2 MASTER PLAN

2.1 Spatial Framework

The three Urban Cores (MICE, Center and East) are placed on the southern side of the railway track in current marshaling yard. The Center Core is located next to the new station area in the south. The MICE Core is located in the Ngong river area next to Uhuru highway. The East Core is on the eastern side of the site bordering the Muthurwa area.

A horizontal axis runs through the three core areas essentially connecting each core. The street commercial area is planned to be next to the station area, due to its potential as an economic activities' catalyst. In addition, there is pedestrian traffic flowing from Uhuru park in the west to Machakos termini in the east. The railway front area bordering the old CBD is composed of TUK zone and urban service zone, which is similar to the approach of the previous options. Below figure shows the spatial framework of the final option.

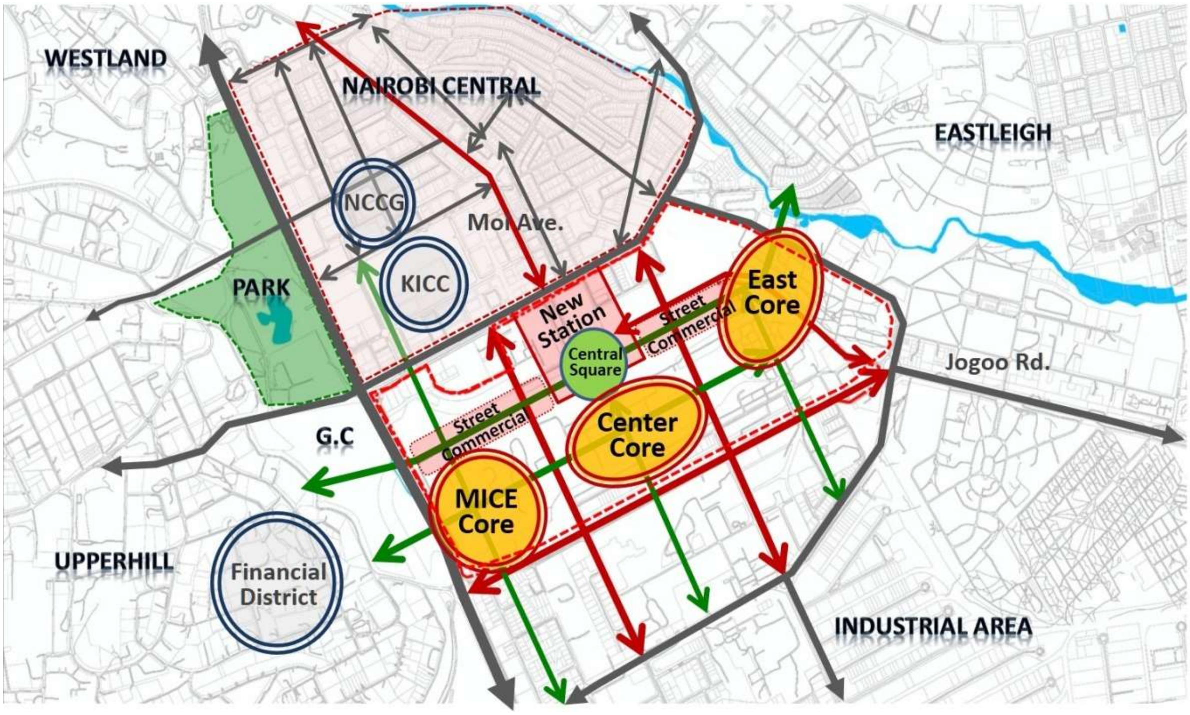


Figure 2-1: Spatial framework of the final option

Source: The Consultant

2.1.1 Economy Layer –Private sector

The core area requires major investment to ensure viable mixed-use developments that include retail, office and housing programs. The main housing area is located on the eastern side, but different housing types are located in the entire area to ensure night time activity. The housing demand in general, is stable in urbanized areas, especially in this kind of metropolitan scale cities. Thus, to ensure the development is profitable for developers, the mixture of housing and other programs such as commercial is recommended even in the one block scale.

The main housing area is valuable because the housing program could be implemented early to ensure the monetary return on the infrastructure investment.

Each core has different characteristics. The MICE Core (MICE facilities are oriented) is proposed to be a commercial area with a predominantly MICE function complimented by office and housing functions. An international office zone is adjacent to the MICE core with the potential to absorb the office demand in the Upper hill area. Grade A office buildings with retail areas could generate synergy and boost the office working environment. It would be prudent to include international companies and or their agencies in workshops. The East Core is characterized by public anchor programs which will provide public services to the surrounding areas.

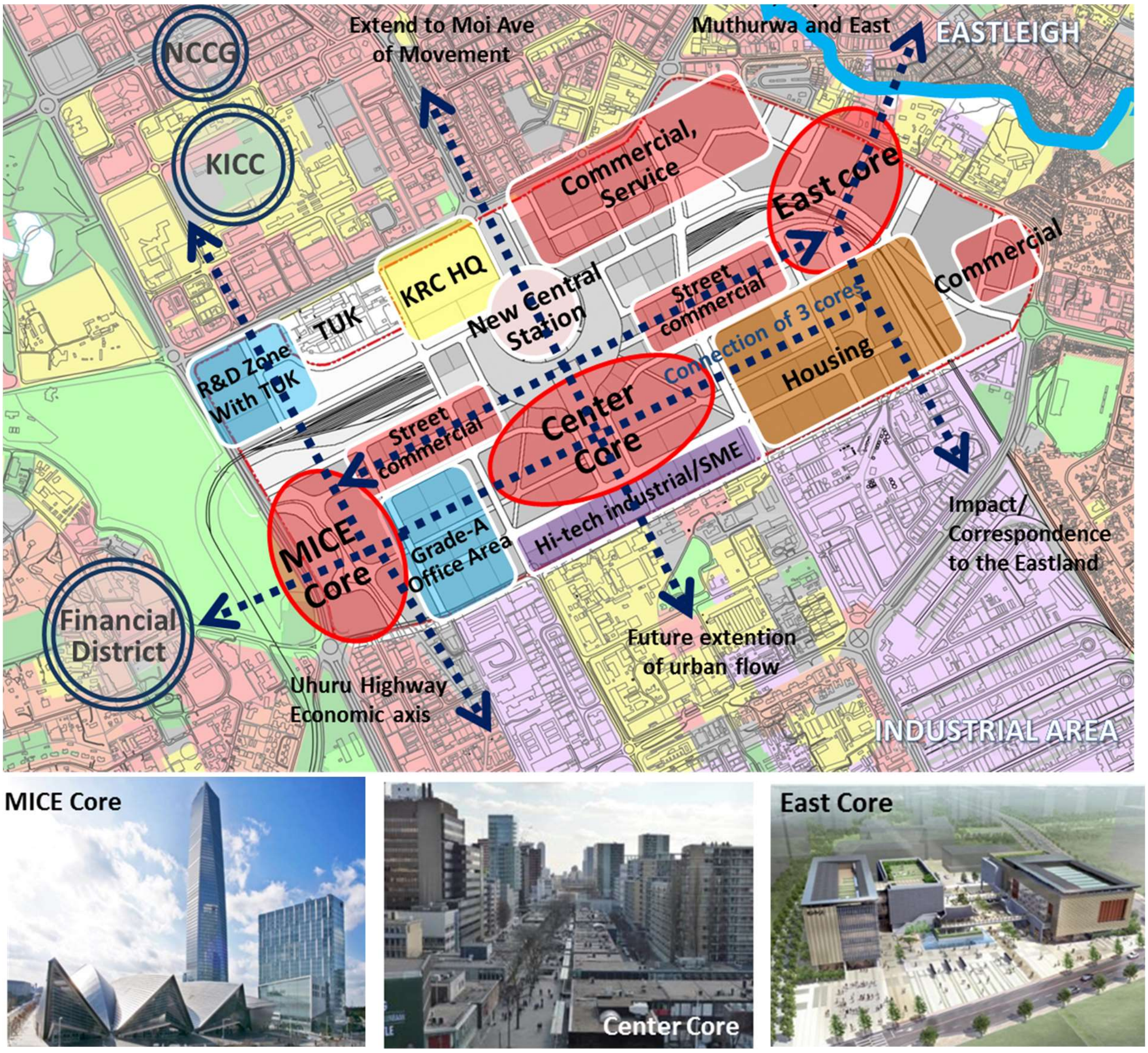


Figure 2-2: Economy layer of the final option

Source: The Consultant

In the south, bordering the existing industrial area, a new SME (Small Medium Enterprise) or light industry could be initiated. The current urban plot has a narrow form, and it would be better if it is merged with neighboring blocks for more sizable and viable development opportunities in future.

The Street commercial is the main retail-oriented place in Railway city. It is located along the main pedestrian walkway between Uhuru park and the Machakos termini. This area has massive potential for small-scale investors. There will be approximately 2 km linear “street shopping mall” providing a unique and vibrant retail place along the main walkway. Two street commercials are proposed in both the east and the west. The street commercial will originate at the central station square and branch towards the respective cores. The West street commercial focuses on the office-mix, whereas the East commercial will complement the housing function.

The eastern side of the railway front area borders Haile Selassie Avenue and the existing CBD. Most of the land in this area is under private ownership and therefore the long-term development approach needs to be analyzed. The Easy Coach and Old Coffee Mill Building are historical buildings that should be preserved.

A R&D or knowledge hub zone is proposed near the TUK area. TUK in conjunction with other neighboring universities, namely University of Nairobi and Kenyatta University could also act as catalysts for a research-based industry in this area.

In the three-core strategy, every core has a specific impact and correspondence with neighboring areas. The Western Core as MICE could achieve strong connection with the existing KICC (Kenya International Convention Center) and government offices as well as the Upper hill area and the Kenya Railway golf course. The Center Core is adjacent to the public square and the new central station. It will impact the existing southern industrial area positively spurring future transformation. The East core is located at the edge of the eastern area of the site. It shall positively impact the neighboring areas namely Eastlands areas. Figure 2-2 shows the impact of the three cores on their surroundings.

2.1.2 Social and urban space layer-public sector

The social programs are located in both the eastern and western sides divided by the central square. On the western side the social programs comprise of cultural programs and MICE oriented facilities. The consultant proposes that the Kenya railway headquarters be transformed into the “Kenya Railway Cultural Center”. It shall accommodate diverse cultural programs such as education, art performance and exhibition areas. An outdoor amphitheater will be located near Uhuru highway near the railway golf course. The social programs located on the eastern side are comprised of essential social infrastructure programs will include administrative government offices, a hospital, a school and/or a community center.

The green and open space network should create a connection between the different areas. The Central square is located at the center of the city with a fan shape, providing strong spatial perception of centrality to the Nairobian. To the west, Ngong River is a significant spine of the green corridor. The eastern and western areas are linked by an open space network which will create physical link between those two areas.

