

BUILDING SUSTAINABLE ROAD INFRASTRUCTURE: THE FCDA MODEL AND LESSONS FOR NATIONAL DEVELOPMENT

**A PRESENTATION AT THE 2ND INTERNATIONAL
WORKSHOP ON GLOBAL TRENDS IN DESIGNS &
CONSTRUCTION OF DURABLE ROAD PAVEMENT**

BY

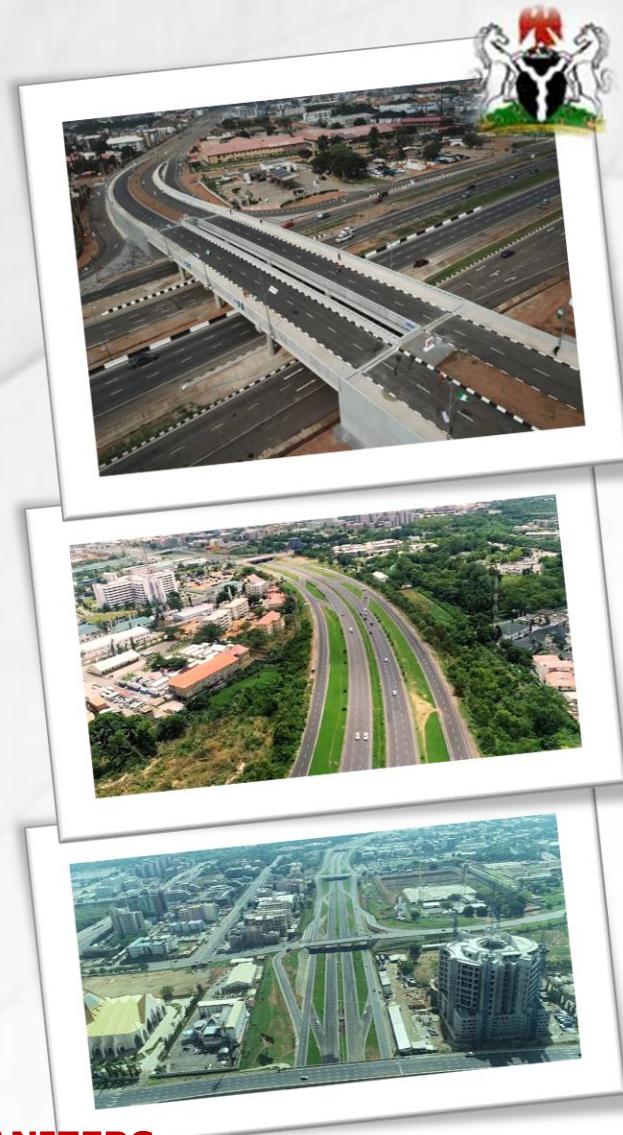
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Federal Ministry of Innovation, Science and Technology



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CREATION OF FCT, ABUJA – HISTORICAL BACKGROUND

In 1975, the then Federal Military Government of **General Murtala Ramat Mohammed, GCFR**, yielded to the consideration of the unsuitability of Lagos remaining as the Nation's Capital and thus constituted a seven-man Committee chaired by **Dr. Timothy Akinola Aguda**.

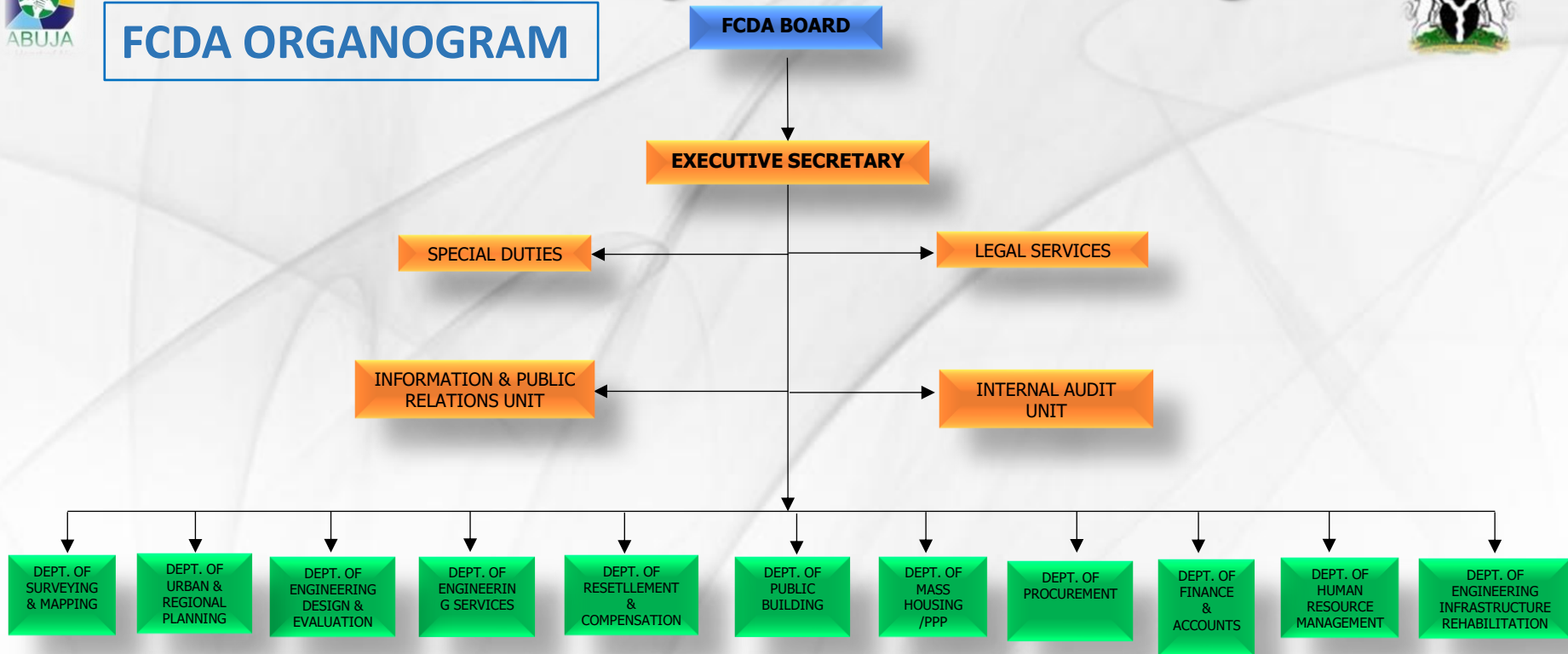
The outcome of the committee work resulted to the creation of the Federal Capital Territory (FCT) and the establishment of the Federal Capital Development Authority (FCDA) by Decree No. 6 of 1976 (Cap 128 Laws of the Federation. The Decree charged the FCDA with the responsibilities of planning, development and administration of the Federal Capital City (FCC) and the Federal Capital Territory (FCT) as a whole.



