMITATION OF THE STUDY.

This study is intended to investigate the rate of traffic route development using multi-temporal or sequential Remote sensing techniques. With the use of an urban change detection system, the transport routes will be mapped out and categorised for the three time periods of the aerial photographs.

The design of the road network would be scrutinized from the aerial photographs and ground survey.

However the study is not intended to determine the rate of accident nor safety precautions on our highways. It will therefore not investigate the role of the law enforcement agents in traffic control nor vehicles that ply the roads. Most of the investigations will be by remote sensing techniques backed up by minimal ground survey.

1.5.0 THE STUDY AREA

The Federal Capital Territory (F.C.T) is located at the centre of Nigeria which falls within latitude 7^0 25'N and 9^0 20' North of the Equator and between $0^o45'$ and 7^0 39' East of the Greenwich Meridian. It is bounded to the North by Kaduna State, to the West by Niger State to the East and South-East by Nassarawa State and to the South-West by Kogi State.

The F.C.T, which is about 300 metres above sea level, is located on a Pre-Cambrian Basement rock complex covering more than eighty (80) percent of the land of the territory. The remaining twenty (20) percent of the land consist of sedimentary rock and mainly towards the southern part of the territory.

The land is generally flat with isolated rock domes, inselberg, and hills. The underline igneous and metamorphic rock is expected to provide suitable bases for engineering structures and materials for building.

There are Fadama and alluvial valleys in the areas of the sedimentary rocks which is "the most fertile soil and the best agricultural lands of all the plains of the F.C.T. Such land are also ideal for urban development and the relatively high fertility status of the soil is of advantage to the successful landscaping and beautification of public places, street tree planting within the built up area of the city" (Abuja Handbook 1998)

1.51 Climate:

The total annual rainfall for the territory ranges between 1100mm to 1600mm over a span of eight months from March to October known as the period of rainy season. The amount and intensity of rainfall decreases northwards.

The dry season, which is usually from November to March, is characterised by excessive heat well above the physiological comfort level except in some few areas of high elevation. The cold, dry harmattan winds from the Sahara desert punctuate the period of dry season especially from January to March. Evapotranspiration is equally very high with its attendant problem and dry season agriculture.

1.5.2 Vegetation:

The whole of the F.C.T falls within the grassland region known in Africa as the Savanna. The Savanna is sub divided into grassy woodland and Shrub.

The grassy Savanna occupies about 53 percent presenting 42311km of the total area of F.C.T. The woodland covers 12.8 percent i.e. 1026km of the territory and the and the shrubs mainly in rough terrain close to hills and ridges covers 12.9 percent or 1032km of the land area. (Abuja Handbook 1998) See figure 1.1

Figure 1.1

Map of Nigeria showing Abuja F.C.T.

CHAPTER TWO

2.0.0 RESEARCH METHODOLOGY

This chapter is devoted to highlighting the key steps in carrying out this study by enumerating the processes of data collection, mapping and analysis.

2.1.0 DATA SOURCES: -

Information for this study has been collected from three main sources classified here as primary and secondary data

Primary data sources are (1) Federal Capital Development Authority (F.C.D.A) Engineering Department (2) Abuja Master Plan document. And (3) Ground truthing
The secondary data source is from aerial photography and satellite imagery.

The Engineering department of F.C.D.A supplied information with regard to the design of Abuja road network especially the secondary road systems as already explained in chapter one of this write up. They also provided useful hint on implementation so far on the key road networks.

From the Abuja Master Plan one could derive the existing roads and differentiate them from the non-existing ones as contained in figure 4.5 where the yet to be constructed roads were clearly shown on the map. The master plan document also provided the policy framework for the development of the Federal Capital Territory.

Ground truthing is meant to verify the accuracy of delineated road networks and verify the computer classification of the road network mapped out. (see appendix vi-ix) It was discovered that some computer network classification were not correct as some roads features were mis-read and some roads are ancient roads that are no longer in use due to the development of, and implementation of the Masterplan. This explains the uncoordinated nature of the computer generated maps. With the ground truthing all these were eliminated, and accurate maps (Figures 4.3 – 4.5) were generated representing the true nature of the roads as they were at that particular time period.

The secondary sources of data are the aerial photographs for 1982 and 1988. The aerial photographs were mosaic from several aerial photographs generated to one aerial

photograph of a scale of 1: 25,000.00. A 1996 satellite image was also used in this analysis.

2.2.0 TRANSPORT ROUTE CLASSIFICATION

Route classification is essential in organising the needed information in a manner that satisfies the objectives of the research.

There are standard road classification schemes of universal application such as primary, secondary and highways or surfaced and un-surfaced roads but for the purpose of this research the technical classification of Abuja roads have been used. The road classifications are based on two major factors, that is, the width of the road and the purpose it is meant to serve.

There are therefore two major classification i.e. the secondary road system and the express road system with their sub-classification as shown below

A. Secondary Road categories

1. Local Street / Cul de sac
2. Important local street
3. Collector roads
4. Arterial Roads

B) Express Roads categories

1. Boundary freeways
2. Inner freeways
3. Parkways
4. Central Area Connector
5. Airport Access Expressway

The Classification of the various road classifications has been fully explained in Chapter Four of this Thesis.

2.3.0 MAPPING

To generate the maps from the information gathered two major steps were taken. The first is the mapping of the routes from the aerial photograph and the satellite, pictures by the use of computer remote sensing software referred to as laboratory analysis carried out at the National Centre for Remote Sensing (NCRS) Jos. The resultant maps is a general classification of all roads in the study area as shown in the appendix . The roads represent all roads in the aerial photograph whether they are still in use or not. The roads therefore appear unco-ordinated as old roads that are no longer in use were mapped.

To generate the actual map the Abuja master plan was use as a guide and the use of computer aided design (CAD) the development maps of Abuja for 1982, 1988 and 1996 were generated showing the roads as they developed from time to time.

From the Master Plan document one could detect roads that were to be in existence but not yet constructed. Such roads were indicated for analysis in the third map, fig4.5, which is the most comprehensive of them all. The routes of the yet to be constructed roads, were traced from the aerial photographs and the satellite image and fund to be in conformity with the original plan. During ground truthing, it was observed that that these pieces of land are still reserved for what they are meant.

2.4.0 DATA INTERPRETATION

Ground truthing and reconnaissance survey were carried out together to ensure an accurate interpretation of the data. It was during this exercise that ancient road that are no longer in use but mapped out by the computer were discovered and eliminated from the final map as the implementation of the Master Plan has over taken the usefullness of such roads. The inclusion of such roads on the map would have made the maps meaningless and the beauty of a planned town like Abuja would be difficult to be appreciated from such maps.

A zoom mirror stereoscope with 15x magnification was used in the interpretation processes and an overlay was placed on each of the images to extract the desired data and these were brought to the same scale with the use of a planvariograph.

The length of the various roads were determined by taken linear measurement of the road through the use of a non-elastic string, measured on a meter ruler and multiplied

by the scale of the map. The lab analysis from NCRS accurately measured the length of the roads but this was discarded because road classifications are more numerous on the maps than they were on computer analysis from Jos. Secondly some routes were discarded after ground truthing but such roads were equally calculated by the laboratory analysis in the computer.

Sixteen care was however taken in the manual measurement to ensure high level of accuracy.

Accessibility maps were generated and classified into good, moderate and poor by the computer but it was discovered that it was limited to the major streets as virtually all residential area, have good accessibility to miner roads some of which the images could not detect. The maps are included in the appendix but of limited use in the analysis.

CHAPTER THREE

3.0.0 LITERATURE REVIEW

This chapter is devoted to the analysis of works already carried out in the field of transportation planning and development. The information was extracted from books journals newspaper articles, similar papers among others. The literature are presented under various subheadings as follows:

3.1.0 REMOTE SENSING FOR TRANSPORT PLANNING AND DEVELOPMENT

Aerial photograph is perhaps the most useful tool for transportation planning as it offers a three dimensional visualization of the Municipality which according to Bowden (1979) "can be acquired in no other way and which is essential for urban analysis and many city planning decisions." According to him the whole transportation subsystems from freeway to local street can be viewed and studied with respect to the "effectiveness of each separately and with respect to the interconnecting and interrelationship between them."

Cities are never static as they are dynamic therefore periodic photograph reveals dynamic changes in the Municipality and other districts. No other information or data collection system can effectively detect changes like in aerial photographs as "quickly and inexpensively". The summary of Bowden's work is that "the best way of providing the necessary physical spatial and environmental information is by aerial photograph".

According to Rudd (1974), man is distributed very unevenly over the earth surface piling ourselves many stories in certain favoured locations. There is therefore the need for planning if the need of population is to be met as capabilities and numbers are constantly changing. He is of the opinion that "the cost of resolving problem situations in our urban areas which results from unplanned or inadequately regulated growth is reaching proportions which indicate that restricting planning budget is false economy". According to Rudd, the rate of change in many localities has increased to explosive proportions and only vast quantities of data will suffice for today. Remote Sensing "offer the prospect of markedly greater variety and amount of data" Rudd (1974).

The work of Rib et al (1979) centred mainly on the use of remote sensing in Highway Engineering, with generalisation to other transport systems. They enumerated six major stages for which image interpretation techniques can be applied. These are (1) highway planning (2) condition and inventory surveys (3) traffic surveys (4) highway location surveys (5) construction surveys and (6) maintenance surveys.

While aerial colour photograph has proved very useful in identifying items to be inventoried like road types, width, conditions, drainage conditions and kind and number of structures. Colour infrared photograph are more useful in identifying road boundaries, drainage features, like seepage, sedimentation and pollution areas. They recommended the use of photologging, which is ground photographic survey to compliment the aerial photographs as "some features that must be inventoried are not even discernible on the large scale photographs.

They agreed with the statement of Johnson (1928) that "the aerial photographic survey of traffic offered a means of making for better observations than is possible otherwise". According to Rib et al (1979) this statement is still true today.

Two most notable techniques developed for traffic evaluation parameters based on aerial data collection are density contour maps and vehicle trajectory maps. The formula for calculating traffic density from aerial photographs is given as:

$$\text{Traffic density} = \frac{\text{vehicle count}}{\text{Subsection length x number of lanes}}$$

In Nigeria Ikhuoria (1990) carried out a study in urban blight in Benin City by the use of remote sensing techniques. He agreed with the opinion that remote sensing expedite data collection and has significant role in urban information gathering and planning systems. He concluded that remote sensing "serves as a means of delineating and maintaining blighted environments. Structural conditions street conditions, refuge accessibility and flood are variables which can be interpreted from aerial photographs as indicators of environmental quality".