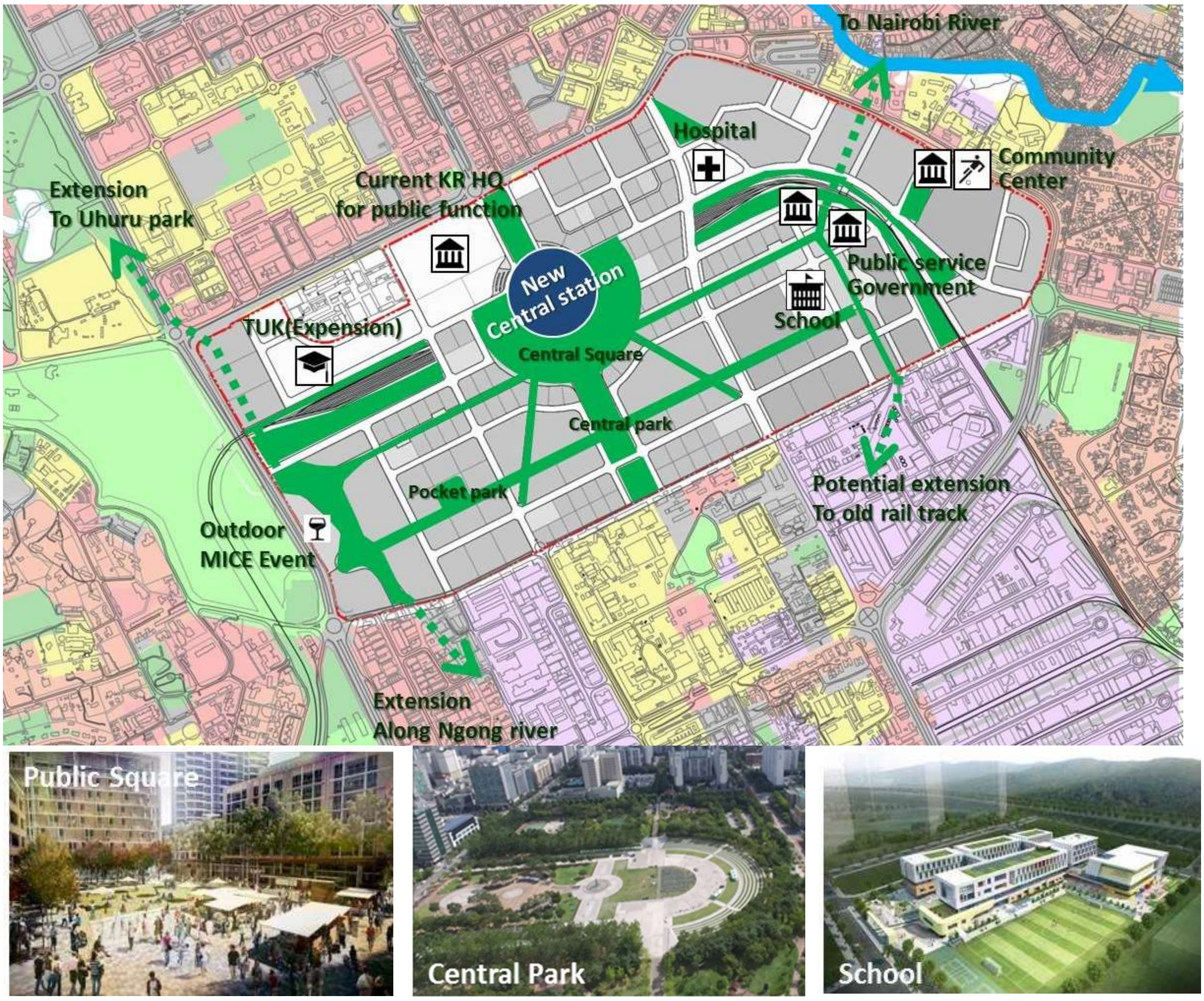


Figure 2- 1 Social layer of the final option

Source: The Consultant

2.1.3 Network Layer

The Railway city road network consists of three main collector roads; in the North-South direction, the extended Workshop road and Enterprise road, and in the East-West direction Bunyala road extending into Commercial road. These three roads are the main missing links connecting to the existing city center (Central Business District area in Nairobi).

The project shall ensure integration of the Bus Rapid Transit (BRT) in the Station area, ensuring easy interchangeability of commuter modes. There are 4 BRT lines accessing the project site. Line 1 and 2 runs from Uhuru Highway to Enterprise road then into Haile Selassie Avenue. Line 3 runs along Haile Selassie Avenue touching northern boundary of the project site. Further, the newly proposed Line 6 running along Enterprise road thereby providing important link to JKIA, provides a connection to the international airport. The route could also be used to access the industrial area which will be a key economic production area for Nairobi.

There are several key proposed pedestrian network links providing access to and through the project site. One of the main pedestrian links runs from Uhuru Park through the Central Square, passing through the project commercial area into the Machakos termini. The route will relieve the pedestrian traffic volume from Haile Selassie Avenue and Upper hill, through the project site to Eastlands. Another important spine of the pedestrian network runs from Bunyala road through to Commercial road, providing a link between Nyayo Stadium and City Stadium. In the North-South direction running from Moi Avenue is a grand open space that will provide a connection between the existing CBD and the Industrial area as shown in below figure. Currently the Industrial Area bears strong potential for further development following development of links to the Nairobi South Station and the JKIA.

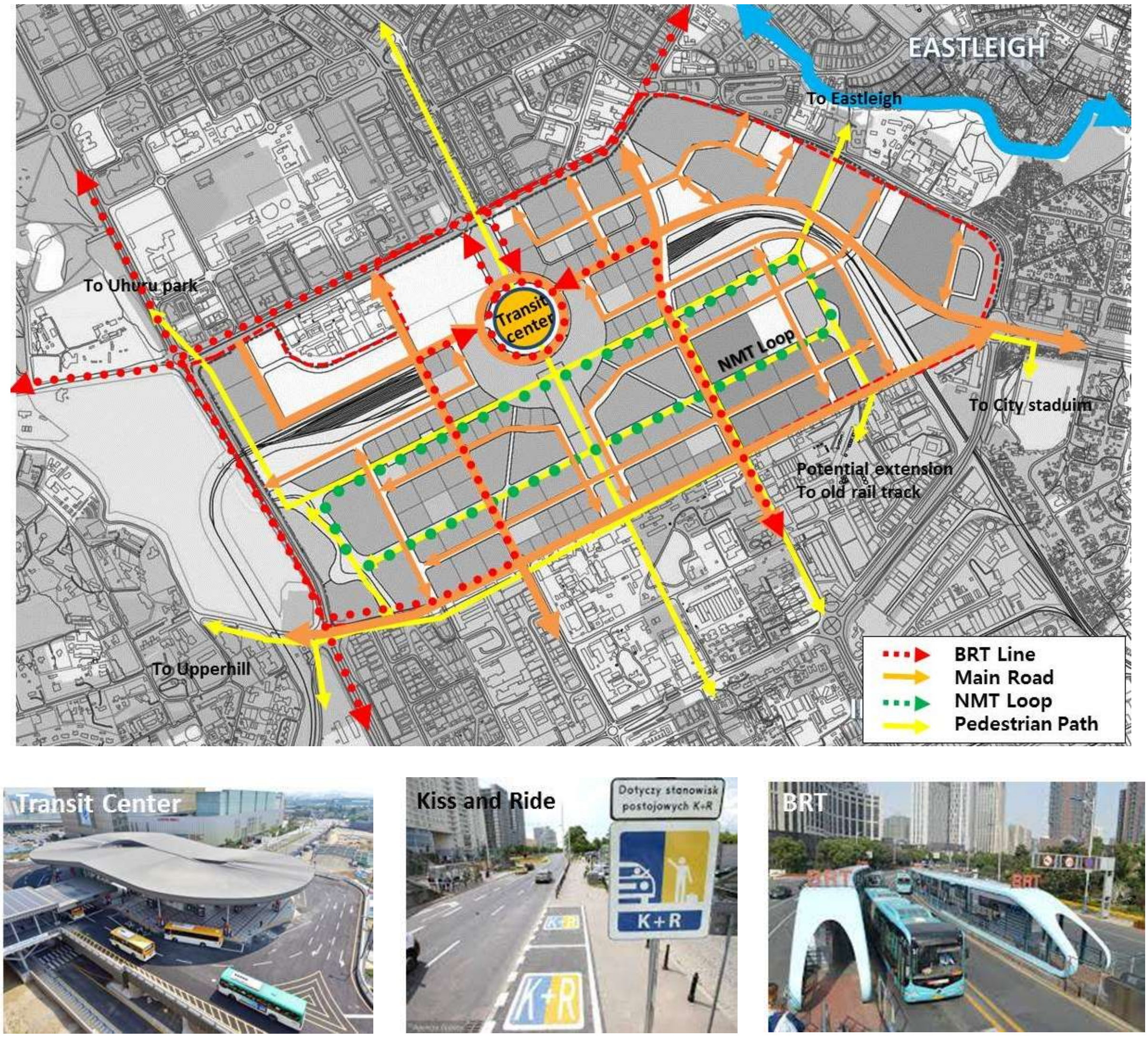


Figure 2- 2 Network layer of the final option

Source: The Consultant

An “NMT loop” is proposed in the final option to provide easy flow of pedestrian and bicycle traffic in especially in the flat areas of the project site. It eases traffic movement and access to the main urban area, resulting in decreasing of motorized traffic volumes.

2.2 Land use plan

2.2.1 Land use plan

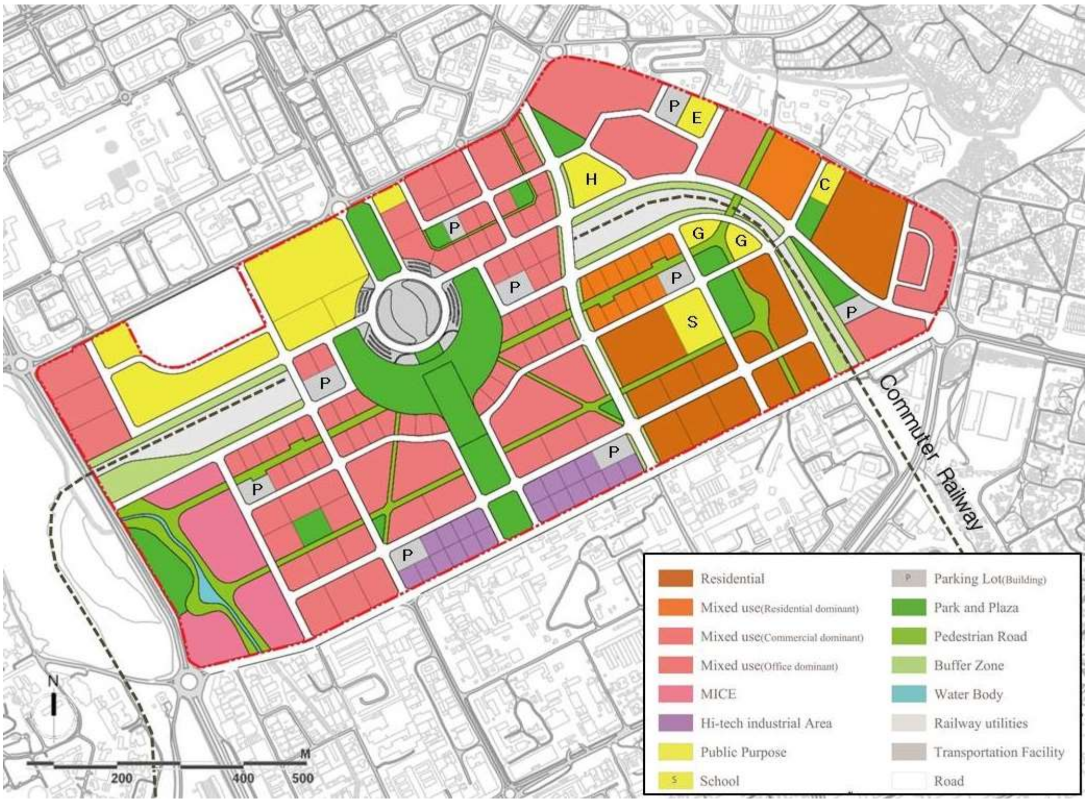


Figure 2- 3 Land use plan

Source: The Consultant

Table 2-1: Land use plan table

Classification	Option Final	
	Area (m²)	Proportion (%)
Residential	151,300	8.8
Mixed use(Residential dominant)	47,200	2.7
Mixed use(Commercial dominant)	291,500	17.0
Mixed use(Office dominant)	199,700	11.6
MICE	73,900	4.3
High-tech Industrial	42,200	2.5
Public Facilities	98,100	5.7
School	13,900	0.8
TU-Kenya Expansion area	43,700	2.6
Transport	36,500	2.1
Railway Utilities	70,700	4.1
Open Space	337,000	19.6
- Park and Plaza	165,800	9.7
- Pedestrian Road	88,100	5.1
- Railway Buffer Zone	77,100	4.5
- Water body (Ngong River)	6,000	0.3
Parking lot (Parking Building area)	38,600	2.2
Road	275,500	16.0
Total	**1,719,800**	**100.0**

Source: The Consultant

The Central station area is located at the center of the Project site. It is surrounded by a fan-shaped open square, which is the melting pot of diverse activities and also the heart of the new monumental new city.