Creation of FCT, Abuja – Historical Background



FCDA ORGANOGRAM



LEGEND

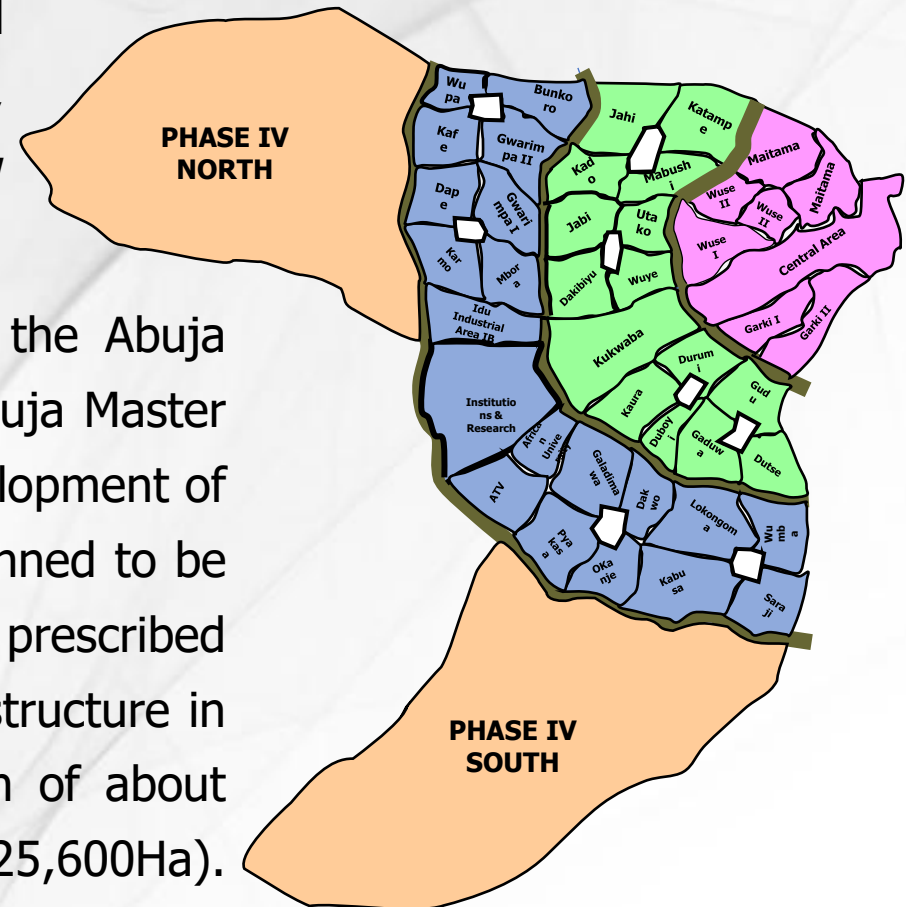
-  FCDA Board Members
-  Office of the Executive Secretary
-  Departments

Brief on the Abuja Engineering Infrastructure Master Plan



The FCDA in carrying out its mandates, commissioned the **International Planning Associates (IPA)** in 1977, to produce a Master Plan for the New Capital City and its Regional Grid.

In 1979, Messrs IPA finally submitted the Abuja Master Plan to the FCDA Board. The Abuja Master Plan as approved, provided for the Development of the Capital City in three (3) Phases; planned to be developed over a 25 Year period with a prescribed pattern for the provision of Social Infrastructure in the Territory for an ultimate population of about 3.1 million over an area of 256km² (25,600Ha). The plan also provided for Phases IV (North & South) as corridors for future expansion of the New Capital City.



Brief on the Abuja Engineering Infrastructure Master Plan ...Cont'd



Following the submission of the Master Plan Documents by the IPA, Detailed engineering studies were carried out as well as Preliminary and Final Engineering Designs were conducted by various consultants for the provision of numerous components of Engineering Infrastructure Services for the city, which comprises of Primary & District Infrastructure.

Primary Infrastructure

The Primary Infrastructure covers the following:-

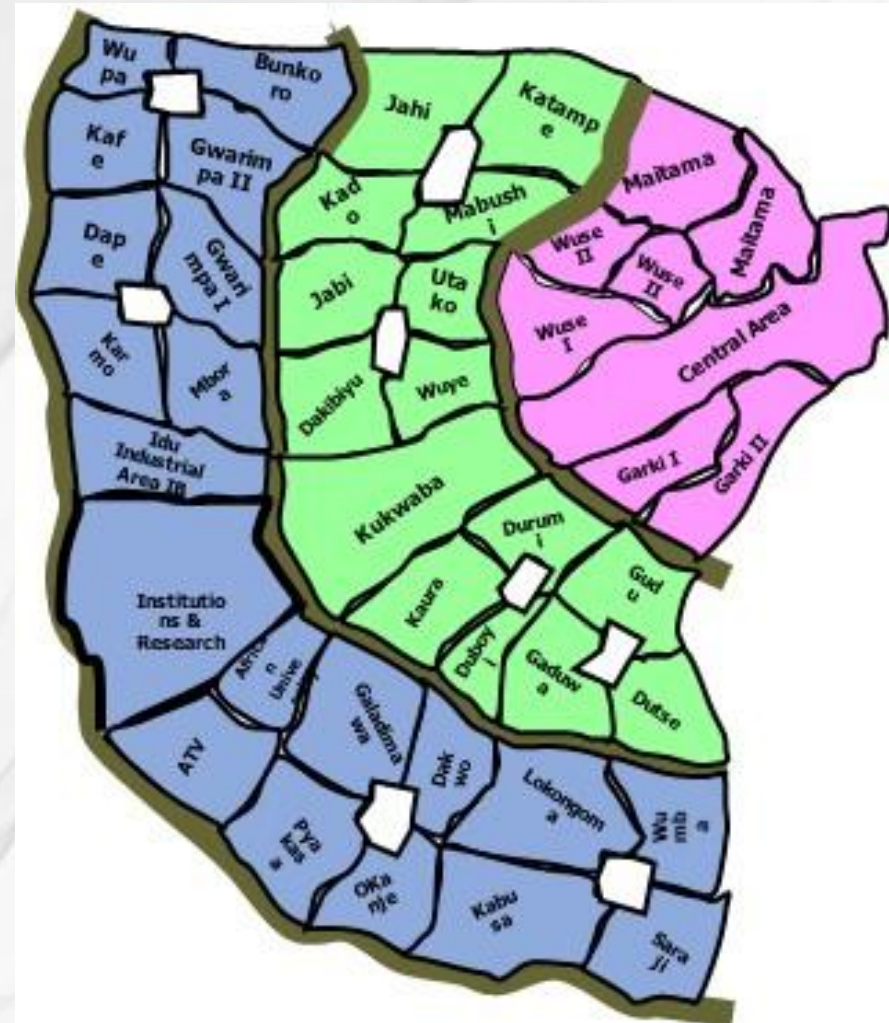
- Transportation Network (Road, Rail & Airport Development)
- Water Supply Network
- Foul Sewerage Network
- Storm Water Drainage Network, Erosion Control & River Training Infrastructure
- Solid Waste Management System
- Electrical Power Supply

District Infrastructure

The original Abuja Master Plan provides for the development of the Federal Capital City (FCC) in three (3) Phases namely Phases I, II & III with a provision for future expansion along the Northern and Southern flank (Phase IV North & Phase IV South respectively) of the city. Each Phase is further sub-divided into Districts, while the Districts are divided into neighbourhoods.

The District Infrastructure Services comprises of Integrated Networks of Roads, Water Supply, Electrical Power Supply & Street Lighting, Storm & Foul Sewer Lines as well as Telecommunication Ducts, for provision of services to plots within the Districts.

In this presentation, emphasis will be given to Planning and Development of Road Infrastructure in the FCC.