The study of Dimayati et al (1996) reveals that "settlement growth had a high correlation with road accessibility evaluation which could be carried out from remote sensing data as a basis for intelligent intervention by Government.

Thomson and Dams (1990) used satellite images of Synthetic Aperture Radar (SAR) for road detection especially images in the X and L bands. This study is a confirmation of an earlier work by Wan Ahmad (1988) carried out in Malaysia Peninsula. All the studies show that high resolution satellite images can be of limited application in transport planning. This conclusion is further collaborated by the University of Kansas research, which shows that "it is difficult to extract transportation linkages from color space photographs of the GEMINI and APOLLO scale and resolution types". Paved highways and Federal interstate systems were detected easily because of their width. As the class of the road changes towards a smaller width only portions of the road are visible. Peplies (1976).

According to Couloigner et al (1998), it is better to use multiresolution processing to extract street information class by class as well as their topology especially in a quadrangular urban network consisting of different classes of streets. According to them "the finer the spatial resolution, the easier the discrimination between two neighbouring urban objects and thus the richer the cartography of urban network". Fully of semi-automatic extraction of urban network may be disturbed by little objects like cars, houses or trees, along streets but large towns with quadrangular network (like in North America) are easier to analyse from remotely sensed images than towns with dense urban structures and sinuous network (like in Europe and Asia)"

De Wit (1998) recommended edge-detect filter as an image enhancement technique that is best suited to extracting road and urban areas data because "roads and urban areas are generally objects with distinct and sharp boundaries to the surrounding area" He carried out his studies with SPOT PAN images but recommended radar imagery (ERS) for change detection as this type of imagery is less costly and acquisition is more certain.

3.2.0 TRANSPORT DEVELOPMENT IN NIGERIA.

Transport development in Nigeria has witnessed a steady growth in road usage from 1980-85 as shown by the table below:

Table 3.1 Road Network in Nigeria

Year	Length in Kilometre				% Paved	Density of total Network
	Main Road	Secondary Road	Other Roads	Total		
1980	31087	16368	62,563	110,058	56.1	0.01
1985	34491	16824	67,586	118,901	65.1	0.12

Source: UNTACDA (1988)

The number of vehicle par thousand inhabitants in 1985 was 6.5 in the West Africa subregion. It is twenty (20) in North Africa and three hundred (300) in Europe.

There are six (6) vehicles par kilometre of main and secondary roads in the same period compared to 50 in Europe Road usage outside the urban areas is extremely low and 18.3 percent of usable road was permanently surfaced with bitumen.

The railways which "were designed to serve particular enclave activities remain the major carrier of bulky goods over long distances with increase in freight traffic from 51,751 million ton-km in 1980 to 62,205 million tons-km in 1985 in the whole of Africa. The United Nations report concluded that during 1960-1970 railway goods traffic grew by 16.7 per cent. The growth was 66.1 per cent during 1970-1980 and 22.1 percent during 1980-85 for Africa in totality. (UNTACDA 1988)

In Nigeria the railways grounded to a halt in the same period and beyond. It is only recently that efforts are being made to revive the system.

3.3.0 TRANSPORTATION AND DEVELOPMENT IN NIGERIA.

> "Transportation is a necessary pre-occupation of the exchange economy and it is indispensable to economic growth. Where there is no transportation economic activities are restricted to hand-to-mouth subsistence level. Specialization and generation of surplus for exchange on the basis of comparative advantage are not

possible without the capacity to move resources and goods from one place to another". World Bank (1972).

According to Gana (1990) transportation has serious integrative and development effects. He therefore advocated for the development of rural roads in Nigeria not only because it facilitates the evacuation of agricultural produce but equally "vital to create a conducive network of rural feeder roads to integrate rural economies into the national space-economy".

3.4.0 TRANSPORTATION PLANNING POLICY AND RESEARCH.

Onakomaya (1990) while quoting Adeyemo (1975) believes that "the ultimate success of any transport development process depends on the quality of planning of the project level which in turn is a function of the quality of data and research inputs – into the pre-construction project planning process. The inadequacies in the planning process has led to the present state of our transport development and more regrettable "no significant effort to promote research and education in the transport sector by all the levels of government". Onakomaya (1990).

He advocated for Federal guidelines and policies with regards to network planning, Highway Code and road traffic and safety especially in the urban areas. There should be database for planning and of concern to the planning process is the ecological problem and devastation of roadside land.

Ajayi (1990) emphasised the need for both qualitative and quantitative information related to transportation system development economic efficiency, services and safety among others for a serious business of formulating transport policy. This position is further strengthened by Chima (1990) who advocated for highway statistics in the area of facilities, equipment utilization and finance. Adeyemo (1990) recommended research and development "with a view to producing socio-economic and traffic flow data for traffic forecasting and projection of future traffic flows. He emphasised the need for local construction materials, locally made spare parts, research into traffic

management, control and safety measures such as identification of accident black sports on our highways and environmental pollution.

CHAPTER FOUR

4.0 DATA ANALYSIS

To give adequate treatment to this analysis, it has been divided into three main sections:

(i) Analysis of Abuja road network design

(ii) Analysis of static transport routes for the periods 1982, 1988 and 1960

(iii) Analysis of the changes in road network from time to time.

4.1.0 ABUJA ROAD NETWORK DESIGN

4.1.1 The policy framework:

Efficiency is considered the most important factor in the design of the transportation system in Abuja. This according to the Master Plan is the "dominant structural element" which has basically a linear form (spine system) with nodes to guarantee maximum efficiency "through arrangements of land-uses in co-ordination with transportation and maximizing accessibility among interrelated activities" (F.R.N 1979)

The policy objectives for transportation plans in the F.C.T are:

(i) Maximize public transportation mobility for those who do not own cars;

(ii) Maximize the use of public transportation by individuals who own cars;

(iii) Minimize through-traffic in the various development sectors

(iv) Avoid network bottleneck through the provision of multiple highway paths between the development sectors; and

(v) Achieve the maximum self-containment within the sectors. F.C.D.A (1983).

It is clearly evident that these objectives are guided by two main aims. That is the need for free flow of traffic and ease of public transport. The policy framework for the whole of the Federal Capital Territory is the development of transportation "integrating the city with its regions and the nation through on efficient transport system" F.R.N. (1978).

KEY TO FIGURES 4.3, 4.4, AND 4.5 (MAPS)

ANALYSIS OF TRANSPORT ROUTE DEVELOPMENT IN ABUJA FCT

Boundary Freeways

1a Murtala Mohammed Expressway North and South
1b Nnamdi Azikiwe Expressway

Transverse Parkways

2a Inner Expressway North*
2b Inner Expressway South*

Central Area Connectors

3a Ibrahim Babangida Drive
3b (Independence Way)
3c (Constitution Road)

Central Parkway

4a Sani Abacha Parkway
4b Abuja Parkway South*

Arterial Roads

5a Ahmadu Bello Way North & South
5b Shehu Shagari Road North & South
5c Herbert Macaulay Raod North & South
5d Olusegun Obasanjo Road.

Collector Roads

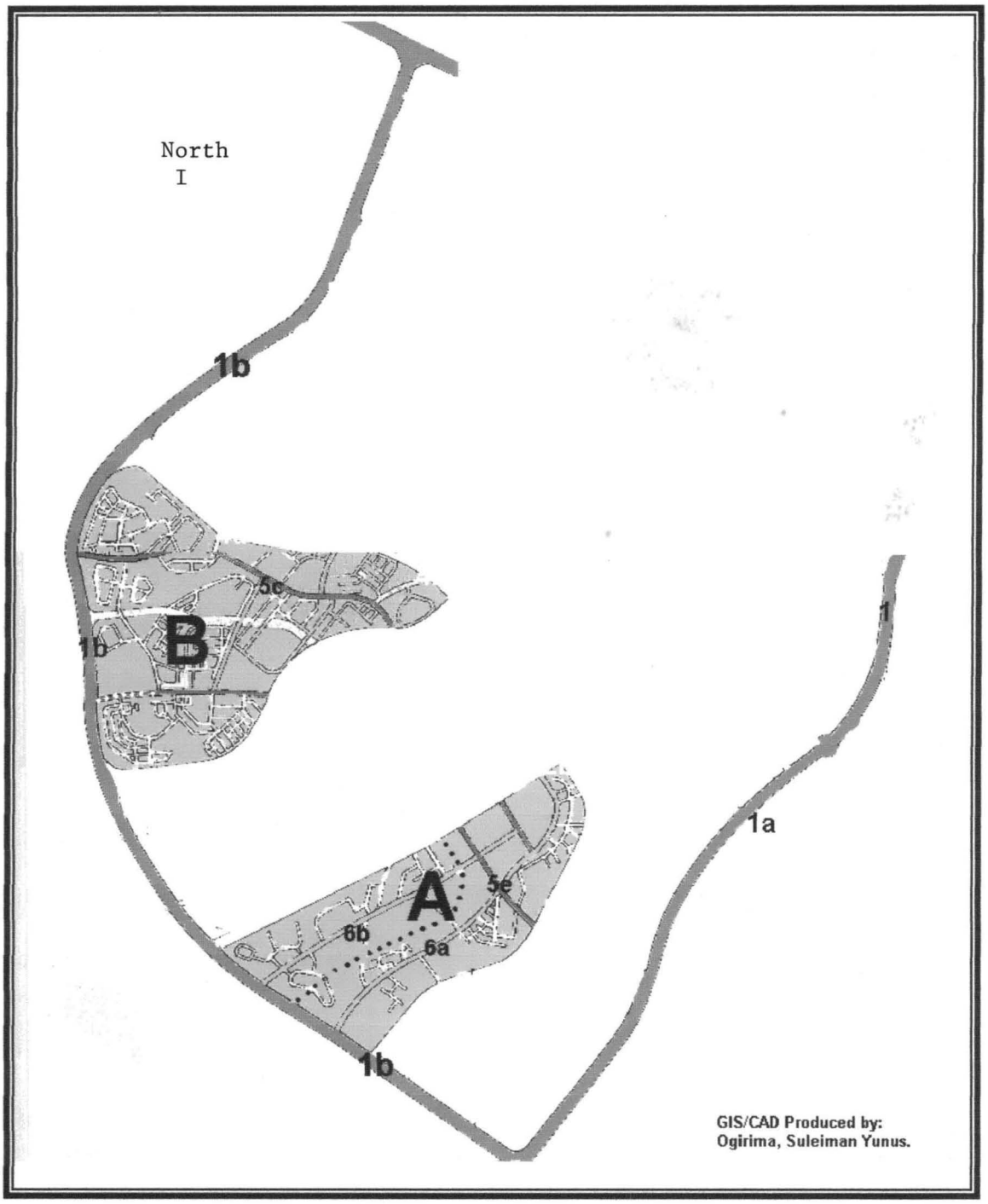
6a Tafawa Balewa Road
6b Mashood Abiola Road
6c IBB Boulevard
6d Yakubu Gowon Crescent

Built Up Areas

A Garki I
B. Wuse I
C. Wuse II
D. Maitama
E. Asokoro
F. Garki II
G. Central Area

* Roads not yet constructed.