- For the vitality and sustainability of the urban environment, a functional mix is proposed in the land use plan with every "Core" area- MICE, Center and East taking a strategic location and characterized by high density development which will be a catalyst for spinning off adjacent development.

- The ratio of private land uses accounts for 49.1%[2] while public land uses is for 50.9% so that the two land are balanced at the initial stage.

- The highest percentage of land is allocated to open space such as parks and plazas, Pedestrian road, buffer zone, which accounts for 19.6%. This space is important in creating a more livable and vibrant city because the existing CBD condition shows insufficient allocation of open and green space and disconnected green areas. The roads occupy 16%, creating an efficient block-type development.

- The private sector, Commercial and Office dominant mixed uses are 28.6% of the total land. The residential and residential dominant mixed uses are 11.5%, Public purpose (5.7%), and

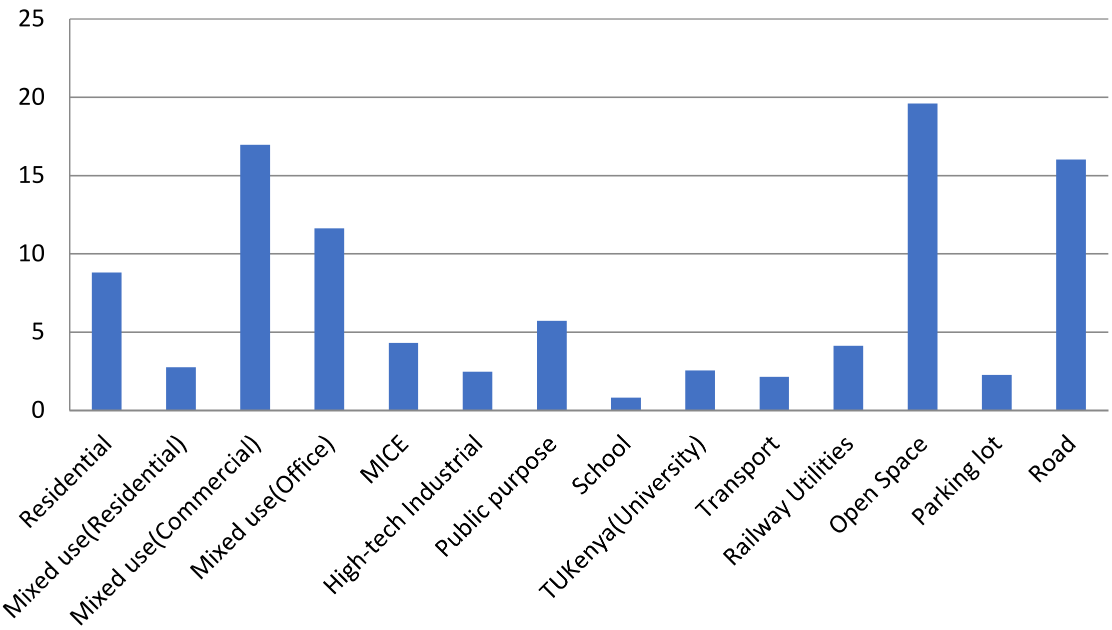


Figure 2-3: Program ratio in Railway city

[2] Salable area is 49.1% of the project program. Those are Residential, All type of Mixed use, MICE, High-tech industrial, and Parking lot.

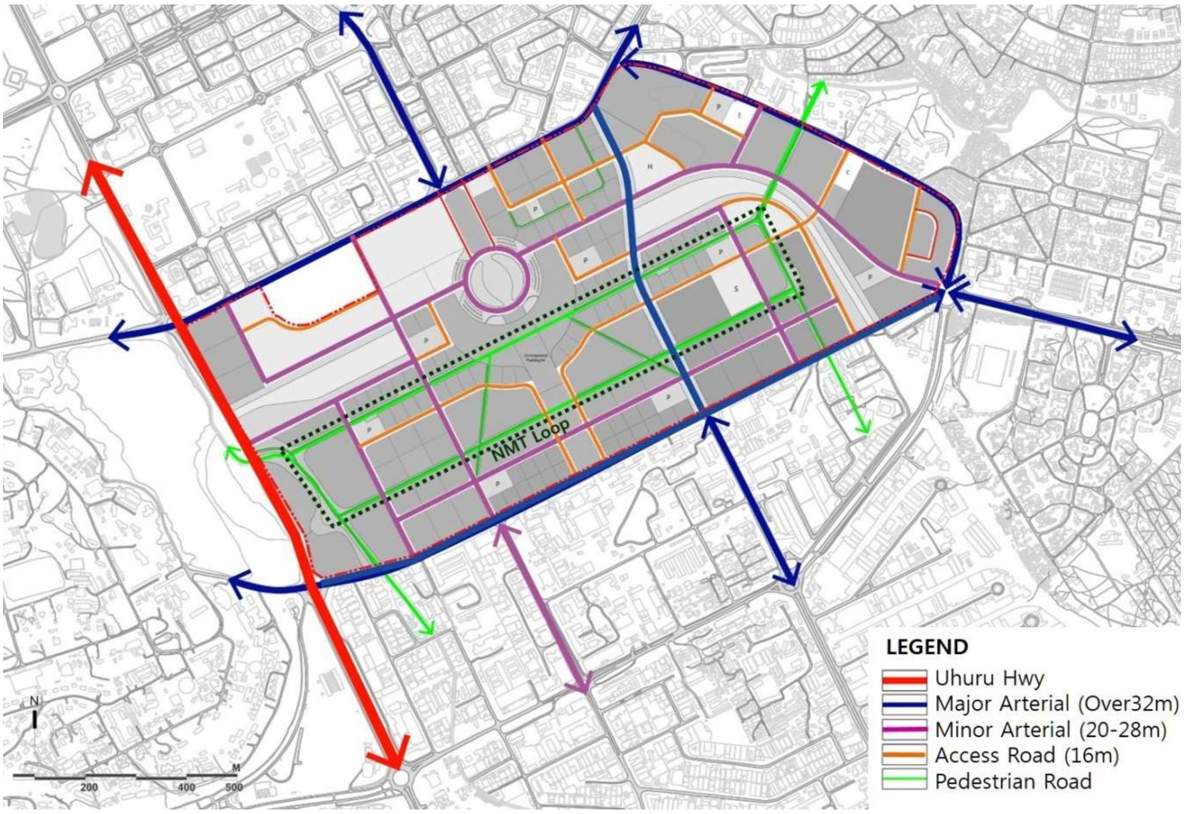
2.2.2 Transportation plan

A comprehensive internal network will be provided within the Railway City in order to relieve current traffic congestion along Uhuru Highway and Haile Selassie Avenue. As concluded in the analysis of traffic volumes for the ‘Green Mall’ study, the provision of one north-south link from Enterprise Road to Haile Selassie Avenue provides profound relief not only for Uhuru Highway and Haile Selassie Avenue, but also for Jogoo Road, Lusaka Road and other neighboring roads. This was found to be the case for both current and future traffic. This shall be described further in the transportation analysis section in this report.

The consultant also aims to create a better accessible and walkable Railway City. District distributor roads provide easy circulation circle around the area so that traffic volume is minimized within the central urban areas of the project site.

Local distributor roads and pedestrian roads connect the urban functions and the urban plot resulting in decreased traffic volume. The NMT loop is located at the heart of Railway city promoting sustainable transportation modes such as walking, biking and public transportation.

For better utilization of urban functions, commercial districts are accessible through these pedestrian and bicycle roads. This network could be expanded to nearby Eastlands, Upper Hill and industrial areas in the south.



Major arterial with BRT

Access Road

NMT Loop

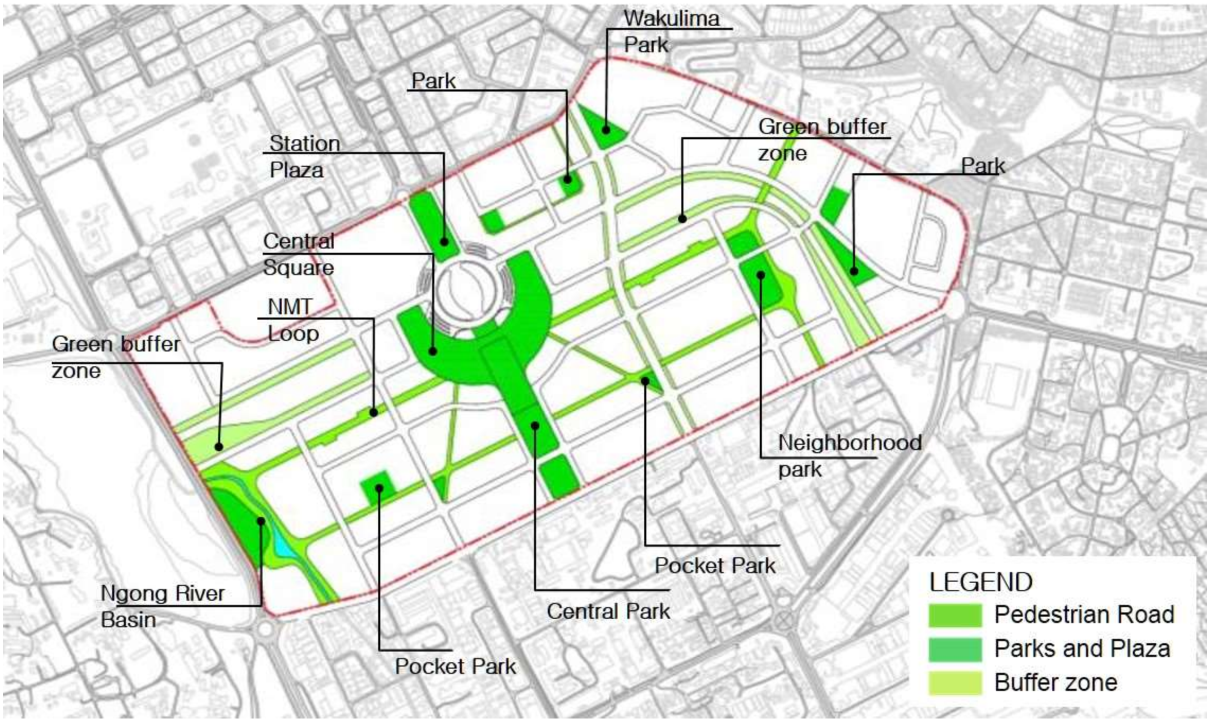
Figure 2-4: Proposed road hierarchy

Source: The Consultant

2.2.3 Open space plan

The open space plan is important in the master plan as it seeks to connect the existing disconnected open space network.

Diverse forms of open spaces are proposed in the land use plan. The figure below shows a plaza, river basin, small park, square and buffer area. The central plaza has a special meaning as it functions as the gateway to the Railway City, a monument and a landmark for the project.