PLANNING/DESIGN OF ROAD INFRASTRUCTURE IN THE FCC

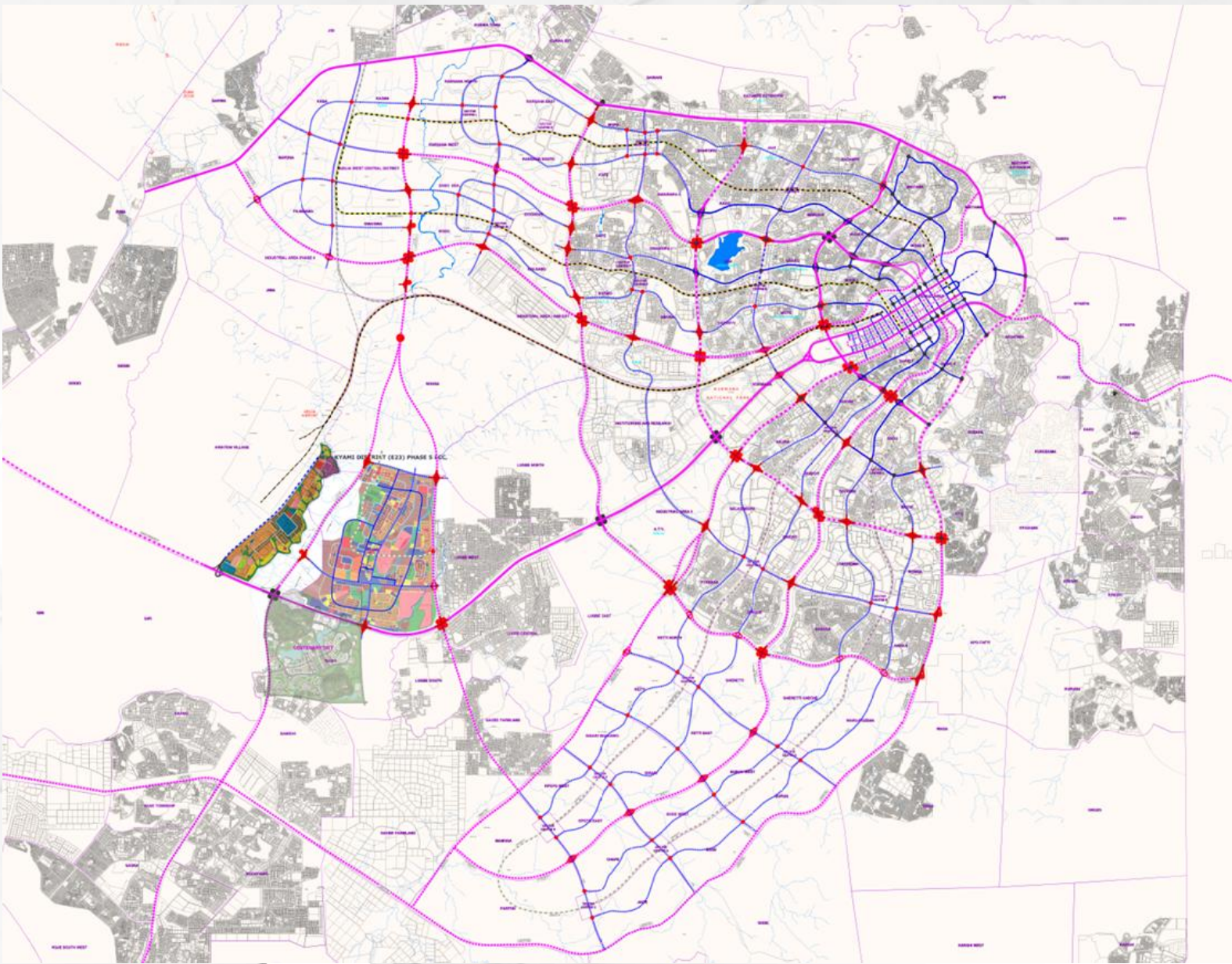
Planning/Design of Road Infrastructure in the FCC

The City of Abuja being developed as an urban City, is comprised of functional road transportation network that provides the basis for the provision of other Engineering Infrastructure Services. This includes Primary Roads and District Roads (Secondary & Tertiary) as shown on the layout of Transportation Network in the FCC.

The roads are designed and developed as flexible pavement for all categories.

Planning/Design of Road Infrastructure in the FCC

TRANSPORTATION NETWORK IN THE FCC



LEGEND

- EXPRESSWAY**
 - - - - - EXISTING OR UNDER CONSTRUCTION
 - - - - - PARTLY DEVELOPED
 - - - - - FUTURE
- ARTERIAL ROAD**
 - - - - - EXISTING OR UNDER CONSTRUCTION
 - - - - - PARTLY DEVELOPED
 - - - - - FUTURE
- RAILWAY**
 - - - - - EXISTING OR UNDER CONSTRUCTION
 - - - - - FUTURE
- TRANSITWAY**
 - - - - - EXISTING OR UNDER CONSTRUCTION
 - - - - - FUTURE
- JUNCTION**
 - - - - - EXISTING OR UNDER CONSTRUCTION
 - - - - - FUTURE
 - - - - - EXISTING INTERSECTION WITH FUTURE
 - - - - - FUTURE
 - - - - - FUTURE

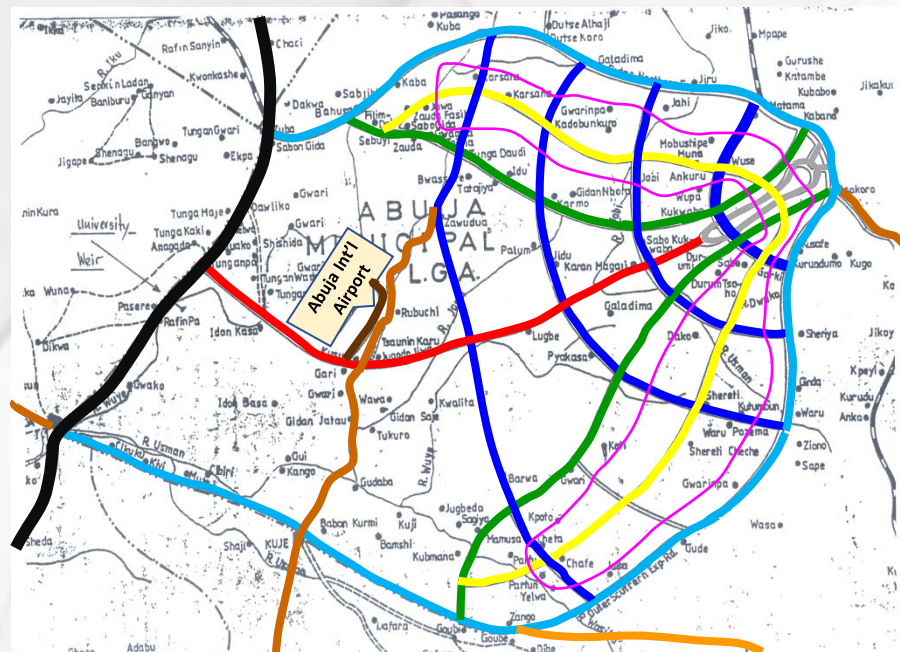
FEDERAL REPUBLIC OF NIGERIA	
FEDERAL CAPITAL DEVELOPMENT AUTHORITY	
ABUJA FUTURE PROJECTS	
GENERAL LAYOUT	
TRANSPORTATION NETWORK	
CENTURY CITY	
1 : 50,000	

PRIMARY ROADS

Network of Primary Roads

The Primary Road Network consists of Expressways bounding and traversing the City as well as providing for effective movement of traffic within the Territory and connecting traffic circulation with the Regional and National Roads Network. These include:-