Figure 4.3 MAP OF ABUJA ROAD NETWORK IN 1982



Scale 1:35,000

KEY

Freeways

Arterial Roads

Local Streets

Colletor Roads

This policy recognised the fact that inter-regional and inter-state linkages were weak hence the need for rural accessibility to the city and national connectivity for easy access to all parts of the country. To further increase the access to other parts of the country and the world at large there is a provision for an international airport and a railway line in the Master Plan. The airport is now fully operational but the metroline for the city, where landspace is reserved, and the railway are meant for the future depending on demand.

4.1.2 Road network design and categorisation

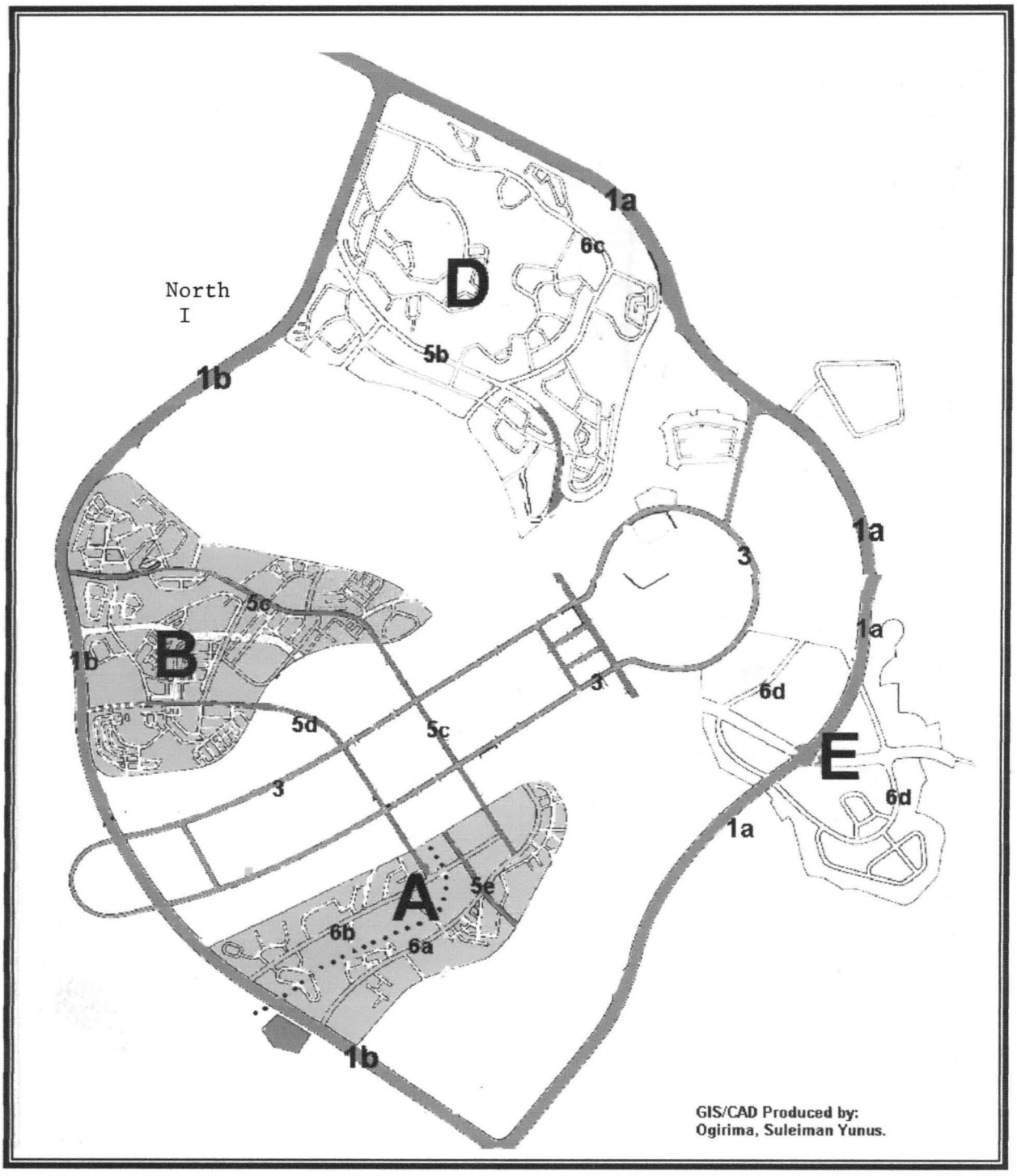
(A) Expressways: This comprises of the freeways and the parkways.

There are two types of freeways – They are the boundary freeway and the inner freeways. The boundary freeway is designed to have three lanes in each direction in the inner portion, and two service lanes in the outer portion in each direction, and an additional reservation of two lanes for future expansion. The boundary freeway marks the extent of the Federal Capital City (F.C.C) distributing traffic to the different districts and a by pass for the F.C.C. Presently the route is yet to be fully developed as only two lanes have been constructed out of the expected ten. This boundary expressways designed for speed of 100km are named the Murtala Muhammad Expressway and Nnamdi Azikwe Expressway. They are also referred to as the ring roads and carry services of only the major water pipes and telecommunication trunklines.

The internal freeways have not been constructed but they have the same dimensions as the boundary freeway with two service lanes and two reserved lanes for future expansion.

In the parkway system we have the central parkway and the transverse parkway. The parkways are to distribute traffic both ways and they have limited access. The central parkway is located between the city corridors and trucks are prohibited. The transverse parkway is technically called transit ways as trucks and buses are allowed. This provide linkages between the street systems, the central parkway and the boundary

Figure 4.4 MAP OF ABUJA ROAD NETWORK IN 1988



Scale 1:35,000

KEY

- Freeways
- Arterial Roads
- Local Streets
- Parkways
- Colletor Roads

freeway. It is designed for bus services to connect districts and important areas without necessarily going through the city network.

(B) Secondary Road System: The road design starts with the Minor Access road and the Cul de sac (MAR/CDS). They are two lanes without parking strip but a 250cm planted area and 200cm walkway in each direction. They take traffic from the residential areas to the local streets or important local streets. The CDS is so called because it terminates at an areas without a thoroughfare.

The Local Street/Important Local Street (LS/ILS) has a dimension of one lane in each direction of 350cm, in width and a parking strip of 250cm, a planted area of 250cm and 200cm walkway. The entire right of Way (ROW) is 2,100cm. The planted areas takes the services provided that is, the street lights while the drainage foul water and storm water, electricity and telecommunication cables are all buried underground in the planted areas.

Traffic from the LS and the ILS are emptied into the Collector Roads (CR) of 3,.300cm as the limit of the Right of Way (ROW) with three lanes carriage way on each direction. Two lanes for the drive and one for parking having a 250cm width. It has a planted area of 300cm and a walkway of 200cm on each sides. The street lights are located at the centre of the road with 250cm as landspace separating the two sides.

The engineering design of the collector road of the areas is a little different from that of the straight stretch. (see appendix i - v).

The collector roads link the neighbourhood units to the arterial roads while the arterial take the traffic from the collector roads and distribute to the expressways and the districts.

The arterial has a carriage width of 1,300cm made up of 3 lanes for flow and on parking strip of 230cm in each direction. The total Right of Way (ROW) is 4,600 comprising a 300cm planted area and 400cm walkway in each direction. See Tables 4.1 and 4.2 and Plate 1.

Outside the Federal Capital City (F.C.C.) there are two other expressways. They are the airport access expressway (see plate 2) and the Kaduna – Abuja linkage expressway via Zuba.

Table 4.1 Secondary Roads Design Statistics (In One Direction) In Centimetres

Category of Road	Carriage Width	No of lanes	Parking Strip	Planted area	Walkway	Right of Way (ROW)	Street light Location
Arterial Roads	1,300	3	250	300	400	4,600	Centre
Collector Roads	950	2	250	300	300	3,300	Centre
Local Streets	600	1	250	250	200	2,100	Side
Minor access roads/ Cul de Sac (CDS)	600	1	250	None	200	1,600	Side