Ngong River Basin


Central Squre


Pedestrain Road

Figure 2-5: Open space plan

Source: The Consultant

Table 2-2: Open space category

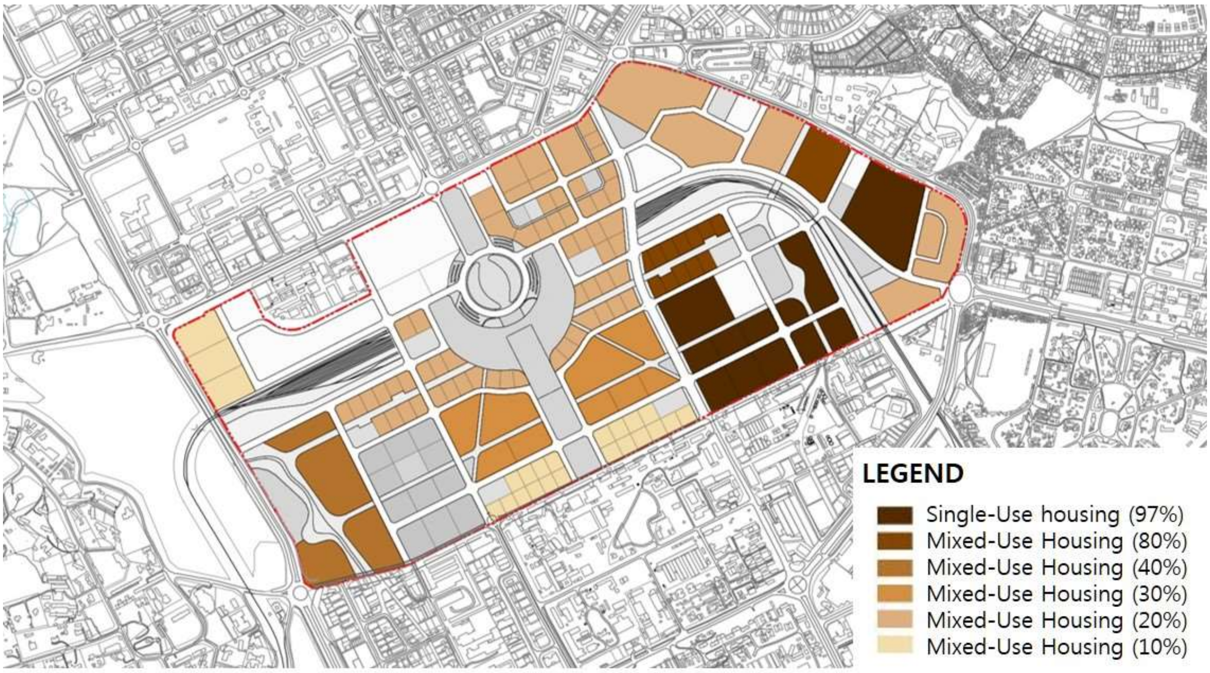
Category	Area (m²)	Ratio (%)	Characteristics
Park and Plaza	165,800	9.7	Station Plaza, Central square and park, Wakulima park, neighbourhood park, pocket park
Pedestrian Road	88,100	5.1	NMT loop, Pedestrian road
Buffer Zone	77,100	4.5	Surrounding railway area and enterprise road
River basin	6,000	0.4	Ngong river
Total	**337,000**	**19.6**	

Source: The Consultant

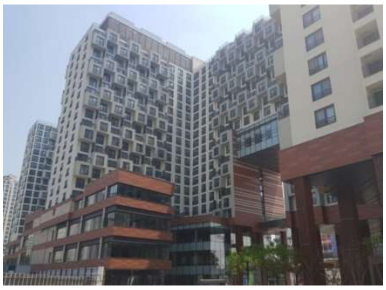
2.2.4 Population and Housing plan

The total population of the Railway City is estimated at 27,534 persons. The housing scheme for these population is categorized into 2 groups~~;~~ Single-Use housing and Mixed-Use housing.

Single-Use Housing scheme means that 97% of floor area is dedicated to housing. Mixed-use housing is divided into 5 sub-groups depending on each mixed housing ratio. From 10 to 80%, diverse type of housing mix could be realized in the Railway city. Other references are addressed in **Chapter 1.4 Real estate segmentation in Housing part, and Chapter 3.4.2 Nine precincts in the Railway city.**



Mixed use housing 30%



Mixed use housing 80%

Single use housing

Figure 2-6: Population and housing plan

Source: The Consultant

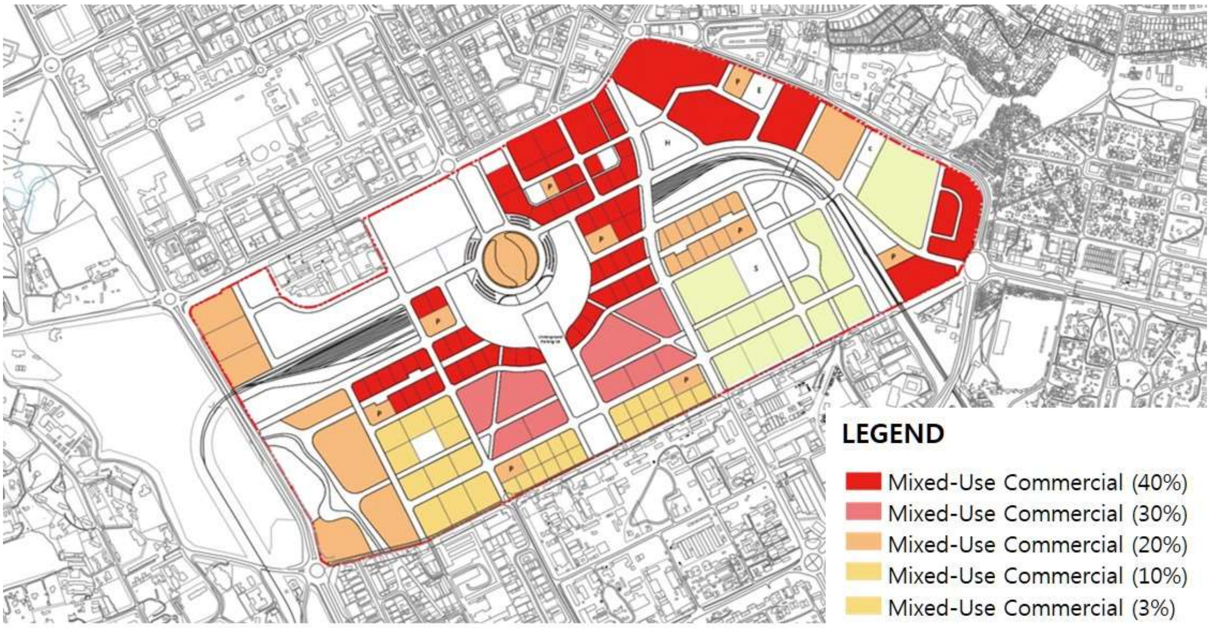
Table 2-3 : Population and housing type

Housing Type	Area(㎡)	Housing Ratio(%)	Housing Area(㎡)	No. of Units	㎡ per Unit	No. of Residents per unit	No. of Residents
Single-Use Housing	151,300	97%	366,903	3,335	110.0	3.2	10,674
Mixed-Use Housing	47,200	80%	104,520	950	110.0	3.2	3,041
	73,900	40%	177,360	2,087	85.0	2.0	4,173
	97,800	30%	146,700	1,334	110.0	3.2	4,268
	291,500	20%	197,430	2,323	85	2	4,645
	78,000	10%	31,200	367	85	2	734
Total	**739,700**	**-**	**1,024,113**	**10,396**	**-**	**-**	**27,534**

2.2.5 Commercial area plan

The total users of the commercial area is estimated at 16,052 persons. This is calculated as one person per 50 square meters in accordance with the Planning Handbook in Kenya.

Similar to the housing mixed use scheme, commercial mixed-use development is also diversely suggested in the Railway city, which ranges from 3% of minimum ratio in Housing area to 40% of maximum ratio in Street commercial and the eastern station front commercial area. The Consultant ensures that diverse forms of commercial mixed uses could be realized in next stage. Details are outlined in **Chapter 3.4.2 Nine precincts in the Railway city.**




MICE commercial
(Mixed use commercial 10%)


Street Commercial
(Mixed use commercial 20%)


New Wakulima Market
(Mixed use commercial over 40%)

Figure 2-7: Commercial area plan

Source: The Consultant

Table 2-4: Commercial area category

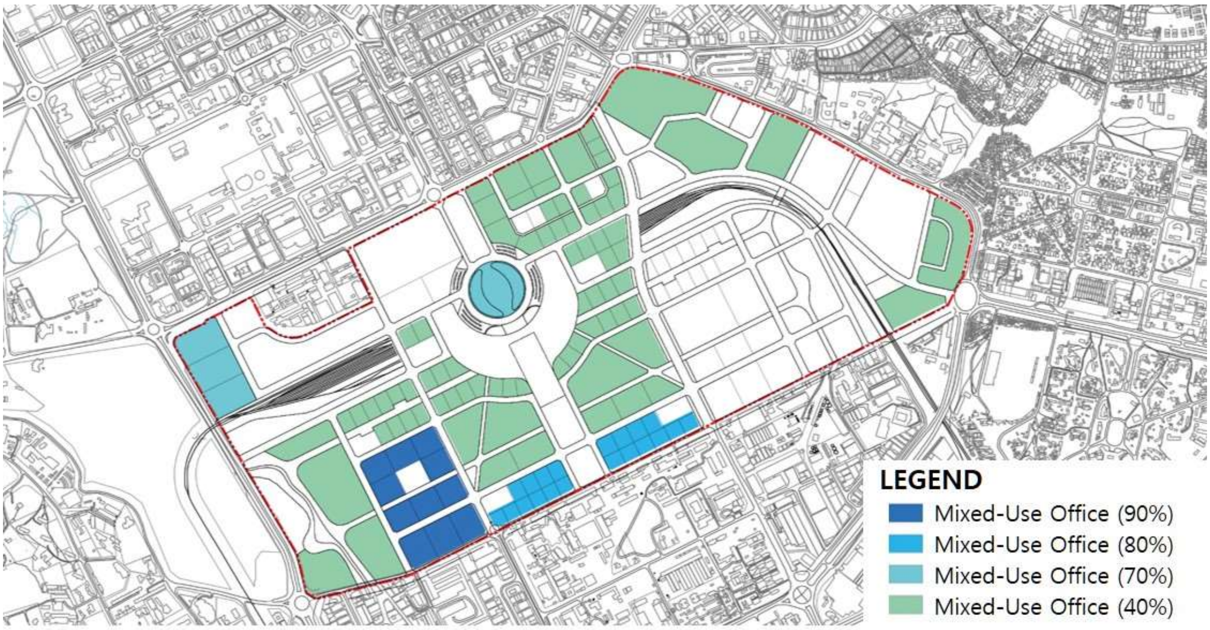
Category	Area(㎡)	Total Floor area(㎡)	Floor area for Commercial area(㎡)	User
Mixed use Commercial (40%)	291,500	987,150	394,860	7,897
Mixed use Commercial (30%)	118,900	573,400	172,020	3,440
Mixed use Commercial (20%)	195,500	839,050	167,810	3,356
Mixed use Commercial (10%)	108,300	565,400	56,540	1,131
Mixed use Commercial (3%)	151,300	378,250	11,348	227
Total	**865,500**	**3,343,250**	**802,578**	**16,052**

Source: The Consultant

2.2.6 Office area plan

Total users of the office area are estimated to be 94,608 persons. This is calculated as one person per 15 square meters in accordance with the Planning Handbook in Kenya. Various types of office mixed use are suggested ranging from 40 to 90% of office area, In Railway city, office space will capture the demand of conventional type office and services in current CBD. Diverse types of high value production space including High-tech industry and R&D facilities could sprout in this area. Thus, the Railway city office area will produce the future economic value of Nairobi by multiple forms of economic, service, and technological transactions.

Among the many office spaces, International office zone aims to be a global top tier class company zone in Nairobi, which will convey the new CBD landscape in future Nairobi with MICE core area. Details are in **Chapter 3.4.2 Nine precincts in the Railway city**.