- Outer Northern Expressway (ONEX)
- Outer Southern Expressway (OSEX)
- Inner Northern Expressway (INEX)
- Inner Southern Expressway (ISEX)
- Airport Expressway (AEW)
- Northern & Southern Parkways (N8/9 & S8/9)
- Ring Roads I, II, III & IV
- Transit Ways (N/S 2 & 12)
- Bill Clinton Drive
- FCT Highways (105, 106, 110, 113, 116, 117), and
- Lower Usuma Dam - Gurara Road



Legend

- Outer Northern & Southern Expressways
- Inner Northern & Southern Expressways
- Airport Expressway
- Northern & Southern Parkways
- Ring Roads I, II, III & IV
- Transit Ways
- Bill Clinton Drive
- FCT Highways
- A2 Kaduna - Lokoja

PRIMARY ROADS.....Cont'd

FUNCTIONS OF THE PRIMARY ROADS			
Primary Roads	Boundary Freeways	ONEX, INEX, ISEX, OSEX, Airport Expressway	Connection with national road network, Intersections are fully grade separated, Trucks permitted.
	Central Parkways	Northern Parkway, Southern Parkway	Trips between sectors, intersections are partly to fully grade separated, Trucks prohibited.
	Transverse Parkways	Ring Roads (I, II, III & IV)	Connection of Arterial Road System Intersections are partly to fully grade separated Trucks permitted.
	Transit Ways	N2, S2, N12 & S12	Made up of Rail Line at the centre and roadways on both sides, connecting all the Sector Centres in the FCC.
	FCT Highways	FCT 105, 106, 110, 113, 116, 117	Traffic movement from North to South, South to East within the FCT and adjoining states of Niger, Nasarawa, Kaduna and Kogi.

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd

GEOMETRIC DESIGN PARAMETERS

ROAD NETWORK ABUJA – PARAMETER					
SN			EXPRESSWAY		
1	Design Speed (acc. DMRB)	km/h	100A	85A	85A
	Speed Limit		100	80	80
	According to International Planning Associates (IPA)		100	80	80
2	Stopping Sight Distance				
	Desirable Minimum	m	215	160	160
	one step below Minimum	m	160	120	120
3	Horizontal Curvature				
	Min R without elimination of Adverse Camber and Transitions	m	2040	1440	1440
	Min R with superelevation of 2.5%	m	1440	1020	1020
	Min R with superelevation of 3.5%	m	1020	720	720
	Desirable Minimum R with superelevation of 5%	m	720	510	510
	one step below Desirable Min R with superelevation of 7%	m	510	360	360
4	Vertical Curvature				
	Desirable Minimum Crest K Value		100	55	55
	One step below Desirable Min Crest K Value		55	30	30
	Absolute Minimum Sag K Value		26	20	20
5	Overtaking Sight Distances				
	Full Overtaking Sight Distance FOSD	m	580	490	
	FOSD Overtaking crest K Value		400	285	

also to be considered; superelevation, transition taper, widening of curves

PRIMARY ROADS.....Cont'd PAVEMENT DESIGN PARAMETERS

ROAD NETWORK ABUJA – PARAMETER		
SN	PAVEMENT STRUCTURE	SPECIFICATION
1	Sub grade	<ul style="list-style-type: none"> • CBR (between 3% - 10%) • Liquid Limit: 50% max • Plastic Limit: 25% max • Plasticity index: 30% max
2	Sub base materials	<ul style="list-style-type: none"> • CBR : 30% minimum • Liquid Limit: 30% max • Plastic Limit: 30% max • Plasticity index: 12% max
3	Base	<ul style="list-style-type: none"> • CBR : 80% minimum • Liquid Limit: 25% max • Plastic Limit: 25% max or preferably non-plastic (in the case of crush rock) • Plasticity index: 6% max
4	Binder course	<ul style="list-style-type: none"> • Optimum Bitumen Content: 4.5% - 6.5% • Stability, not less than: 3.5KN • Flow: 2mm – 6mm • Voids in total mixture: 3% - 8% • Voids filled with bitumen: 65% - 72%
5	Wearing Course	<ul style="list-style-type: none"> • Optimum Bitumen Content: 5.0% - 8.0% • Stability, not less than: 3.5KN • Flow: 2mm – 4mm • Voids in total mixture: 3% - 5% • Voids filled with bitumen: 75% - 82%
6	Macadam	<ul style="list-style-type: none"> • Optimum Bitumen Content: 3.3% - 3.7% • Stability, not less than: 4.9 – 8.8KN • Flow: 2mm – 4mm • Voids in total mixture: 10% - 15% • Voids filled with bitumen: 40% - 70%

PRIMARY ROADS.....Cont'd

CHARACTERISTICS OF THE PRIMARY ROADS

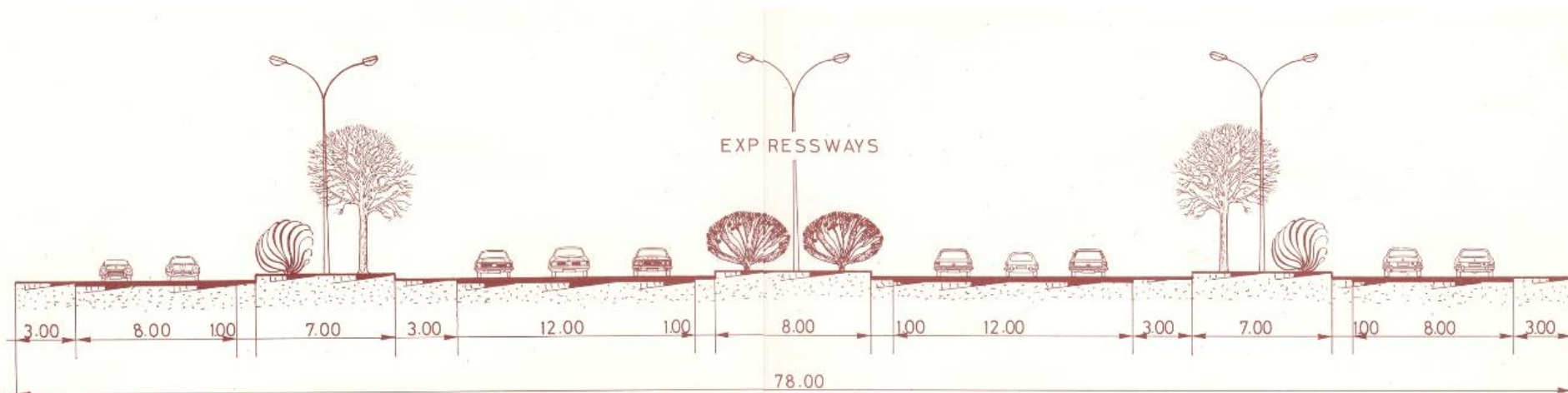
In view of the Abuja Master Plan Provisions and FCDA's Standards & Specifications for Roads, the Primary Roads have been designed with the characteristics as presented in the following slides