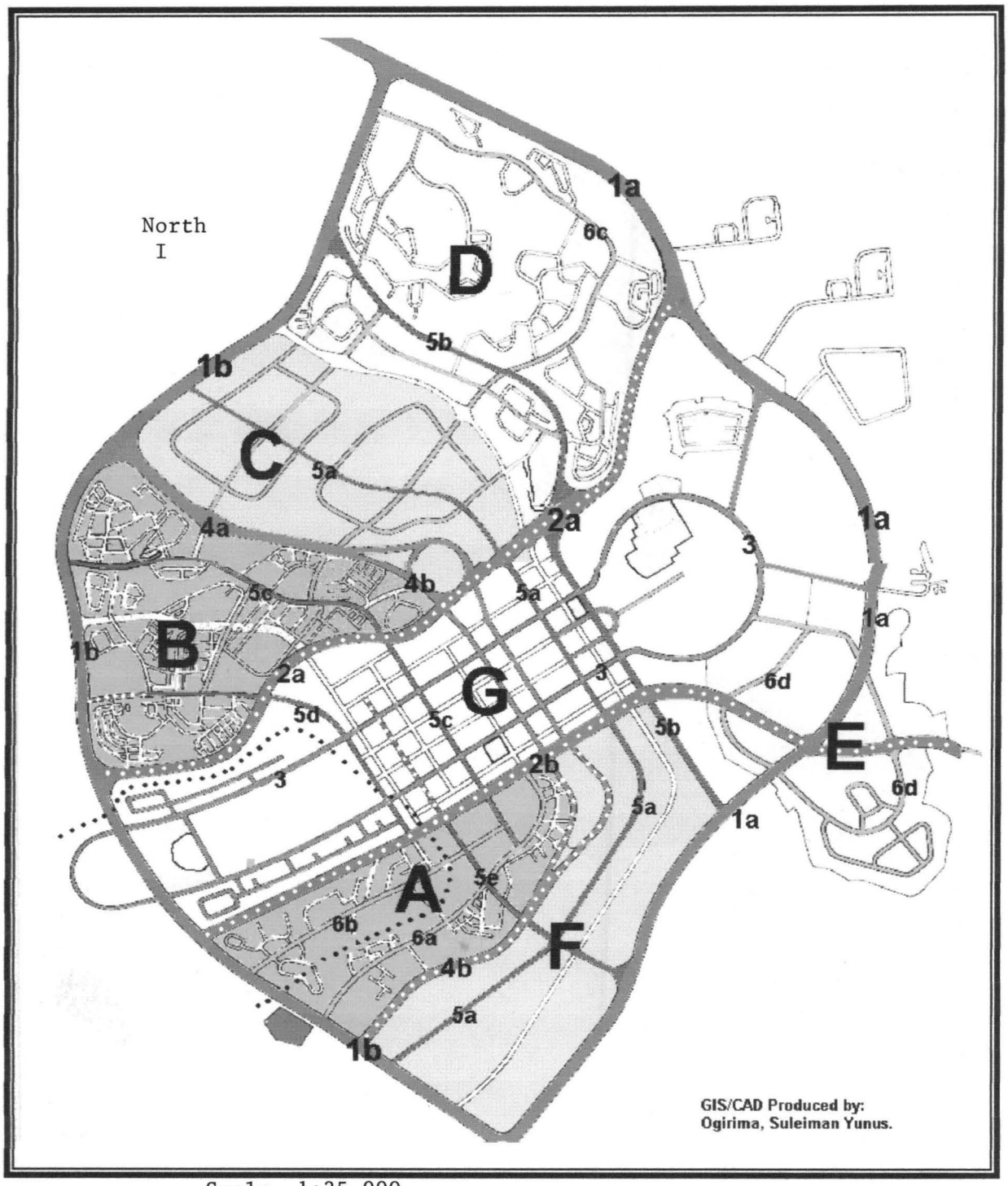
Source : FCDA Engineering Department

Table 4.2 Expreeway design statistics in one direction(in cm)

Category of road	No of lanes	Parking Strip	Planted Area	Walkway	Reserved Lanes
Boundary Freeways	5	250	300	400	4
Internal Freeways	5	250	300	400	2
Central Parkway	4	250	300	400	3
Transverse parkway	4	250	300	400	3
Central Area conector	4	250	300	400	3
Airport acess Expressway	2	250	300	NA	2

Derived from: FCDA Engineering Documents

Figure 4.5 MAP OF ABUJA ROAD NETWORK IN 1996



Scale 1:35,000

KEY

- Freeways
- Arterial Roads
- Local Streets
- Parkways
- Colletor Roads
- Road Not Yet Constructed

4.2.0 ANALYSIS OF STATIC TRANSPORT ROUTES

4.2.1 Transport routes situation in 1982

As shown on table 4.1 a total of about 55 kilometres of road has been constructed in the F.C.C phase I in 1982

The expressway systems in existence at this time are The Nnandi Azikwe Expressway and The Muritala Muhammad Expressway. The two ways are known as the boundary freeways which was 11.97km in length and accounting for about 21.62% of the total road network in existence at that time. A total of 3.54km of arterial roads, 4.76 km of collector roads were existing representing 6.39% and 8.59% of the total network respectively.

The local streets collectively amounted to 35.10 km and they have the highest percentage shared as they accounted for about 63.39% of the total network. These local streets are concentrated within the Garki I and Wuse I districts represented on the maps as A and B. These were the only districts that were developed at that time.

Table 4.3 analysis of transport route network for 1982

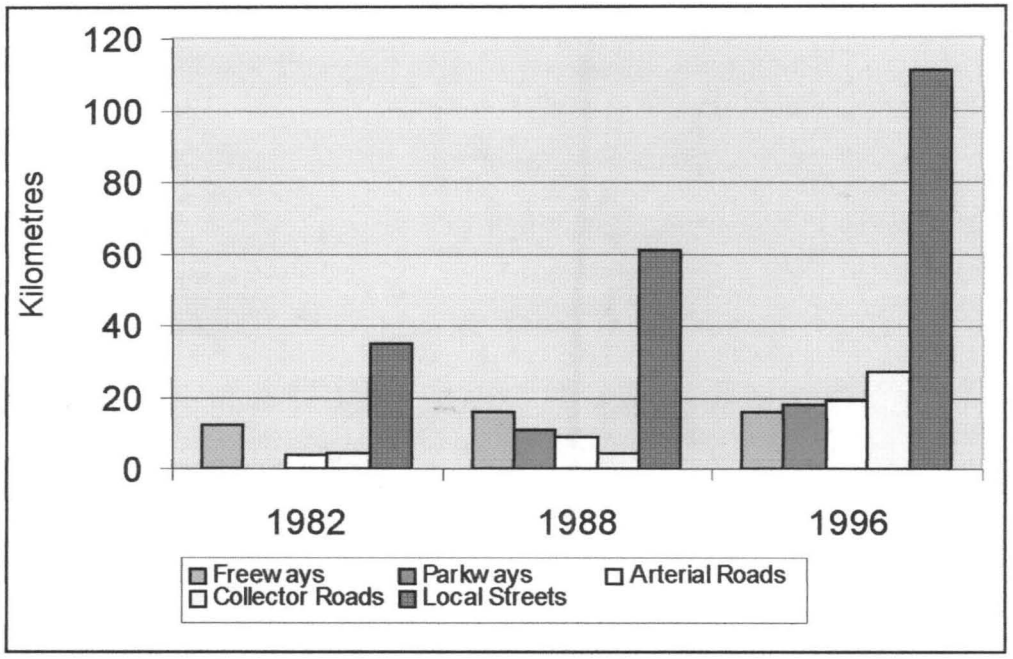
Categories of Road	Length in Kilometres	% of Total
Freeways	11.97	21.62
Parkways	Nil	Nil
Arterial Roads	3.54	6.39
Collector Roads	4.76	8.59
Local Streets	35.10	63.39
Total	55.37	100

Source : 1982 Aerial Photograph. Federal Surveys Abuja..

4.2.2 Transport Route situation in 1988

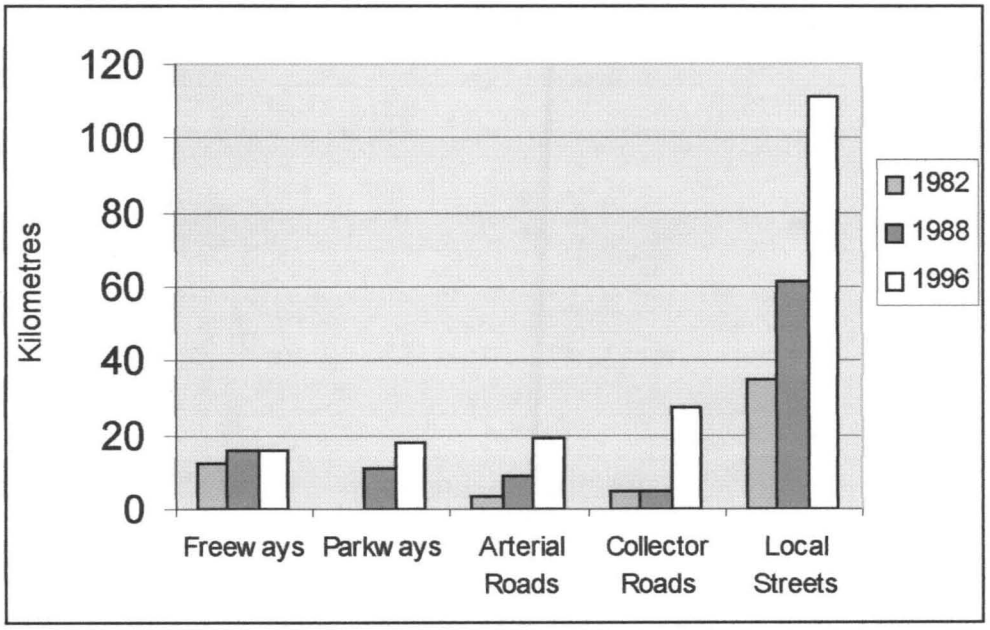
The situation in 1988 shows that the expressway systems has developed as the remaining portion of the boundary freeway has been constructed bring the total to 15.65km accounting for 15.42% of the total network. The parkway system amounted to 10.92 km accounting for 10.72% of the total network. This parkway is the central area connector as indicated by fig. 4.5 on the map. The arterial roads amounted to 8.96km

Figure 4.1 Transport route Analysis by Years



Source : Lab analysis of aerial photograph and SPOT image

Figure 4.2 Transport route analysis by Categories of Roads



Source : Lab analysis of aerial photograph and SPOT image

while the collectors are 4.76% in totality accounting for 8.83% and 4.76% respectively. The local streets amounted to 61.20km representing 60.30% of the total network, which is now about 101.49 kilometres as shown in table 4.4

Table 4.4 Analysis of Transport Route Network for 1988

Categories of Road	Length in Kilometres	% of Total
Freeways	15.65	15.42
Parkways	10.92	10.72
Arterial Roads	8.96	8.83
Collector Roads	4.76	4.69
Local Streets	61.20	60.30
Total	101.49	100

Source : 1988 Aerial Photograph. Federal Surveys Abuja..

4.2.3 Transport route situation in 1996

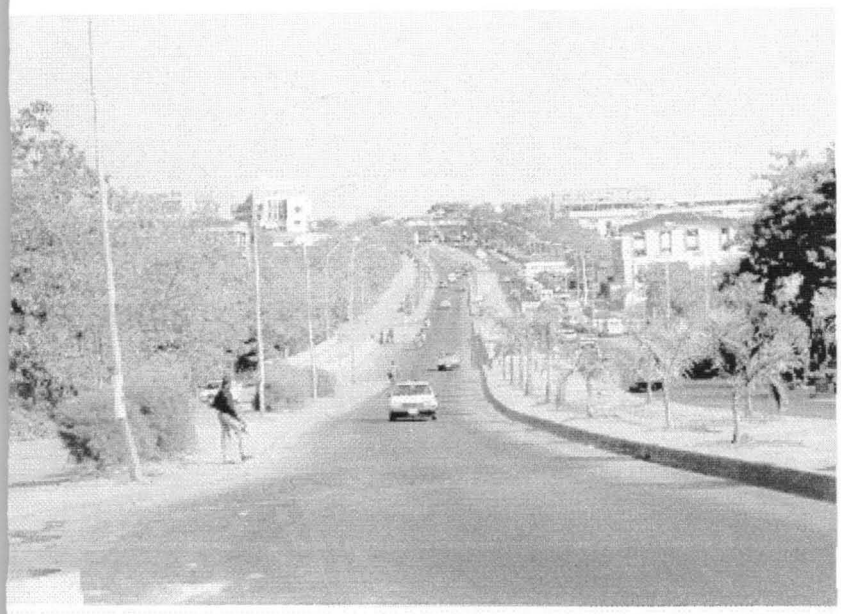
A total of 190.97 km of road were in existence in 1996 out of which 8.20% representing 15.65km is for the boundary freeway and 17.81km for the parkways representing 9.33% of the total. The total length of the arterial roads was 19.36km while the collector roads amounted to 27.36km representing 10.14% and 14.22% of total networks respectively.