MICE office building
(Office floor ratio 40%)

Grade-A office
(Office floor ratio 90%)

R&D Office
(office flor ratio 70%)

Figure 2-8: Office area plan and examples' images

Source: The Consultant

Table 2-5: Office area type

Category	Area(㎡)	Total Floor area(㎡)	Floor area for Office space(㎡)	User
Mixed use Office (90%)	66,100	396,600	356,940	23,796
Mixed use Office (80%)	42,200	168,800	135,040	9,003
Mixed use Office (70%)	56,900	227,600	159,320	10,621
Mixed use Office (40%)	463,200	1,919,550	767,820	51,188
Total	**628,400**	**2,712,550**	**1,419,120**	**94,608**

Source: The Consultant

2.2.6 Public facility plan

The public purpose facilities are mainly located in the eastern and side of the Railway city. The old Easy coach terminal and KR Headquarters are to be preserved as historic areas with cultural facilities. The administrative facilities and community centers are located in the east in order to absorb the needs and demand of the new residential developments and the Eastlands population. TUK has a plan to expand to the Railway City, the consultant has reflected the demands of the university on the land use plan. The University by itself is a very strong urban anchor for not only maintaining urban diversity but also dropping massive footfalls[3] to generate economic transactions in the project area. Details are described in **Chapter 3.3 Guide for the Public Realm**.

School | Community Center | Hospital

Figure 2-9: Public facilities plan

Source: The Consultant

Table 2-6: Public facilities list

Category	Area(m²)	Ratio(%)	Total floor area(m²)	Users
Community Centre	4,900	3%	24,750	1,650
Primary School	13,900	9%	34,750	2,317
Administration	9,800	6%	35,447	2,363
KR Head office	61,500	39%	153750	10,250
TUK Expansion Area(proposal)	43,700	28%	109,250	7,283
ETC (sub-station, Hospital)	21,900	14%	54750	3,650
Total	**155,700**	**100%**	**412,697**	**27,513**

[3] TUK anticipates the future student number who passes the Railway city reaches 25,000. Interviewed by the Consultant. 2018.10.

2.2.7 Building Height plan

The broad view of the Railway city skyline is that west is high, and the east is low. The tallest building has 45 floors and is located in the MICE core area and with 25floor buildings at the international office zone. The Centre core maximum height is 20 floors, whereas housing area has a maximum of 12floor. The Street commercial is the lowest zones with 8 floors.

Considering the future CBD as Railway city, the Consultant analysed all the skyscrapers in the entire Nairobi and made a skyscraper map. The map indicated that beside some buildings in Westlands and Upperhill areas, most of high-rise buildings are located in the existing CBD, which is west-north side of Railway city. Based on the research, we designated the west area next to Uhuru highway (especially within the MICE core) to be the future high-rise zone in Railway city. (refer to **Chapter 3.4.2 Nine precinct in the railway city**)

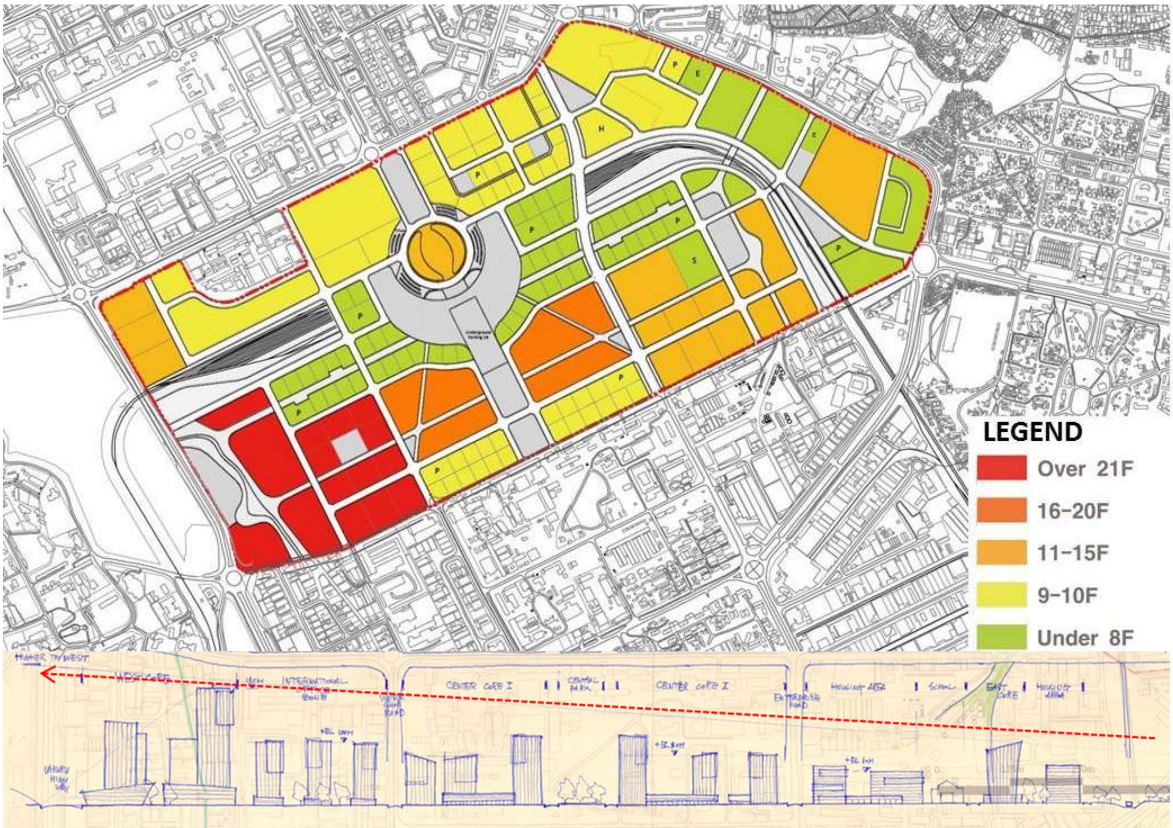


Figure 2-10: Building height plan and skyline

Source: The Consultant

The other important determinant factor of the skyline is Moi airbase. The project site is about 1.5km away from the Moi Airbase, and hence it has a direct impact on the building height due to the flight safety zone. The Consultant tried to obtain a right aviation flight regulation in inception stage, with no success.

The consultant therefore proposes the Railway city's building height guidelines with reference to international regulations and Eastlands masterplan. The land use and the floor height plans were submitted to KCAA (Kenya Civil Aviation Authority) for review, and the proposal was accepted.

Figure 2-11: Flight safety zone example (left, simulation of flight path from Moi airbase by the Consultant), Aviation figure from Eastland project

Source: The Consultant, NCCG

2.2.8 Zoning plan

Conventional zoning plan normally indicates a mono functional approach for urban design. However, in the Railway city, the Consultant proposes the use of "precinct" instead of "zone", so as to facilitate the multiple function mix and strengthen ~~the~~ site-specific characters. The Railway city will be composed of 11 precincts**.**

2.2.8.1 Meaning of the precinct (Zone) in the Railway city

a) Precinct identity

Each precinct should possess a "precinct identity" showcased by a specific urban program package, landscape and urban atmosphere. As the project site is surrounded by diverse neighbors e.g., north side next to the existing CBD, east to Eastlands, west to Upperhill area and south to industrial area. All directions are adjacent to a different urban landscape, development history, urban fabric and social fabric as well. Thus, to adapt to these heterogeneous surroundings, railway city shall be composed of diverse precincts with each having its own spatial and physical identity.

b) Mixed use approach

Every precinct shall have dominant urban functional character. However, a certain mix use program ratio is suggested for securing urban diversity. The Consultant expects commercial program to be "daytime keeper" of urban activity, housing program as "night time keeper" of urban environment. This mixed-use approach will also ensure the viability of the project implementation. "Portfolio investment"[4] could be realized in precinct as well as on a single plot development.

c) Precinct Developer

A precinct could be developed by one "sub-master developer" as "precinct developer". In the umbrella of master developer, every precinct developer could make actual control or guide the development of each individual plot. Thus, a hierarchical order, master developer-precinct developer- individual developer could be implemented.

[4] Portfolio investments are investments in the form of a group (portfolio) of assets, including transactions in equity securities, such as common stock, and debt securities, such as banknotes, bonds, and debentures. Sourced by *World Development Indicators.* World Bank.2014. In the field of real estate investment, a group of programs could make more balanced and more tolerable than single program implemented adapting to the market fluctuation.

2.2.8.2 Precinct division

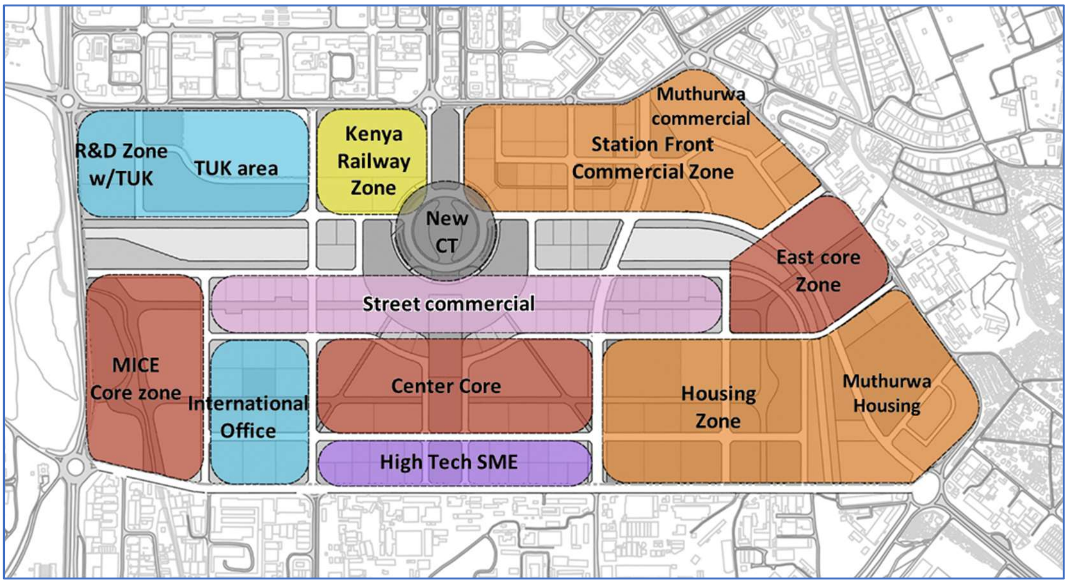


Figure 2-12: Precinct map in Railway city

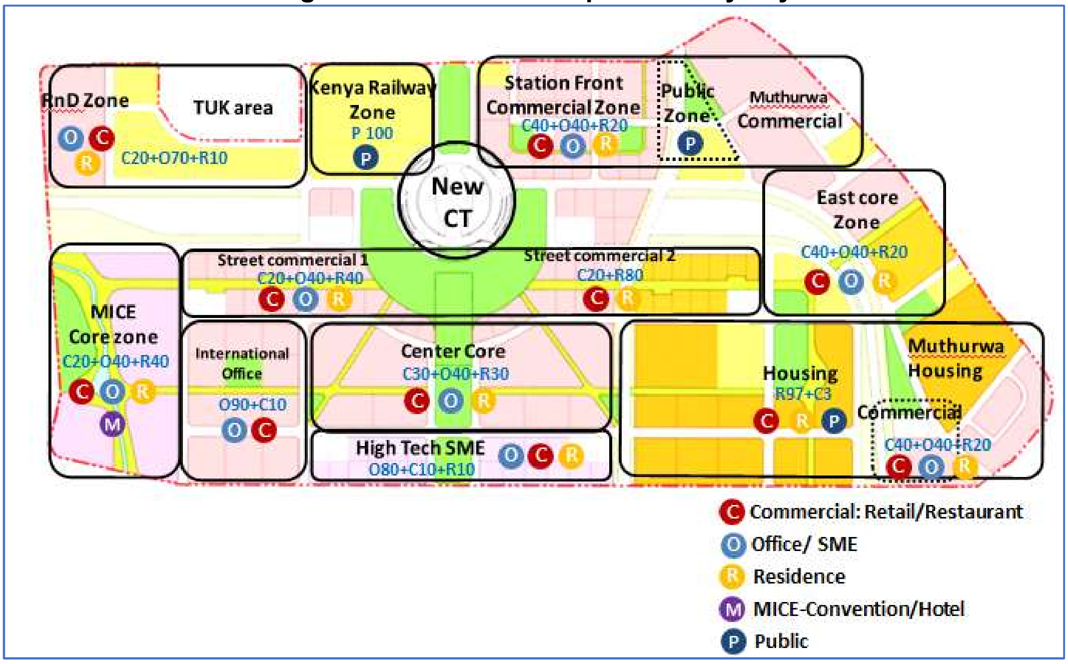


Figure 2-13: Mixed used approach of zoning plan

Source: The Consultant

The consultant proposes the following 11 precincts;

- Street commercial
- Mice core zone
- Center core zone
- East core zone
- International office zone
- Housing zone
- High tech SME zone
- Railway front commercial zone
- Kenya Railway zone
- R&D zone with TUK zone
- New Central Station zone

Each precinct can be developed as site-specific approach with unique spatial character and identity.