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd

CHARACTERISTICS OF THE PRIMARY ROADS

Expressways and Ring Roads



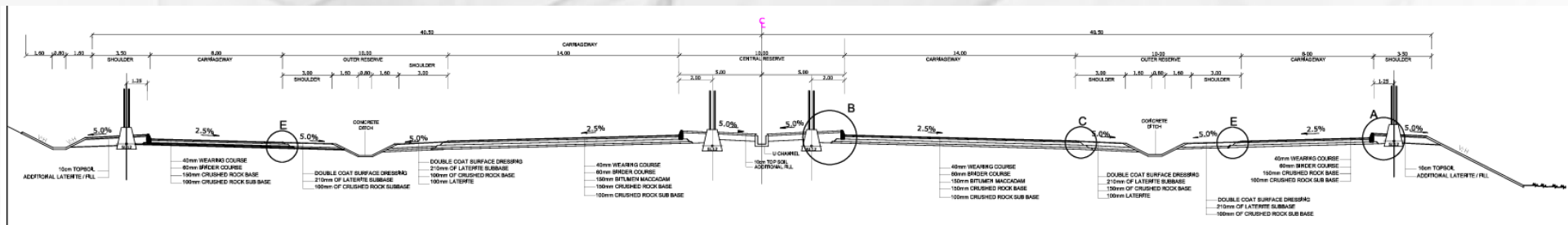
Road	Right of Way (78m)	Pavement Structure	
		Main Carriageway (MCW)	Service Carriageway (SCW)
Expressway/Ring Road	<ul style="list-style-type: none"> Dual carriageway, each made up of a Main carriageway (MCW) and Service Carriageway (SCW). 10m Median reservation between the 2 carriageways, 3 lanes of 4m each driveway on the MCW, 10m outer reservation between the MCW & SCW, 2 lanes of 4m each driveway on the SCW, 4m shoulder. <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm Maccadam 150mm crushed rock base 100mm crushed rock subbase 	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm crushed rock base 100mm crushed rock subbase

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd

CHARACTERISTICS OF THE PRIMARY ROADS

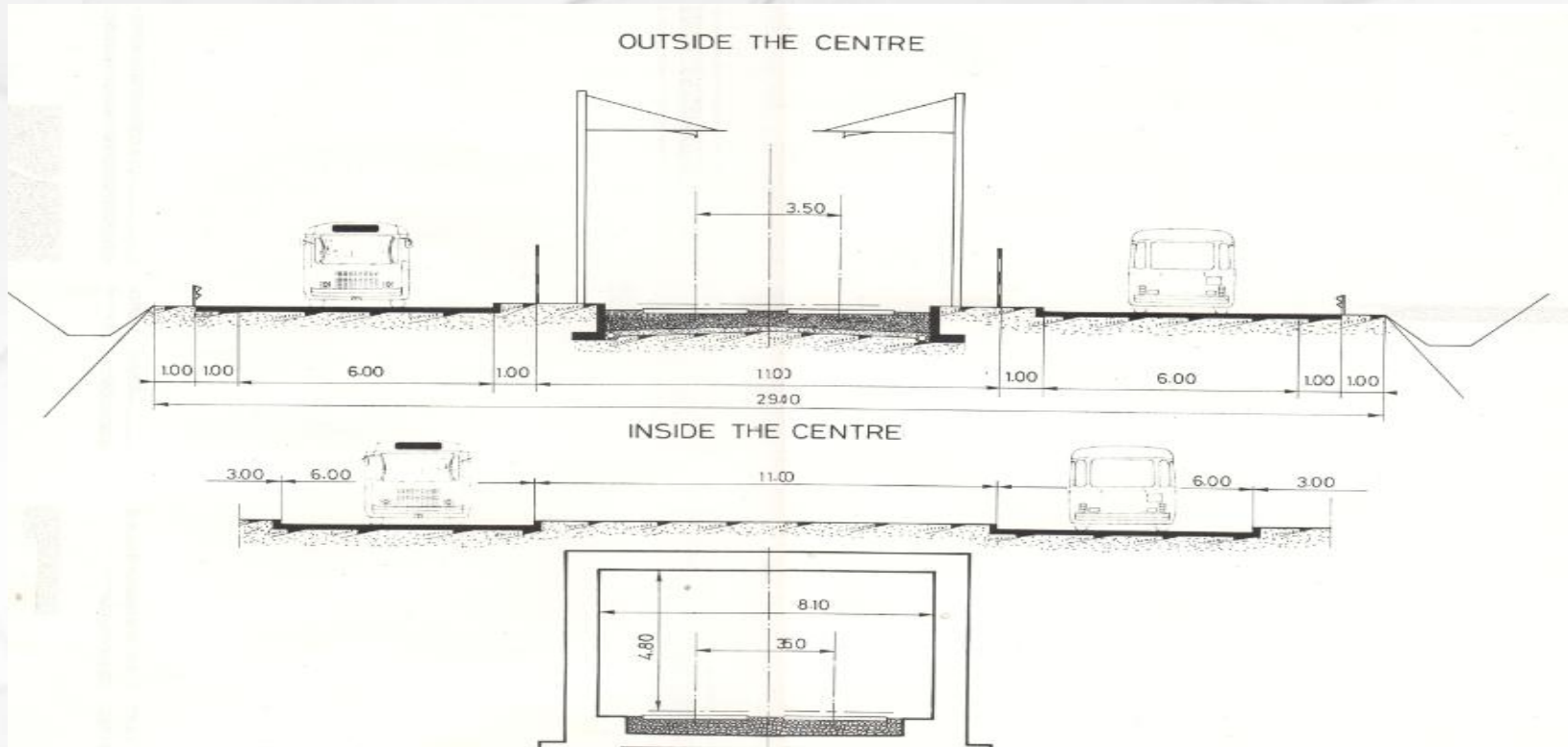
Park Ways



Road	Right of Way (81m)	Pavement Structure	
		Main Carriageway (MCW)	Service Carriageway (SCW)
Parkway	<ul style="list-style-type: none"> Dual carriageway, each made up of a Main carriageway (MCW) and Service Carriageway (SCW). 10m Median reservation between the 2 carriageways, 4 lanes of 3.5m each driveway on the MCW, 10m outer reservation between the MCW & SCW, 2 lanes of 4m each driveway on the SCW, 3.5m shoulder. Single carriageway, made up of 2 lanes of 3.5m driveway, 3m parking lane on both sides, 2m verge on both sides and 2m side walk on both sides <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm Maccadam 150mm crushed rock base 100mm crushed rock subbase 	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm crushed rock base 100mm crushed rock subbase

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd Transitway



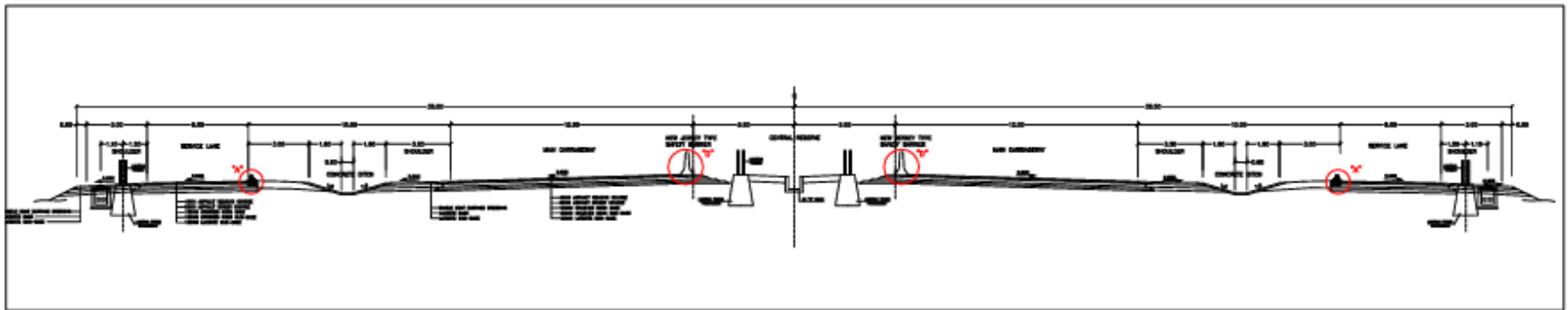
Road	Right of Way (29m)	Pavement Structure
		Road way
Transitway	<ul style="list-style-type: none"> Made up of Rail Line at the centre and roadways on both sides. 11m Corridor for the rail line 6m drive way, 1m verge and 2m side walk (Same on the two sides) <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm crushed rock base 100mm crushed rock subbase