Table 4.5 Analysis of Transport Route Network for 1996

Categories of Road	Length in Kilometres	% of Total
Freeways	15.65	8.20
Parkways	17.81	9.33
Arterial Roads	19.36	10.14
Collector Roads	27.16	14.22
Local Streets	110.99	58.12
Total	190.97	100

Source : Lab analysis of 1996 SPOT image.

Plate 1



A section of Herbert Macauley Street - a collector road

The local streets amounted to 110.99km representing 58.12% of the total network and still taken the lion's share.

Roads yet to be constructed as at 1996 were as analysed in table 4.6 below:

Table 4.6 Analysis of Transport Routes yet to be constructed

Categories of Road	Length in Kilometres	% of Total
Freeways	9.76	73.38
Parkways	3.15	23.68
Arterial Roads	0.39	2.93
Total	13.3	100

Source : Lab analysis of 1996 SPOT image and the Abuja Masterplan.

4.3.0 ANLYSIS OF ROAD NETWORK CHANGES

4.3.1 Analysis of road network changes from 1982 to 1988.

By 1988 the portion of the Murtala Muhammad freeway not existing before has been completed accounting for the 30.74% increase in the period under review.

The parkways which was not in existence before has a boast of 10.92km with the construction of the central area connector known as the Ibrahim Babangida Drive. It has no bases of comparison therefore the percentage change can not be determined. The highest percentage change within this period was in the development of the arterial roads with 153.1% increase over the situation in 1982 but the collector roads remain unchanged. From the map of 1988 one discovered that two other districts were being developed. They are the Maitama and Asokoro districts depicted as D and E respectively. The two districts have a large network of Arterial roads local streets without any collector road developed within the time frame.

4.3.2 Analysis of road network change from 1988 to 1996

The freeways did not witness any change in length as indicated in the Table 4.7 below

Plate 2

A section of airport access expressway.

However during reconnaissance survey we discovered that part of the Murtala Muhammad expressway is being dualised. This is happening in the year 2000. Two other expressways known as the inner expressway north and the inner expressway south are yet to be constructed. The total length amount to 9.76km as shown on Table 4.6

Table 4.7 Changes in Road Network from 1982 to 1988

Categories of Roads	Length in Kilometres		Percentage Change
	1982	1988	
Freeways	11.97	15.65	30.74
Parkways	Nil	10.92	----
Arterial Roads	3.54	8.96	153.10
Collector Roads	4.76	4.76	0
Local Streets	35.10	61.20	74.35

Source : GIS analysis and Desktop work by the researcher.

Table 4.8. Changes in Road network from 1988 to 1996

Categories of Roads	Length in Kilometres		% Change
	1982	1988	
Freeways	15.65	15.65	0
Parkways	10.92	17.81	63.10
Arterial Roads	8.96	19.36	116.07
Collector Roads	4.76	27.16	470.59
Local Streets	61.20	110.99	81.35

Source : GIS analysis and Desktop work by the researcher.

The outer boundary expressways (Murtala Mohammed Expressway) has four lanes out of the expected ten while, the inner boundary freeway (Nnamdi Azikiwe Expressway) has only two lanes . For now they do not qualify to be called proper freeways until when fully completed.

During the period under review the Sani Abacha parkway came into being given and increase of 6.89km representing a change of 63.10% in the parkway system.

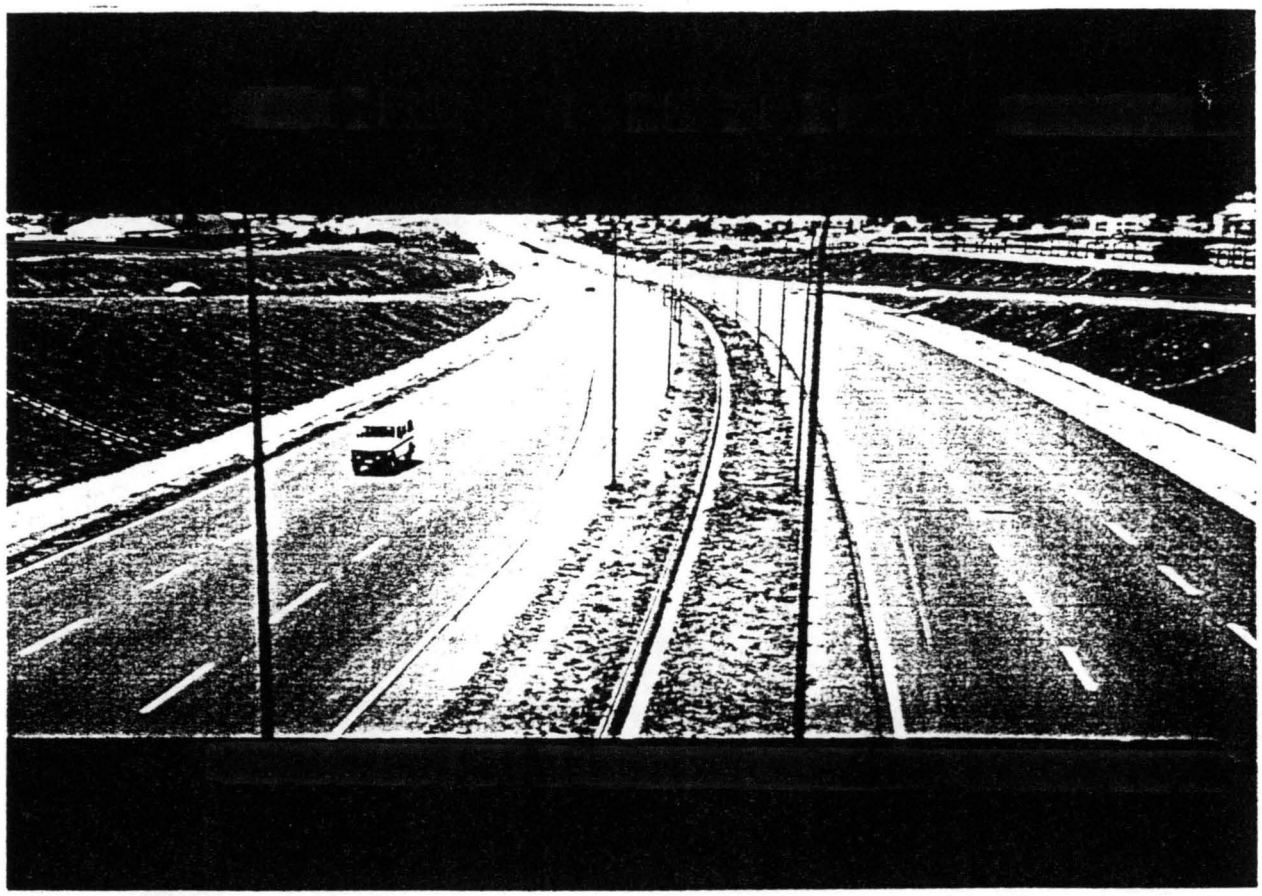
The arterial roads have a very high boast with 116.07% increase while the collector roads recorded the highest increase of about 470.59%. The local streets increased from 61.20km to 110.99km representing a change of about 81.35%. All these changes can be attributed to the development of two additional districts and the need to increase interconnecting in the network. The two districts are Garki II and Wuse II depicted by letters F and C respectively on map 3. During this period the Ahmadu Bello ways (north and south), Shehu Shagari arterial roads (North and South) and Olusegun Obasanjo way were fully developed except a small portion of the Obasanjo way amounting to 0.39km that is yet to be constructed.

4.2.0 ACCESSIBILITY ANALYSIS.

The accessibility map generated by the computer could be used effectively to determine areas of need because its analysis was limited to the Arterial roads and the expressways. During ground truthing however it was discovered that virtually all residential areas within the F.C.C. are within twenty metres from the local streets.

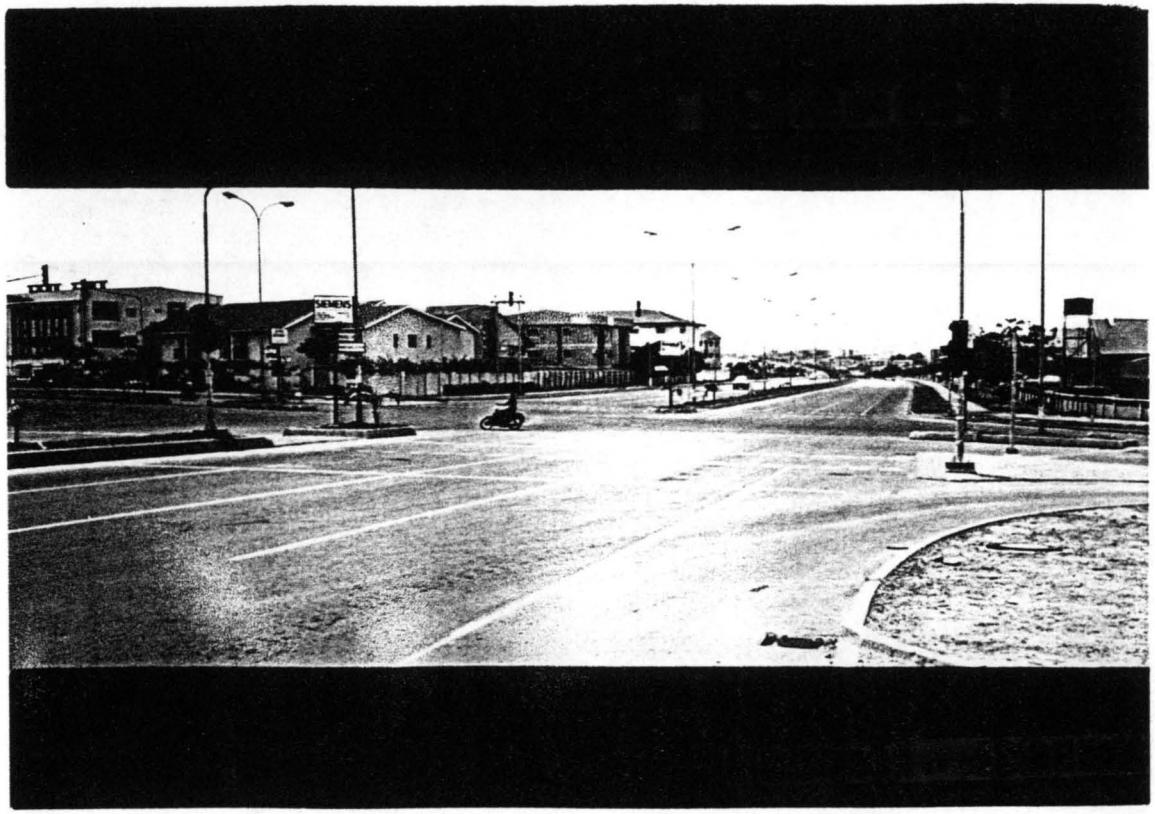
However the adjacent districts of Katampe, Wuye, and Durumi have no constructed road network as yet. Houses are been built, but they are too far from the nearest constructed roads. Hence this analysis of road network can not be extended to such areas.