2.2.8.3 Enhancing Mixed Use approach.

Geographically, the railway city will be an extension of the CBD, therefore the mixture of urban programs is crucial in sustaining the new city. In line with the idea of commercial and housing function as “time keeper” of urban atmosphere, commercial and housing programs are critical. The table below indicates the tentative program allocation.

Table 2-7: Precinct land use ratio

	Precinct	Program mix (unit: %)				
		Housing	Commercial	Office	MICE	Public [2]
1	Street commercial 1,2	32	38	30	-	-
2	Mice Core Zone	(40)	(20)	(40)	100 [3]	-
3	Center Core zone	30	30	40	-	-
4	East Core Zone	42	24	14	-	20
5	Housing Zone	76	10	-	-	14
6	International office zone	-	10	90	-	-
7	High tech SME zone	10	13	60	-	17
8	Railway Front commercial Zone	18	37	33	-	12
9	Kenya Railway zone	-	-	-	-	100
10	R&D Zone with TUK	6	11	34	-	43 [4]
11	New Central Station zone	30	70	-	-	-

Source: the Consultant

Note.
1. Every zone has segmented further more by the specific site conditions and urban functions, so the number is not precisely determined by 10 digits. (refer **the chapter 3. Urban plan table**)
2. Public means public building indoor area such administrative building, hospital, office and university
3. MICE is mixed program itself as being composed of Housing, Commercial and Office.
4. R&D zone with TUK public purpose is TUK extension floor area number.

As indicated above all precincts shall have a commercial program even if it’s in small percentages. This will guarantee the daytime activity in every precinct. All precincts shall have a housing program, with exception of the Railway front commercial zone, the New central station zone, and International office zone.

2.3 Transportation plan

2.3.1 Introduction

As a Transit Oriented Development (TOD), the transport system acts as the backbone to the Nairobi Railway City and it is paramount that adequate access and connectivity is provided in the planning area. It is important that the transport network provides connectivity, not only within the Nairobi Railway City, but also to the existing CBD to the north and other areas surrounding it including the Industrial Area to the south, commercial and residential areas to the east, and the Upper Hill to the east. It is also necessary for various modes – both motorized and non-motorized – to interact in a safe, convenient and efficient way.

The main transport planning considerations and recommendations will be in relation to the:

- Road Network
- Public Transport
- NMT Network

Analysis to show adequacy of capacity of the networks will also be summarized in this section, especially for the road network. Proposals for further and future considerations shall also be made.

2.3.2 Road Network

As previously reported in the 1st Interim Report, the planning area creates a barrier for north-south and east-west movement through the Nairobi Central Business District (CBD). Currently, North-South movement is mainly through A104 Uhuru Highway, which is part of the Northern Corridor, a major arterial that serves landlocked East and Central Africa. This highway is heavily trafficked and this creates severe congestion in the CBD, especially in the morning and evening peak hours. The other major north-south link is Landhies Road which is also severely congested.

The main east-west links around the planning area are Haile Selassie Avenue and Bunyala Road. Haile Selassie Avenue is a major ingress and egress for public service vehicles, especially matatus, that operate services on Ngong, Langata and Mombasa roads and constitute over 40% of the traffic on the road.

There are 9 main traffic outlets from the CBD in the vicinity of the Railway City planning area as shown in the figure below. These are:

- Ngong Road
- Chiromo Road/ Waiyaki Way
- Thika Rd/ Limuru Road/ Waiyaki Way
- Thika Road
- Jogoo Road
- To Langata Road/ Mombasa Road/ Enterprise Road
- Mombasa Road
- Langata Road
- Enterprise Road & Industrial Area

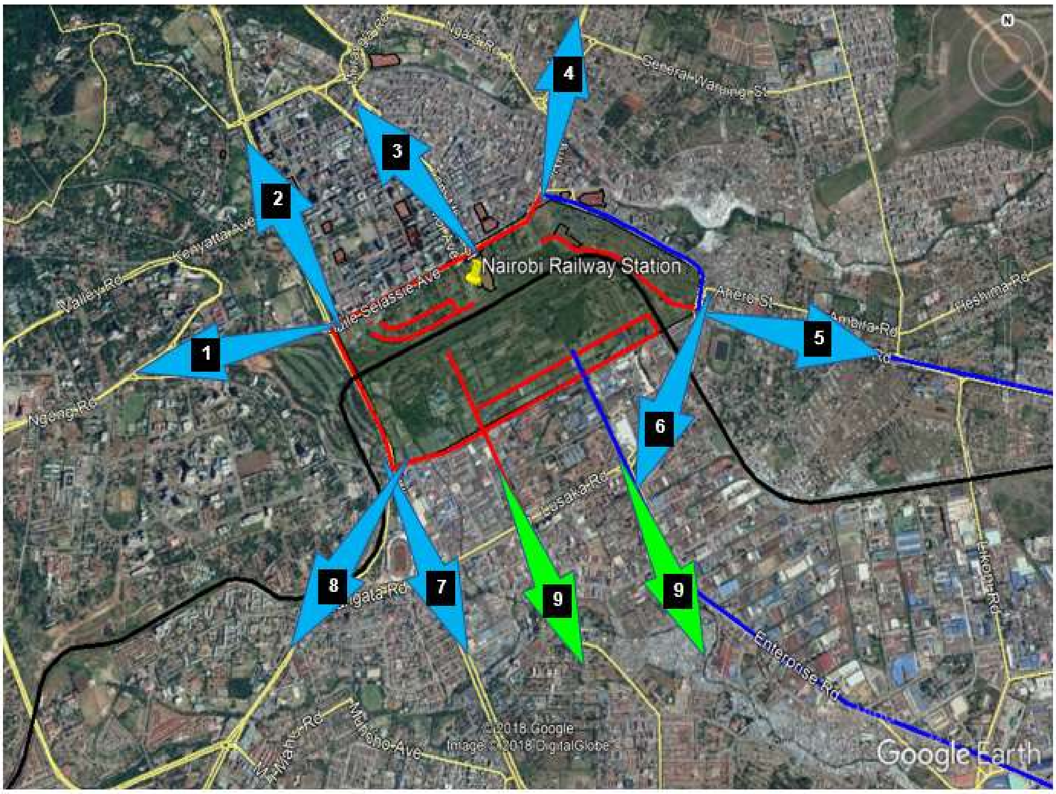


Figure 2-14: Traffic Outlets in the Immediate Vicinity of the Railway City

There are several missing links within the planning area as shown in the figure below.

Figure 2-15: Missing Road Network Links

As detailed previously, we proposed links as follows:

North-South Links

- Extension of Enterprise Road northward to link up with Haile Selassie Avenue
- Extension of Workshop Road to provide planning area access to Bunyala Road and Haile Selassie Avenue

East-West Links

- Missing link from Commercial Street to Jogoo Road (at City Stadium)
- Extension of Station Road to Haile Selassie Avenue and Landhies Road
- Collection of an East-West collector through and for the planning area

A detailed traffic model developed by the 'Green Mall Project'[5] for the Railway City area showed great relief on A104 Uhuru Highway and Lusaka Road resulting from provision of north-south links, which in this case mainly included the link through Enterprise Road to the CBD. The Green Mall project also proposed the missing link from Bunyala Road via Commercial Street to Jogoo Road at City Stadium. Although we have not been able to obtain the model from the Green Mall project consultant, we have used results from this model and NIUPLAN data to carry out further analysis to evaluate the effects of the additional links proposed above by the Nairobi Railway City which shall be further evaluated in Section 2.3.5 of this report.The figure below shows the proposed road network and hierarchy provided within the Nairobi Railway City.

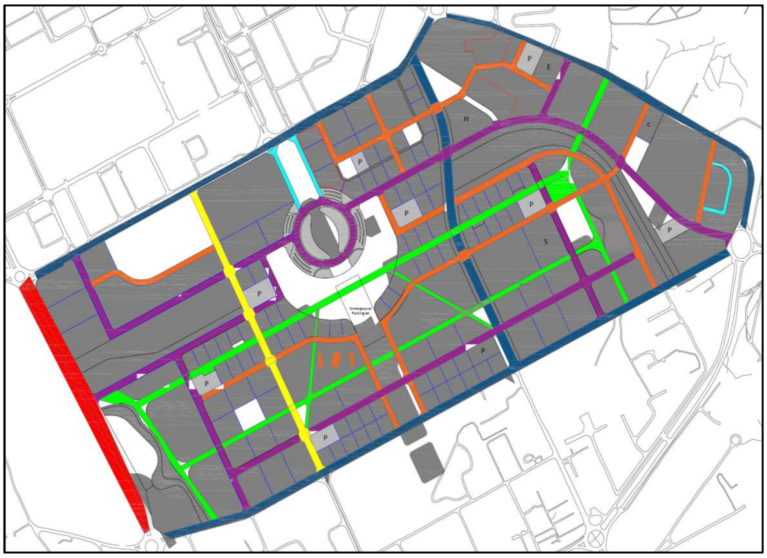


Figure 2-16: Nairobi Railway City Proposed Road Network and Hierarch

Uhuru Hwy

Major Arterial (32m)

Major Arterial (28m)

Minor Arterial (20m)

Minor Collector (16m)

Minor Collector (10-12m)

Pedestrian Rd (20m, 15m, 6m)

[5] Consultancy Services for Undertaking Preparation of Feasibility Studies, Detailed Designs, Tender Documentation and Supervision of Selection Roads and a Green Mall Street Bus Station in the Nairobi Railway Station and its Surroundings

2.3.3 Public Transport Network Proposals

Road-based public transport accounts for 40.6% of all trips in Nairobi. As Nairobi Railway City is being developed as a Transit-Oriented Development (TOD), provision of well-planned, adequate public transport facilities and network is critical.