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd

Characteristics of Primary Roads

FCT Highways



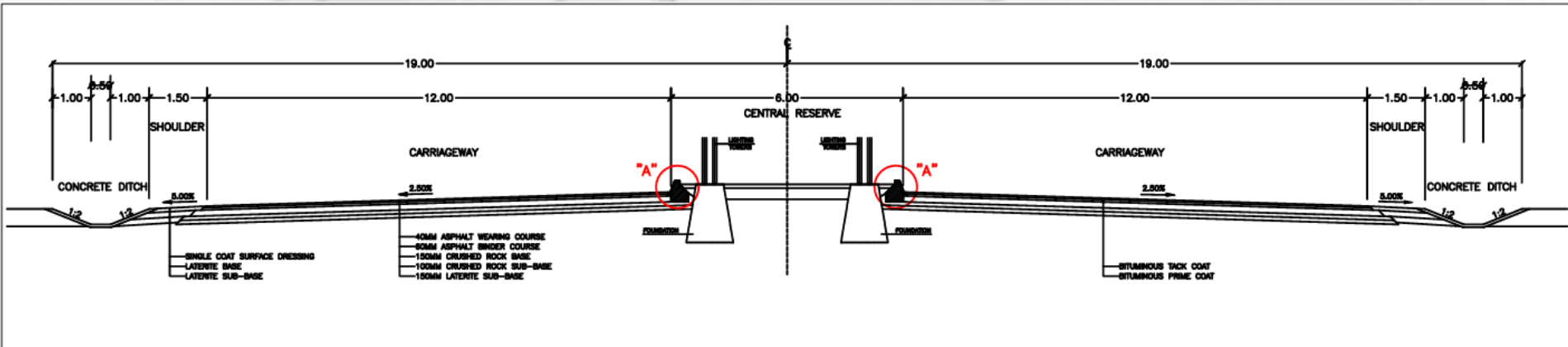
Road	Right of Way (71m)	Pavement Structure	
		Main Carriageway (MCW)	Service Carriageway (SCW)
FCT Highway (Section within the FCC)	<ul style="list-style-type: none"> Dual carriageway, each made up of a Main carriageway (MCW) and Service Carriageway (SCW). 10m Median reservation between the 2 carriageways, 3 lanes of 4m each driveway on the MCW, 10m outer reservation between the MCW & SCW, 2 lanes of 2.5m each driveway on the SCW, 3.5m shoulder. <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 60mm binder 40mm wearing 150mm Maccadam 150mm crushed rock base 100mm crushed rock subbase 	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 100mm crushed rock subbase

Planning/Design of Road Infrastructure in the FCC

PRIMARY ROADS.....Cont'd

Characteristics of Primary Roads

FCT Highways



Road	Right of Way (38m)	Pavement Structure
FCT Highway (Section out of the FCC)	<ul style="list-style-type: none"> 6m Median reservation Dual carriageway, each made up of 3 lanes of 4m driveway, 1.5m shoulder, open side drain of 2,5m top width. <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 100mm subbase

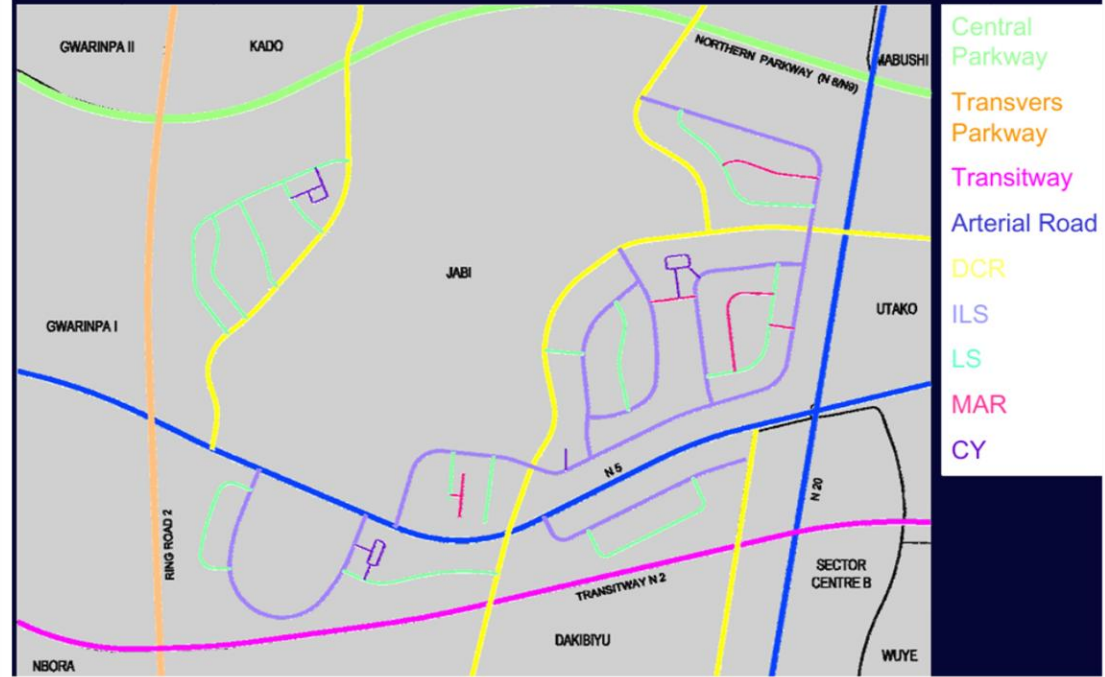
DISTRICT ROADS

Network of District Roads

Typical Network of District Roads in the FCC is made up of interconnected roads planned in order of hierarchy, from the lowest being the Plot Access to the highest, the Arterial Road, to enhance circulation within the Districts and Inter-Districts connection. The Roads in order of hierarchy is as presented below:-

- Minor Access Road/Street (MAR/MAS)
- Local Street (LS)
- Important Local Street (ILS)
- District Collector Road (DCR)
- Arterial Road (AR)

NETWORK OF DISTRICT ROADS IN THE FCC



DISTRICTS ROADS.....Cont'd

FUNCTIONS OF DISTRICT ROADS	
Arterial Road	Connecting the sector with the expressway; major traffic flow within the sector.
DCR	Connecting neighbourhood units with the arterial road.
ILS/LS/MAR	Immediate access to individual dwelling units and connection to district collector.