Plate 3



A section of Sanni Abacha Parkway

Plate 4



A section of Ahmadu Bello Way in intersection with Aminu Kano crescent – An arterial and a collector roads respectively.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

In order to achieve the aim of this research it is important to summarise the findings and conclusion and make recommendations that may better the live of the inhabitant of the Federal Capital.

5.1.0 FINDINGS AND CONCLUSION

Road network, which has been described in the master plan document as the most important structure government is putting in place in the Federal Capital to create efficiency in movement of goods and services, has achieved a remarkable goal. However, much is yet to be accomplished as the expressway system ment to diffuse traffic round the territory is yet to be fully developed.

One can conclude that the city is well planned especially with regards to the road network as all districts are well linked and interconnectivity is high.

The metro line indicated by dotted lines on maps fig. 4.5 can only be conceived as a structure of the future. Here cost is a major consideration in the construction and the development of the metroline and the expressways.

The vast majority of the F.C.T residents live in the satellite villages like Karmo, Idu, Gwagwa, Lugbe etc. under sub-human conditions with mud houses lacking in toilet facilities. Many people can built moderation houses in these areas but due to the fact that the city development has not reach such areas people have the fear of demolition of such houses in future.

Displacing such large number of people at a time of road construction may create tremendous social, economic and even political upheaval. Getting the roads in place now and followed by adequate residential and industrial development latter is a better way of preventing crises in future and also a more economically more meaningful measure.

Remote Sensing offers a unique way of monitoring development in adjacent land areas and hence controlling them before they get out of hand. The status of Remote Sensing techniques is very low in Nigeria and indeed in many third world countries despite the huge economic advantage it offers. A researcher in Remote Sensing

applications is therefore highly constrained, as the technical equipment and the software he needs for analysis are difficult to come by. This research has therefore been limited to areas where data is available , but the recommendations are drawn mainly from the ground survey that is meant to compliment the image data.

5.2.0 RECOMMENDATIONS

The following recommendations are hereby proffered, the implementation of which will create a better society for all of us.

1. The FCT is well planned with good network of roads, but efforts should be made to resist altering or modifying the plan due to cost or to satisfy selfish interest of some powerful members of the public.
2. Additional investment is required to construct all the express way system so as to stem the present traffic congestion in the city, which may grow worse in future.
3. Researches must be conducted to develop local roads construction materials to reduce cost and give fast expansion of road network to the areas outside Phase I of the FCC such road development will ensure proper housing and good accommodation to the inhabitants of the FCT.
4. The FCDA as a matter of urgency should have Remote Sensing Laboratory, trained personnel and regular aerial photo coverage to monitor the territory and adequately plan to prevent crises in future.
5. Acquisition of satellite data in making decisions for planning major public works should be a matter of top priority to all levels of Government and particularly the FCT to realise the dream of making Abuja a master piece.

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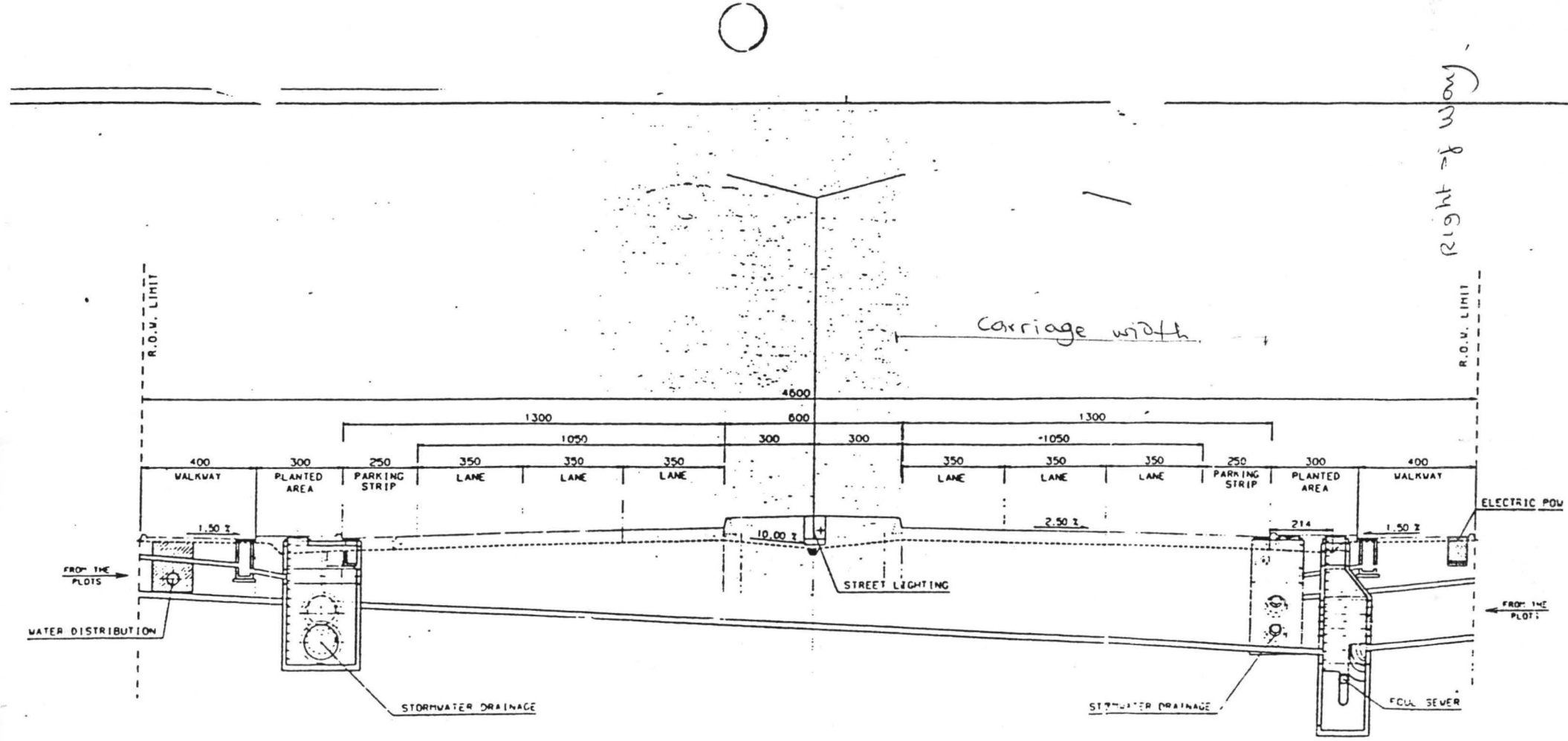
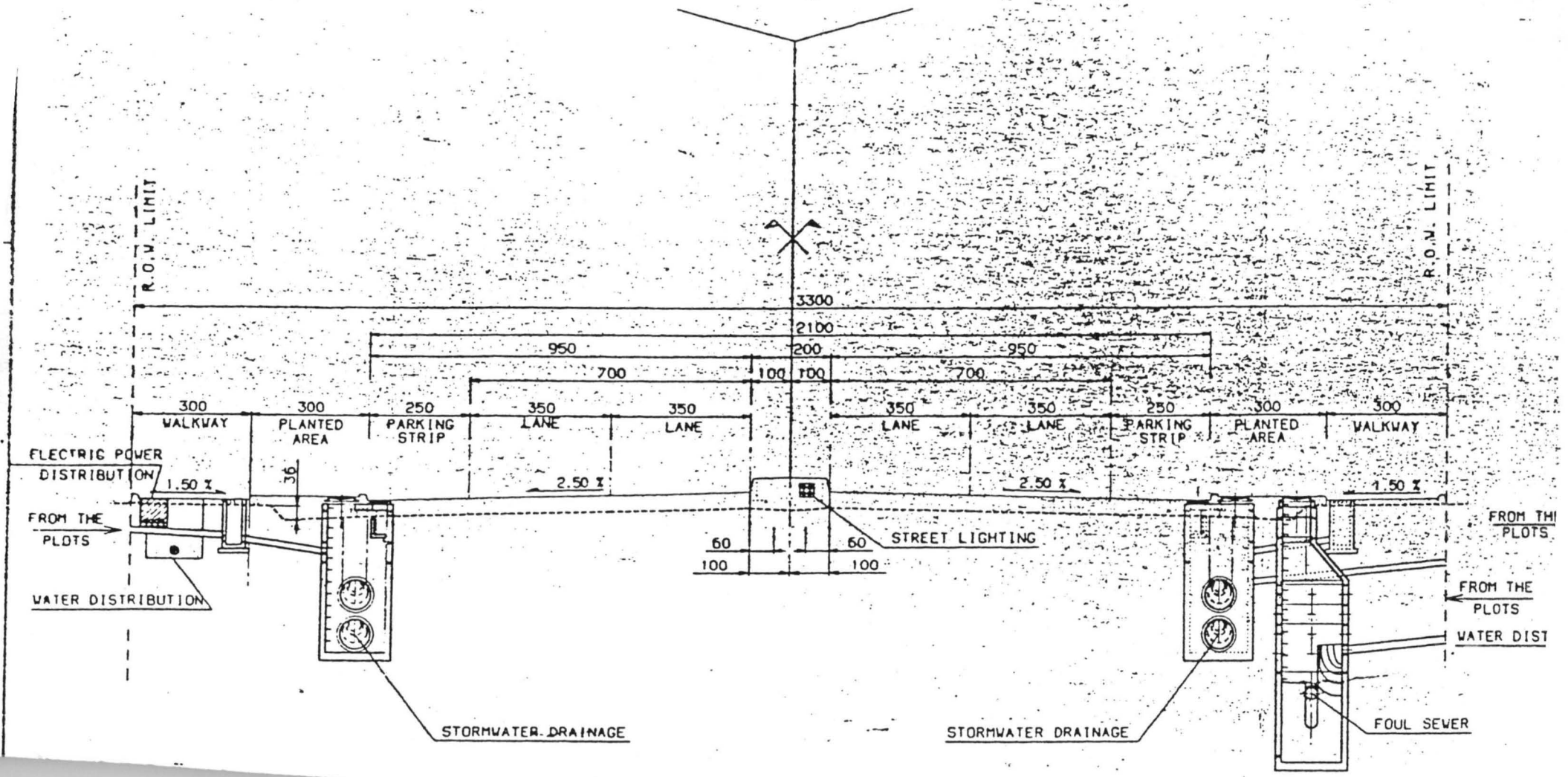
Appendix i