The main issues identified in the first stage of this study regarding the current public transport modes and network in Nairobi include:

- Most public transport routes converge in the CBD where the major termini are located.
- Route continuity is poor and necessitates multiple commuter connections as there is no north-south or east-west through route.
- First and last mile trip connectivity is lacking resulting in uncontrolled growth and provision for motorcycle 'boda boda' trips.
- Termini are located in designated areas as well as on-street termini resulting in severe congestion and blocking of roads. Facilities are also not adequate to cater for the growing numbers of matatus and buses.
-

The main public transport proposals include:

2.3.3.1 Nairobi Mass Rapid Transit System (MRTS) Network

a) Bus Rapid Transit (BRT)

Bus Rapid Transit (BRT) is a high-quality bus-based transit system that delivers fast, comfortable and cost-effective services at metro-level capacities through the provision of dedicated lanes, with busways and iconic stations typically aligned to the center of the road, off-board fare collection, and fast and frequent operations.[6]

Five (5) Bus Rapid Transit (BRT) routes have been proposed under the Nairobi MRTS Harmonization Study for the Nairobi Metropolitan Region (NMR) as shown in the figure below. BRT#5 on Outer Ring Road is not shown as it is outside the scope of this map and does not directly interact with the planning area.

Three (3) of these proposed BRT routes pass along the boundaries of the Nairobi Railway City planning area as follows:

- BRT lines 1 & 2 along A104 Uhuru Highway on the western boundary of the planning area;
- BRT line 3 along Haile Selassie Avenue on the northern boundary of the planning area linking to the existing CBD.

In order to enhance the position of the Nairobi Railway City as a Transit Oriented Development, we proposed the introduction of three additional lines to go through the proposed inter-modal hub at the Nairobi Central Railway Station. These were:

- Spur line 1B and 2B to access the inter-modal transport hub and provide access to the railway city.
- BRT line 6 to provide access from Industrial Area to the inter-modal hub
- Capacity on Bunyala Road be enhanced to accommodate BRT lines
- We also proposed that Haile Selassie Avenue be designed as low-volume vehicle link with provision of crossings for pedestrians and other NMT modes at several locations to provide links to the inter-modal hub from BRT line 3 and from the existing CBD. 45% of the traffic on the road is currently matatus; once these are replaced by BRT, this will be possible.

[6] Source: Institute of Transportation Development and Policy (ITDP), BRT Standard

Figure 2-17: Nairobi Railway City Proposed BRT Spur Lines

b) Commuter Rail

The project 'Consultancy Services for Development of Commuter Rail Master Plan for the Nairobi Metropolitan Region' is covering the redevelopment of commuter rail aspects in the region and therefore in the Nairobi Railway Station. The project aims to carry out a modernization and expansion of under-utilized railway transport infrastructure facilities within Nairobi in order to attract passenger traffic from the roads thus reduce congestion and create an efficient and affordable mass rapid transit transport system from the city.

The development will be within existing railway corridors to provide commuter rail services between Nairobi Railway Station and the following destinations[7]:

- Ruiru
- Syokimau
- Jomo Kenyatta International Airport
- Kikuyu
- Embakasi Village

In the said study it is estimated that the Commuter Rail is forecast to carry 16% of all public transport trips in the Nairobi Metropolitan Region (NMR). It is also estimated that the Nairobi Central station is forecast to have 30,000 station exits, 8,000 entries and 9,000 people changing trains to cross the CBD without entering or exiting the station.

- **Termini Relocation Proposal**

A proposal was made for radical transformation of public transport termini within the Nairobi CBD and the proposed Nairobi Railway City by having this area as an exclusive BRT zone which is also served by the Commuter Rail Network.

[7] Kenya Railways Website krc.co.ke/Nairobi-commuter-rails/

There are two main types of operation designs for BRT systems:

- **Trunk and Feeder System**: Low density areas are served by low capacity vehicles which feed into the high capacity vehicles running on the main line via transfer/feeder stations.
- **Direct Services System:** The high capacity vehicles run along the main line as well as into the residential areas regardless of density.

The proposal would involve implementation of a Trunk and Feeder BRT system for Nairobi. Other public transport modes including buses and matatus run in the local streets and estates in the outer parts of Nairobi and terminate at various specific termini that feed to the BRT routes. Customers then transfer to the BRT for commute to the Central Business District. There is therefore an exclusive BRT zone closer to the CBD resulting in reduced traffic congestion and the possibility of transferring between BRT lines without the need to travel into the central CBD area.

Passengers can also transfer to the commuter rail network along the routes or at the multi-modal interchange at the Nairobi Central Station. The figure below shows this proposal.

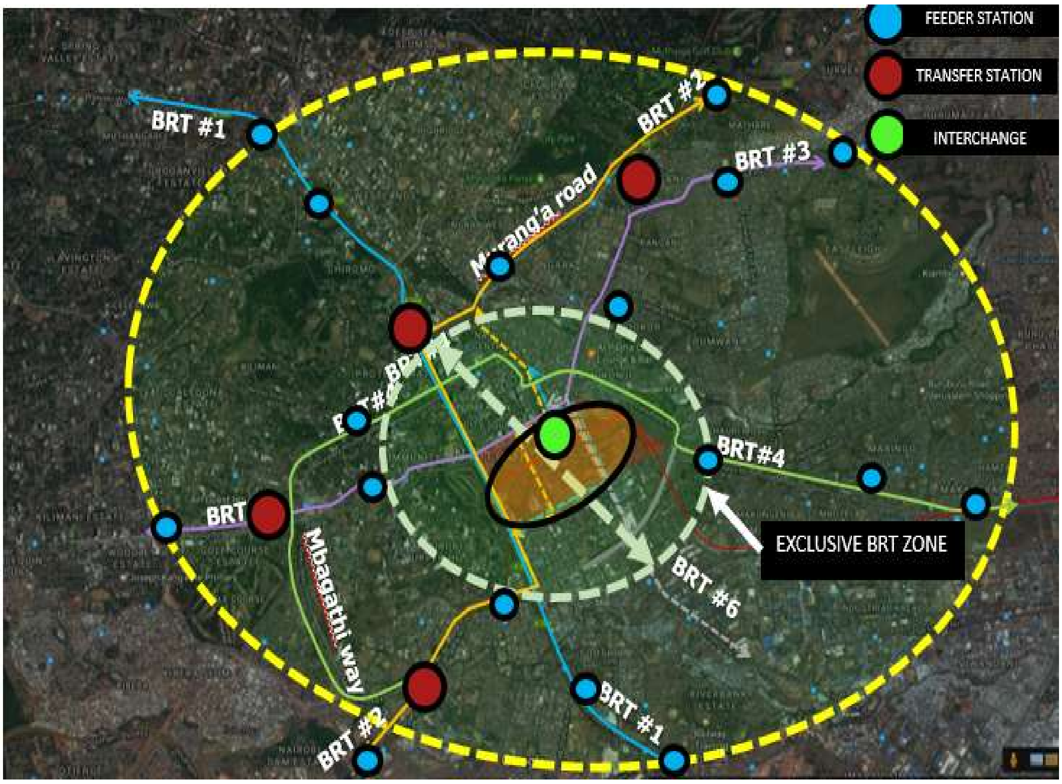


Figure 2-18: Proposed BRT Trunk and Feeder System with BRT Exclusive Zone

2.3.4 Non-Motorised Transport Network

Provision for Non-Motorised Transport (NMT) modes is at the heart of any TOD and the bias for ease of movement in the planning should be towards these modes. Non-motorised modes include:

- Pedestrians
- Cyclists
- Hand carts

NMT has been determined to be the primary mode of travel in Nairobi. According to NIUPLAN, 39.7% of citywide trips are made on foot (pedestrians), which is currently the largest proportion of NMT modes in the city. Only 13.6% of trips are made by private vehicles. However, provision of NMT infrastructure including paths, footbridges etc. is currently an afterthought, inadequate and poorly located.

The Consultant has proposed and provided NMT facilities along the entire road network shown in the Nairobi Railway City. The cross-sections showing this provision are shown in the infrastructure section of this report. As shown in the table below, the facilities provided for NMT along the roadside (as part of the road network) for both pedestrians and cyclists is 35% of the corridors provided.

Table 2-8: Provision of Traffic Facilities in Nairobi Railway City

Dedicated Corridor Section	Proportion	Transit Type
Carriageway (Mixed Traffic)	25%	MT
Bus lanes	3%	MT
Pedestrian walkways (Roadside)	21%	NMT
Pedestrian Corridor	28%	NMT
Cycle Lanes	14%	NMT
Streetlights, Kerbs, Benches etc.	9%	

An additional 28% of the corridor is provided as an exclusive NMT corridor shown below.

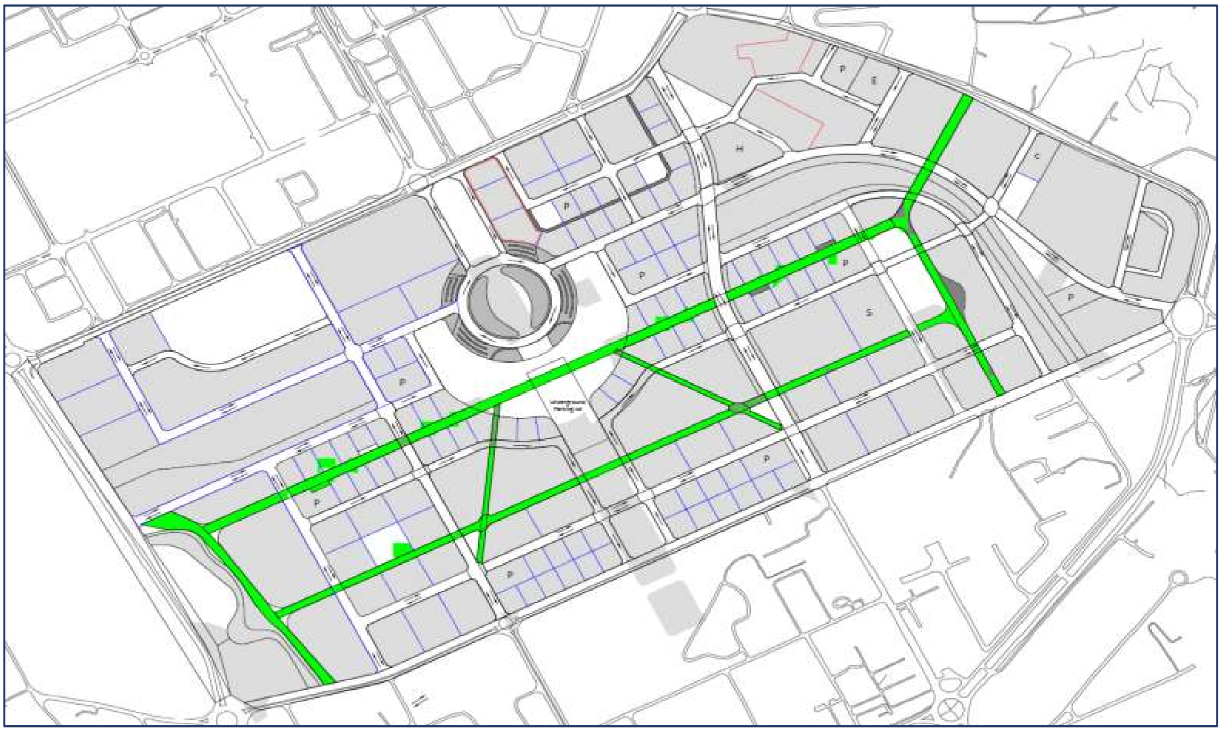


Figure 2-19: Nairobi Railway City Exclusive NMT Corridor

2.3.5 Transport Analysis

The objective of this stage is to establish the transport infrastructure requirements based on forecasted traffic from the surrounding network and traffic generated by the development. Due to the overlapping characteristics of the Green Mall and Viaduct Projects with the proposed Nairobi Railway City project, the traffic data obtained from the two projects was used for further analysis of traffic patterns in the Railway City.