Planning/Design of Road Infrastructure in the FCC

DISTRICT ROADS.....Cont'd

GEOMETRIC DESIGN PARAMETERS

ROAD NETWORK ABUJA – PARAMETER					
SN			AR	DCR	ILS
1	Design Speed (acc. DMRB)	km/h	70A	60B	50
	Speed Limit		50	50	50
	acc. IPA				
2	Stopping Sight Distance				
	Desirable Minimum	m	120	90	70
	one step below Minimum	m	90	70	50
3	Horizontal Curvature				
	Min R without elimination of Adverse Camber and Transitions	m	1020	720	520
	Min R with superelevation of 2.5%	m	720	510	360
	Min R with superelevation of 3.5%	m	510	360	255
	Desirable Minimum R with superelevation of 5%	m	360	255	180
	one step below Desirable Min R with superelevation of 7%	m	255	180	127
	Two steps below Desirable Min R with superelevation of 7%	m	180	127	90
4	Vertical Curvature				
	Desirable Minimum Crest K Value		30	17	10
	One step below Desirable Min Crest K Value		17	10	6.5
	Absolute Minimum Sag K Value		20	13	9
5	Overtaking Sight Distances				
	Full Overtaking Sight Distance FOSD	m	410	345	290
	FOSD Overtaking crest K Value		200	142	100
also to be considered; superelevation, transition taper, widening of curves					

DISTRICT ROADS.....Cont'd

STRUCTURAL PAVEMENT DESIGN PARAMETERS

ROAD NETWORK ABUJA – PARAMETER		
SN	PAVEMENT STRUCTURE	SPECIFICATION
1	Sub grade	<ul style="list-style-type: none"> • CBR (between 3% - 10%) • Liquid Limit: 50% max • Plastic Limit: 25% max • Plasticity index: 30% max
2	Sub base materials	<ul style="list-style-type: none"> • CBR : 30% minimum • Liquid Limit: 30% max • Plastic Limit: 30% max • Plasticity index: 12% max
3	Base	<ul style="list-style-type: none"> • CBR : 80% minimum • Liquid Limit: 25% max • Plastic Limit: 25% max or preferably non-plastic (in the case of crush rock) • Plasticity index: 6% max
4	Binder course	<ul style="list-style-type: none"> • Optimum Bitumen Content: 4.5% - 6.5% • Stability, not less than: 3.5KN • Flow: 2mm – 6mm • Voids in total mixture: 3% - 8% • Voids filled with bitumen: 65% - 72%
5	Wearing Course	<ul style="list-style-type: none"> • Optimum Bitumen Content: 5.0% - 8.0% • Stability, not less than: 3.5KN • Flow: 2mm – 4mm • Voids in total mixture: 3% - 5% • Voids filled with bitumen: 75% - 82%

DISTRICT ROADS.....Cont'd

CHARACTERISTICS OF THE DISTRICT ROADS

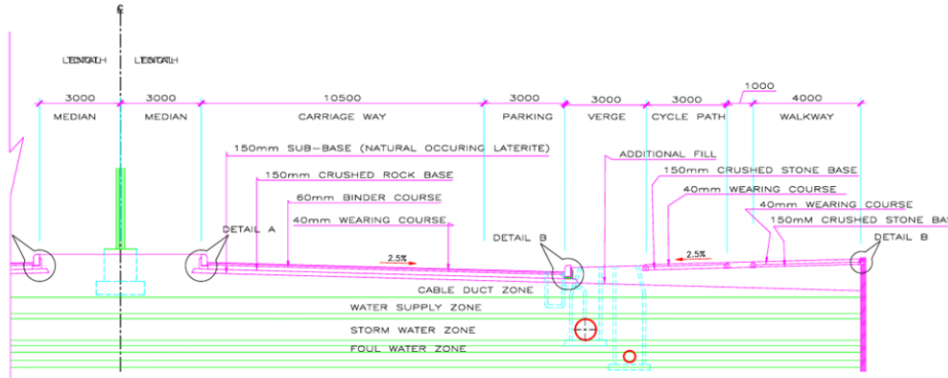
In view of the Abuja Master Plan Provisions and FCDA's Standards & Specifications for Roads, the District Roads (Secondary & Tertiary) were designed with the characteristics as presented in the following slides

Planning/Design of Road Infrastructure in the FCC

DISTRICTS ROADS.....Cont'd

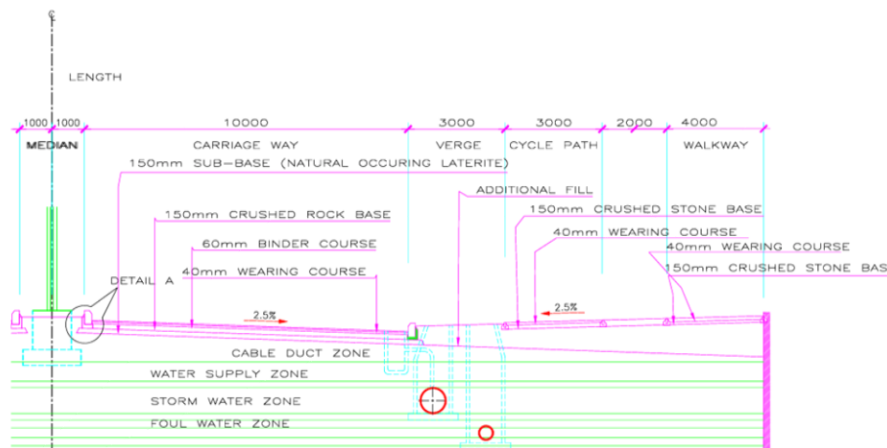
Characteristics of District Roads

ARTERIAL ROADS - 55m



Road	Right of Way (55m)	Pavement Structure
Arterial	<ul style="list-style-type: none"> 6m Median reservation Dual carriageway each made up of 3 lanes of 3.5m driveway, 3m parking lane, 3m verge, 3m cycle path, 1m verge and 4m side walk <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 150mm subbase (natural occurring laterite)

COLLECTOR ROAD - 44M



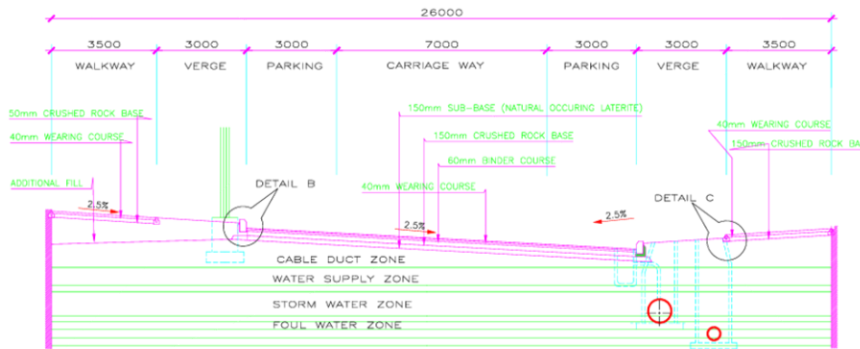
Road	Right of Way (44m)	Pavement Structure
Collector	<ul style="list-style-type: none"> 2m Median reservation Dual carriageway, each made up of 2 lanes of 3.5m driveway, 3m parking lane, 3m verge, 3m cycle path, 1m verge and 4m side walk <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 150mm subbase (natural occurring laterite)