ARTERIAL ROAD IN STRAIGHT
TYPICAL SECTION

Appendix ii


R.O.W. LIMIT
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700
100
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700
300
WALKWAY
300
PLANTED AREA
250
PARKING STRIP
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LANE
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LANE
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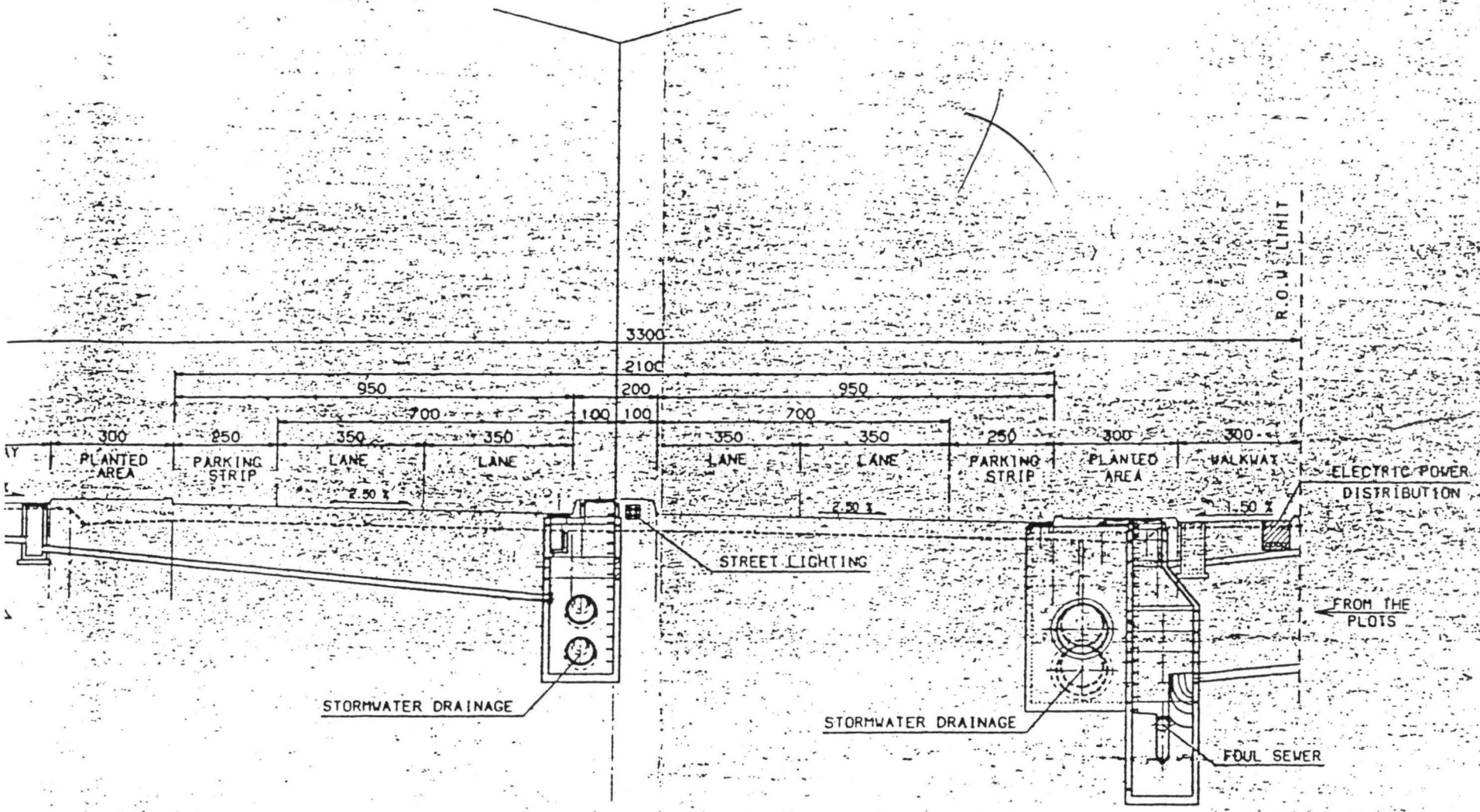
LANE
350
LANE
250
PARKING STRIP
300
PLANTED AREA
300
WALKWAY
R.O.W. LIMIT
ELECTRIC POWER DISTRIBUTION
1.50 %
36
2.50 %
2.50 %
1.50 %
FROM THE PLOTS
WATER DISTRIBUTION
60
100
60
100
STREET LIGHTING
FROM THE PLOTS
FROM THE PLOTS
WATER DIST
STORMWATER DRAINAGE
STORMWATER DRAINAGE
FOUL SEWER

ppendix iii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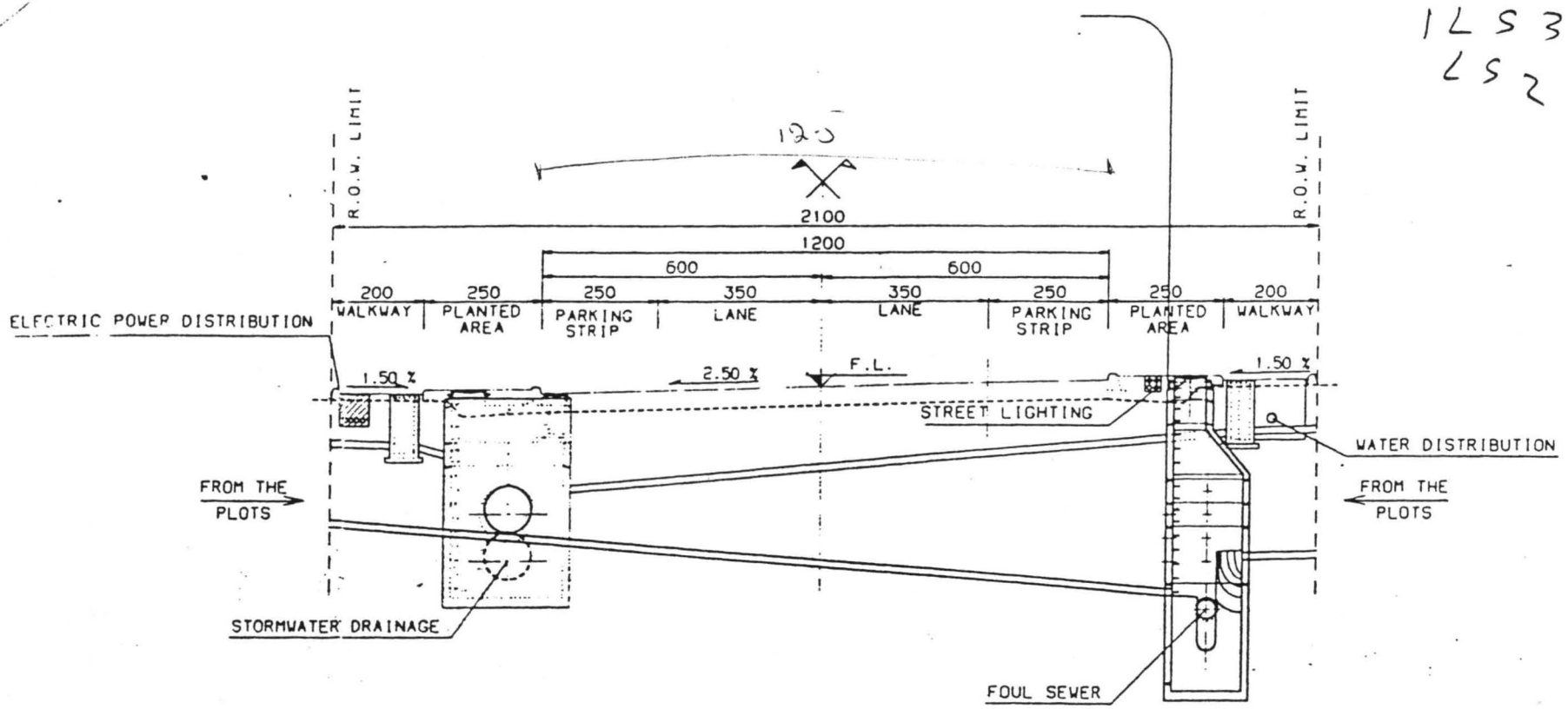
PARKING STRIP
PLANTED AREA
WALKWAY
2.50 %
2.50 %
50 %
R.O.W. LIMIT
ELECTRIC POWER DISTRIBUTION
STREET LIGHTING
FROM THE PLOTS
STORMWATER DRAINAGE
STORMWATER DRAINAGE
FOUL SEWER