Planning/Design of Road Infrastructure in the FCC

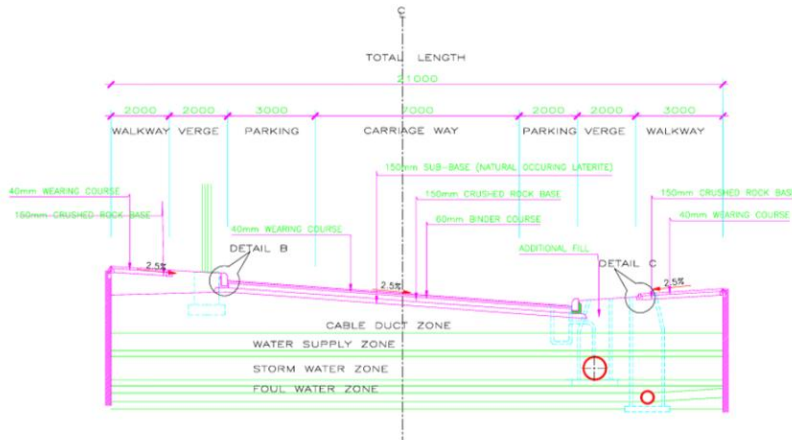
DISTRICTS ROADS.....Cont'd

Characteristics of District Roads

IMPORTANT LOCAL STREET (ILS) - 26m



LOCAL STREET (LS) - 21m



Road	Right of Way (26m)	Pavement Structure
Important Local Street	<ul style="list-style-type: none"> Single carriageway, made up of 2 lanes of 3.5m driveway, 3m parking lane on both sides, 3m verge on both sides and 3.5m side walk on both sides <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 150mm subbase (natural occurring laterite) 150mm crushed rock base 60mm binder 40mm wearing

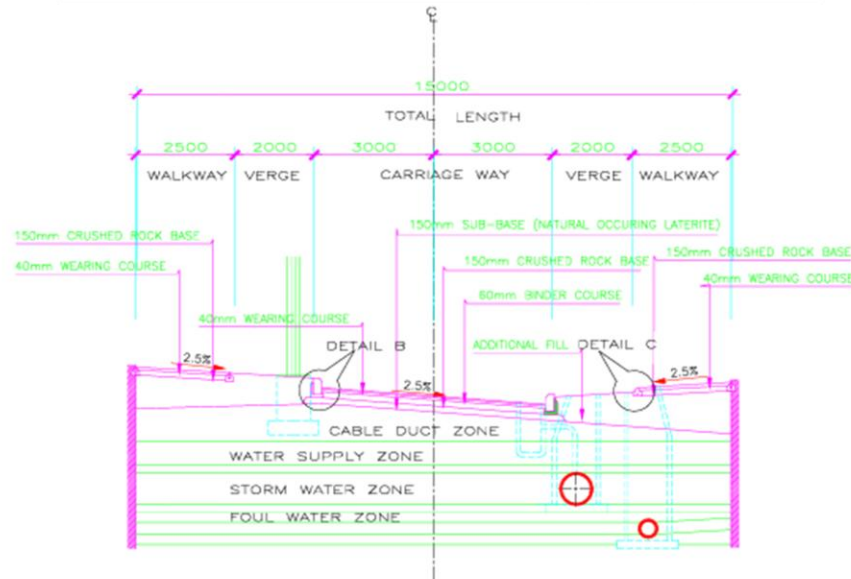
Road	Right of Way (21m)	Pavement Structure
Local Street	<ul style="list-style-type: none"> Single carriageway, made up of 2 lanes of 3.5m driveway, 3m parking lane on both sides, 2m verge on both sides and 2m side walk on both sides <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 150mm subbase (natural occurring laterite)

Planning/Design of Road Infrastructure in the FCC

DISTRICTS ROADS.....Cont'd

Characteristics of District Roads

MINOR ACCESS STREET (MAS) - 15m



Road	Right of Way (15m)	Pavement Structure
Minor Access Road/Street	<ul style="list-style-type: none"> Single carriageway, made up of 2 lanes of 3m driveway, 2m verge on both sides and 2.5m side walk on both sides <p>NB: Inclusive of kerb stone, sewerage, power supply, streetlighting and telecom duct</p>	<ul style="list-style-type: none"> 40mm wearing 60mm binder 150mm crushed rock base 150mm subbase (natural occurring laterite)

DEVELOPMENT/CONSTRUCTION OF ROAD INFRASTRUCTURE IN THE FCC

Development of Roads/Construction in the Federal Capital City commenced in the early 1980s. The construction works depending on the category of roads includes construction of other associated/integrated underground engineering services.

It is important to state that, Development of Engineering Infrastructure is carried out according to the Final Engineering Design, based on the FCDA Standards & Specifications, as discussed in the previous slides. However, there are other very important considerations in practice by the FCDA as outlined below:

Construction Methods: The construction method for roads development is in line with global best practices. However, strict supervision in ensuring that quality control is adhered through laboratory and confirmatory/field tests. The supervision team of the FCDA is made up of highly qualified personnel with cognate experience, who are usually trained on the job over the years. There is also adequate synergy between the relevant technical departments involved in infrastructure development, from concept to project delivery and operation & maintenance.

Development/Construction of Road Infrastructure in the FCC

Integrated Engineering Infrastructure: In line with the Abuja Master Plan Provisions, road constructions in the FCC are carried out along with other associated infrastructural facilities such as network of storm water drainage system (underground pipes, gully inlet and other associated appurtenances), kerbs. These contribute to ensuring a longer lifespan by preventing possible erosion and ponding of water on the road pavement, which is one of the common source of failure of road pavement. Also, indiscriminate cutting across the roads to install facilities, which will contribute to failure is minimized.

Pavement Structure: The development/construction of the flexible pavement in the FCC is generally in line with the global practice in which the structure comprises of **Sub grade, Sub base, Base course, Binder course, Wearing course** as previously shown on the typical cross sections.

It is pertinent to note that in the FCC, **crushed rock** materials are used for sub base and base course which has a significant positive impact on the bearing capacity and life span of the roads.

Development/Construction of Road Infrastructure in the FCC



Furthermore, for high/heavy traffic roads which includes primary roads such as Expressways, Ring Roads, Parkways, FCT Highways, having Main and Service Carriage Ways as well as most of the roads within the Central Area District, are provided with additional layer of **Macadam**.

These are majorly as a result of Standardization which is a derivative of anticipated traffic flow for all the planned roads (Primary and District) based on the Abuja Master Plan Provision.

Maintenance: The primary and District roads in the FCC are constructed with a minimum lifespan of 50 and 30 years respectively. However, periodic maintenance is carried out regularly. It can also be noted that some roads in Wuse and Garki District of Phase I of the FCC, constructed in the early 80s and showed signs of failure, especially having attained the designed life span were recently resurfaced. This practice is of economic benefits to the FCT Administration.

Value Analysis (VA): VA on some completed interchange structures revealed challenges of traffic congestion e.g. Ring Road 1/N11 (Banex Bridge). This necessitated the review of diamond interchange structures within the city to optimize performance and this has been implemented at Ring Road 1/N1 Interchange (Wuye Bridge). Similarly, sustainability of institutional memory is significant in decision-making for the city development.

CONCLUSION

Having discussed the design considerations as well as the construction methods for flexible pavements in the Federal Capital City, the following are worthy of note:

- i. Road construction based on Final Engineering Design ensures timely delivery, minimum cost and quality of works.
- ii. Strict supervision by highly qualified personnel, on-the-job training and synergy between project teams, helps immensely in ensuring adherence to Standards & Specifications and quality assurance in line with global best practice, from concept to completion.
- iii. Construction of roads with provision of integrated engineering infrastructure facilities such as proper drainage system and other associated appurtenances is paramount to prolong life-span of the road.
- iv. Construction of high/heavy traffic roads with the use of crushed rock materials for sub base & base course, as well as the use of Macadam layer has significant positive impact on the bearing capacity and life span of the roads.

- v. Resurfacing of roads that has shown signs of failure, having attained the designed lifespan is of economic benefits.
- vi. Value Analysis (VA) and Institutional Memory are vital tools in addressing challenges and are significant in decision-making for city development.

THANK YOU
FOR YOUR ATTENTION