Appendix iv

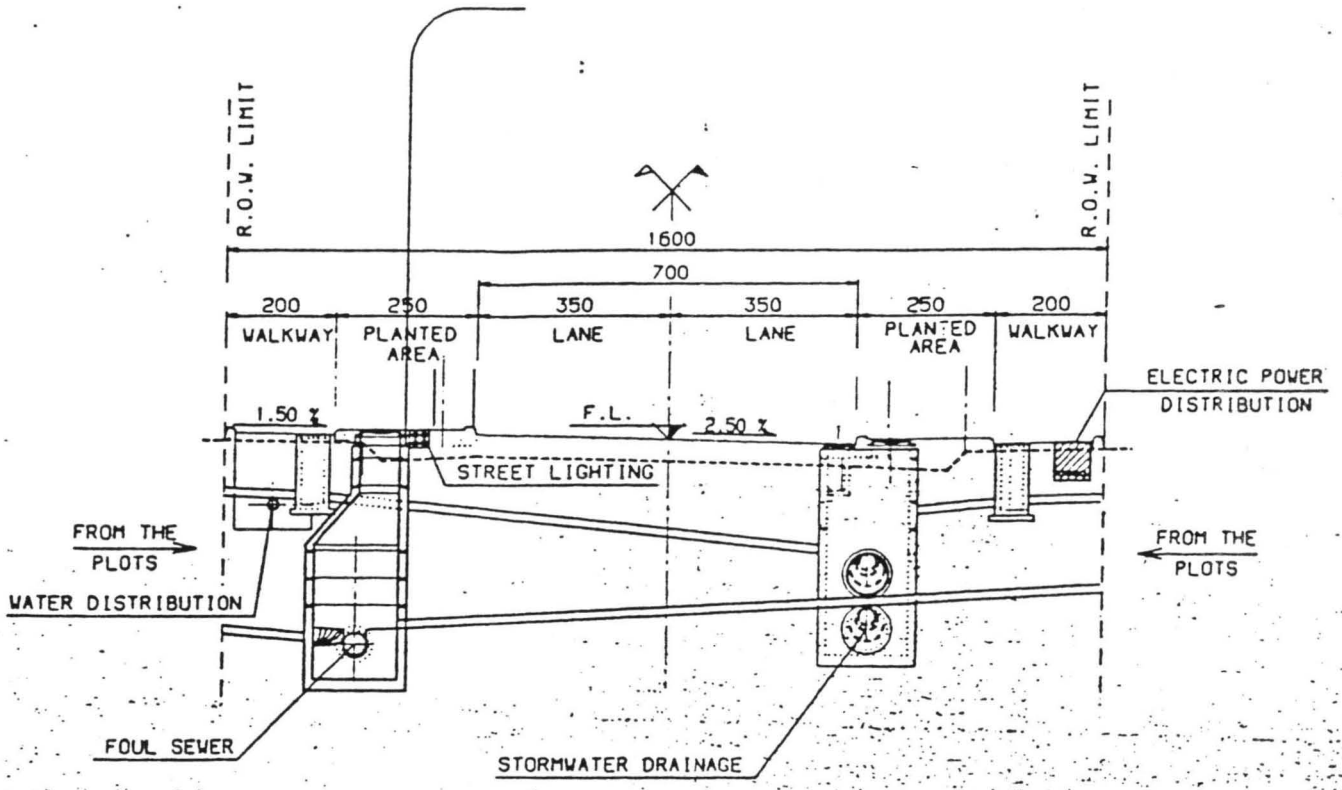
ILS 3
LS 2



ILS/LS

TYPICAL SECTION

Appendix v

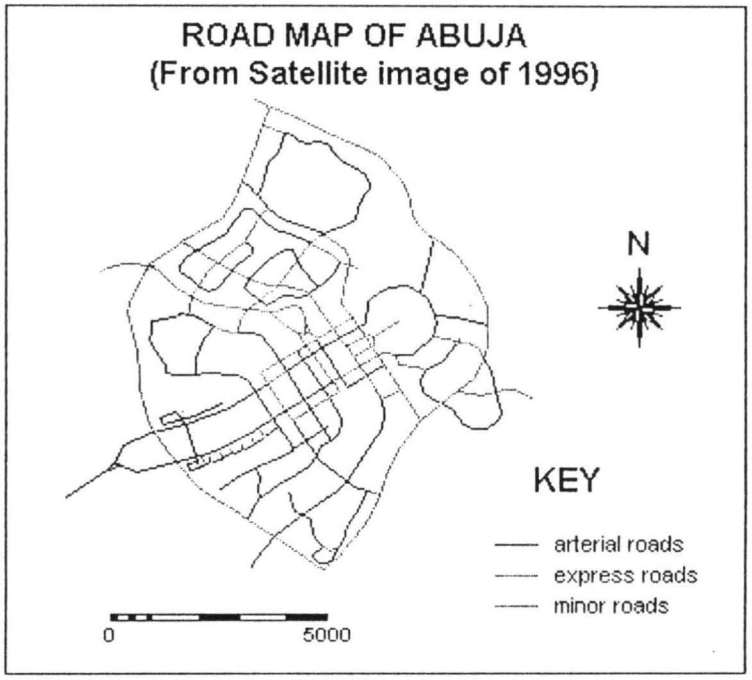


MAR/CDS

TYPICAL SECTION

cul De Sac

Appendix vi


ROAD MAP OF ABUJA
(From Satellite image of 1996)
N
KEY
arterial roads
express roads
minor roads
0
5000

Appendix vii

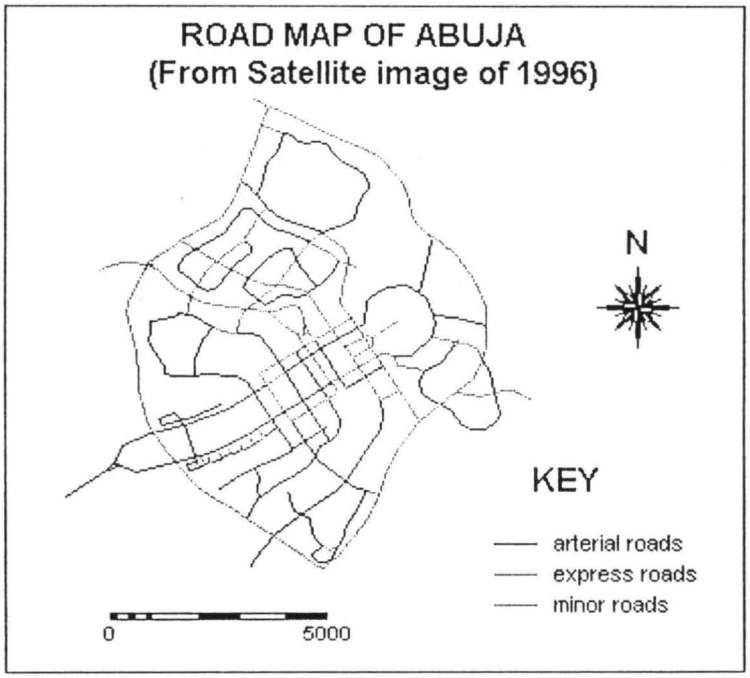
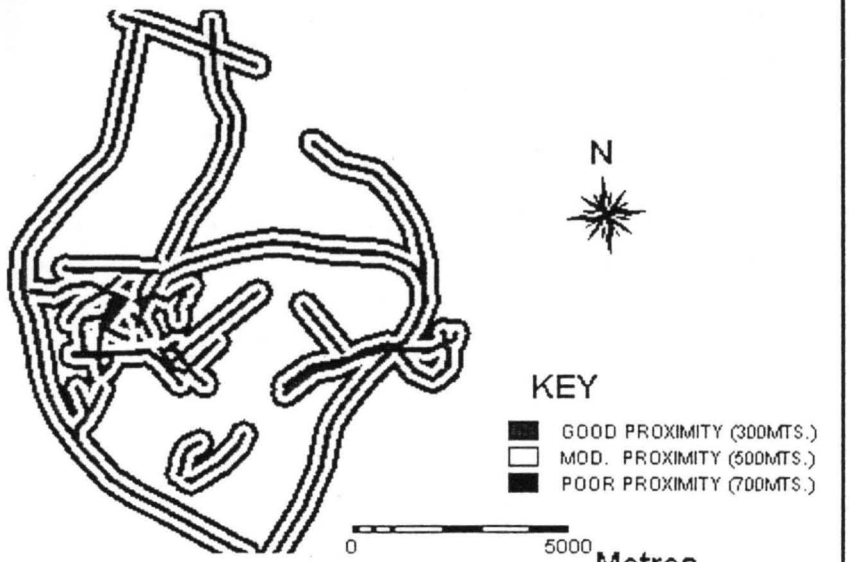
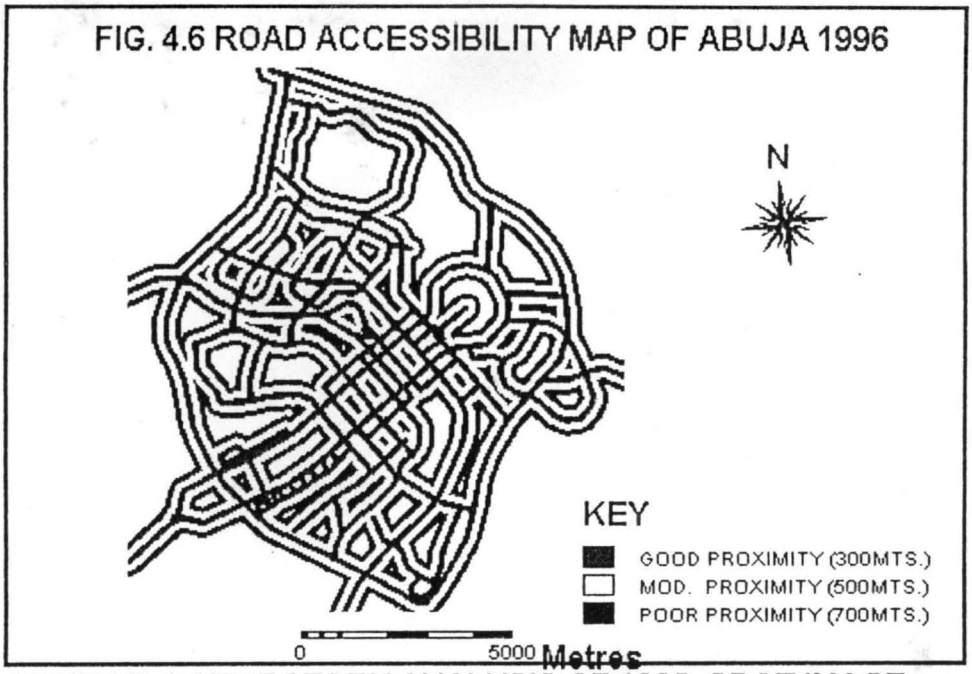


FIG. 4.5 ROAD ACCESSIBILITY MAP OF ABUJA 1982



SOURCE: LABORATORY ANALYSIS OF 1982

FIG. 4.6 ROAD ACCESSIBILITY MAP OF ABUJA 1996



SOURCE: LABORATORY ANALYSIS OF 1996 SPOT IMAGE