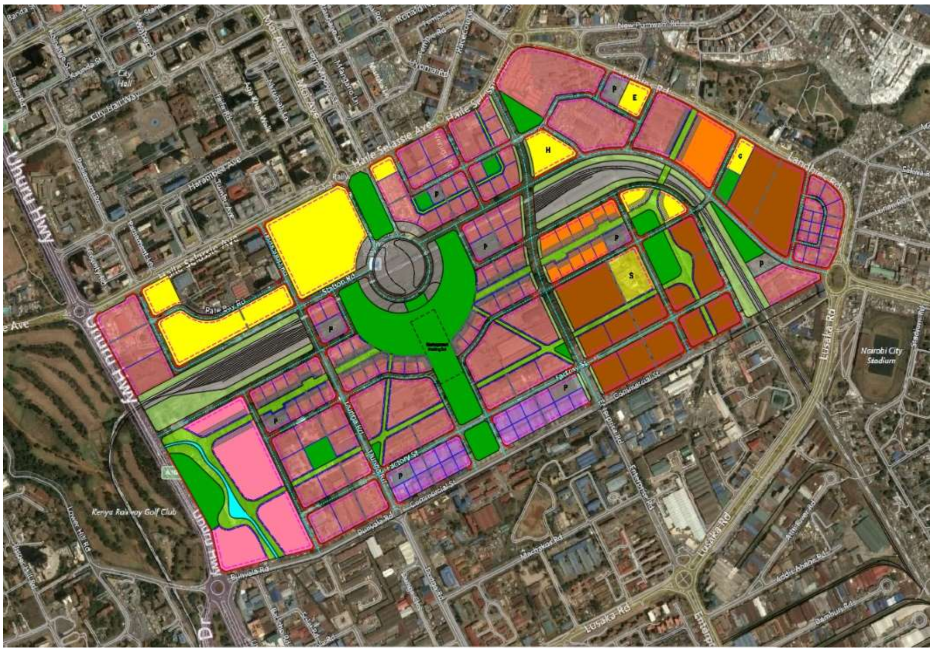


Figure 2-20: Railway City and Surrounding Transport Network

2.3.6 Travel Demand Modelling

The transport demand was determined using the 4-step traffic modelling process which is summarised below:

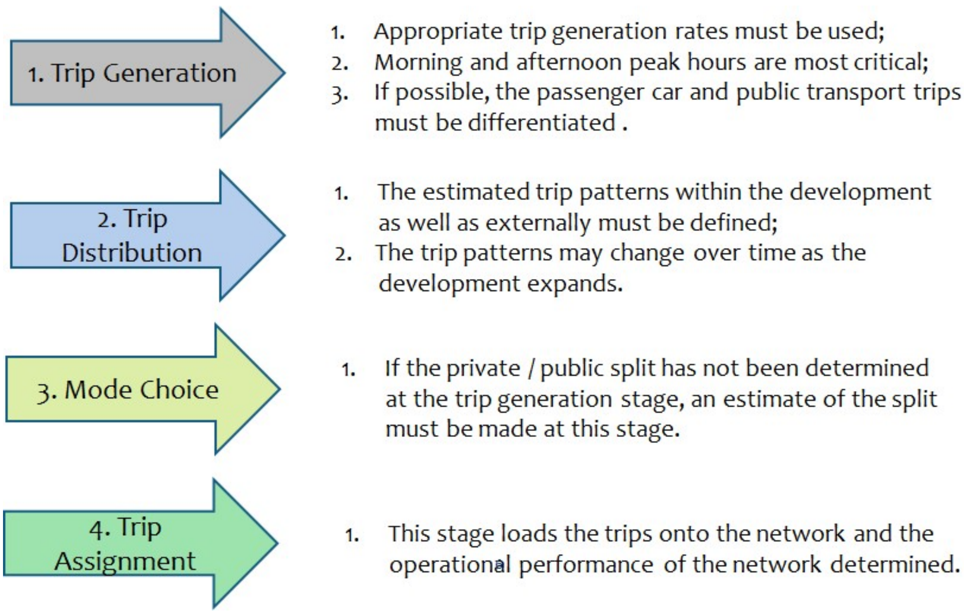


Figure 2-21: Four Step Modelling Process

2.3.6.1 Trip Generation

Trip generation is a critical first step in the determination of traffic impact from proposed developments and plays a key role in this study. Trip generation, based on the prescribed land-uses for the development and their corresponding estimated trip rates, sourced from the 9th Edition of the Institute of Transportation Engineers Trip Generation Manual.

Table 2-9 below shows the total number of person trips generated by the development in the morning peak (AM) and evening peak (PM). The IN trips represent those arriving at the various precincts while the OUT trips are those originating within railway city precincts. As the PM peak is higher, it has been adopted for further analysis since it represents the worst-case scenario.

Table 2-9: Summary of AM and PM Person Trips

Time Period	In	Out	Total (Peak Hour)
AM Trips	29,014	20,844	49,858
AM Distribution	58%	42%	-
PM Trips	34,064	36,850	70,914
PM Distribution	48%	52%	-

Table 2-10 below shows the PM peak hour person trips for the respective precincts, based on their land uses:

Table 2-10: Summary of AM and PM Person Trips

PRECINCT	IN	OUT	TOTAL	IN	OUT
Street Commercial (SC)	2,456	3,273	5728	7.2%	8.9%
MICE Core	2,250	3,773	6023	6.6%	10.2%
Centre Core (CC)	2,936	4,419	7355	8.6%	12.0%
East Core (EC)	386	1,308	1695	1.1%	3.6%
International Office (IO)	608	906	1513	1.8%	2.5%
Housing (H)	12,566	7,226	19792	36.9%	19.6%
Hi-tech SME (H-Tech)	1,647	603	2251	4.8%	1.6%
Wakulima and Muthurwa Commercial (WMC)	4,443	6,483	10926	13.0%	17.6%
Kenya Railway (KR)	1,685	1,754	3440	4.9%	4.8%
R&D Zone With TUK (RD)	792	2,341	3133	2.3%	6.4%
New Central Station (NCS)	4,294	4,763	9057	12.6%	12.9%
TOTALS	**34,064**	**36,850**	**70914**	**100%**	**100%**

2.3.6.2 Trip Generation and Mode Choice for Transit Oriented Developments

Nairobi Railway City is a Transit Oriented Development (TOD). As such, public transit and non-motorized transport are prioritized over private, single occupancy vehicles. NIUPLAN determined that walking was the main mode of movement within Nairobi at 45.7%. This was followed by Buses at 40.7% and private cars at 13.5%.

DAR Consultants, responsible for development of the Nairobi Commuter Rail Masterplan, projected a modal share of 16% for rail, even with BRT implemented. Based on this and additional policies on restricted parking and circulation within the Nairobi Railway City to discourage the use of private cars. the modal share was adjusted as shown below:

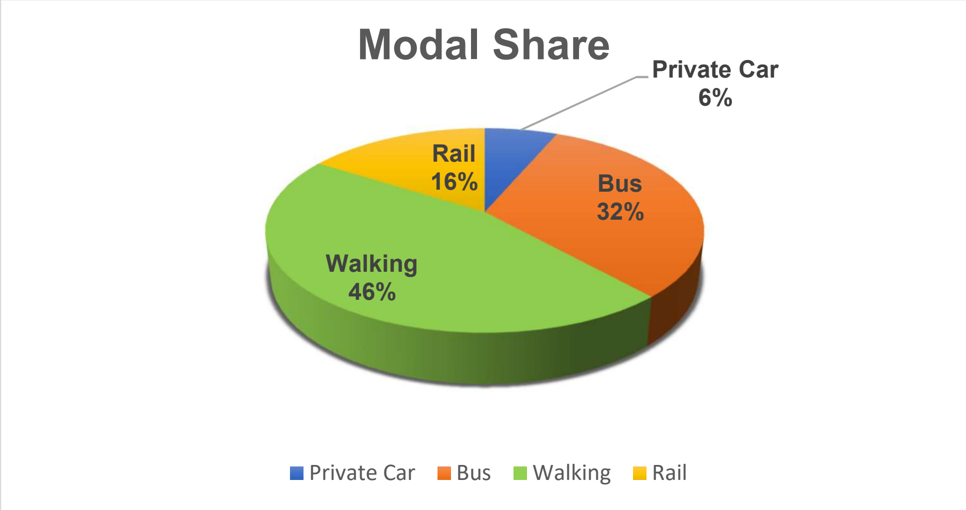


Figure 2-22: Modal Share for Nairobi Railway City

Studies of five TOD's in the United States of America[8] have shown that TOD's generate between 30 – 50% less trips than a conventional mixed used development. For the Nairobi Railway City project, we adopted 40% percentage reduction of vehicle trips, which were shifted to public transit modes.

The equivalent volume of transit trips gained from the reduction of vehicle trips is dependent on the respective vehicle occupancies. Vehicle occupancy as determined by NIUPLAN was 1.96 for private cars and 16.4 for buses. However, since Railway City is founded on the implementation of BRT, it was necessary to convert the bus occupancy into BRT occupancy. Integrated Transport Planning Limited determined that a bus capacity of 75 passengers would be adequate for Nairobi's BRT system. Consequently, we have adopted a conventional occupancy of 40 for BRT buses which translates to 53% of the proposed BRT bus capacity. The trips per mode are summarized below.

Table 2-11: Summary Trips per Travel Mode in the PM Peak

		Person Trips Per Mode		Vehicle Trips per Mode	
Mode of Transport	**Mode Share**	**In**	**Out**	**In**	**Out**
Private Car	6.4%	1,308	1,415	667	722
Bus	32.0%	11,773	12,735	294	318
Walking	45.8%	15,601	16,877		
Rail*	16.0%	5,450	5,896		
Total	**100%**	**34,132**	**36,924**	**962**	**1,040**

[8] *R. Ewing, R. Cervero, et al. 2011. Traffic Generated by Mixed-Use Developments. Journal of Urban Planning and Development and Reid Ewing⁎, Guang Tian, et al. 2016. Trip and parking generation at transit-oriented developments: Five US case studies*

The peak hour vehicle trips per precinct were then calculated as follows:

Table 2-12: Vehicle Trips per Precinct/ Zone in the PM Peak

NAIROBI RAILWAY CITY PRECINCT / ZONE	IN	OUT	TOTAL
Street Commercial (SC)	69	92	162
MICE Core	64	107	170
Centre Core (CC)	83	125	208
East Core (EC)	11	37	48
International Office (IO)	17	26	43
Housing (H)	355	204	559
Hi-tech SME (H-Tech)	47	17	64
Wakulima and Muthurwa Commercial (WMC)	125	183	308
Kenya Railway (KR)	48	50	97
R&D Zone with TUK (RD)	22	66	88
New Central Station (NCS)	121	134	256
TOTALS	**962**	**1,040**	**2002**

2.3.6.3 *Trip Distribution and Assignments*

a) Trip Distribution

In order to carry out the trip distribution, further analysis of the Origin-Destination (OD) matrix developed by the Green Mall Consultant was carried out. This entailed consolidation of 117 OD zones into 6 zones that will feed into the following entry points to Railway City:

- Entry 1: Uhuru Highway (Mombasa bound side after the railway bridge)
- Entry 2: Bunyala Road Roundabout
- Entry 3: New Workshop Road (at Bunyala Road)
- Entry 4: New Enterprise Road (at Bunyala Road)
- Entry 5: Jogoo Road (at City Stadium Roundabout)
- Entry 6: Ring Road Ngara (at Landhies Road Roundabout)

Figure 2-23 : Consolidated OD Zones

A new OD matrix, shown below, was then derived using these zones, highlighting the trips that would originate or terminate in Railway City.

Table 2-13: OD Matrix for Nairobi Railway City

	1	2	3	4	5	6	RC	
1			3.62%	10.88%			0.33%	**15%**
2			16.46%	2.89%	7.24%		1.08%	**28%**
3	3.37%	16.27%				4.22%	1.30%	**25%**
4	10.85%	3.18%					0.05%	**14%**
5		6.37%					0.19%	**7%**
6		3.40%	4.04%				0.36%	**8%**
RC	0.37%	1.14%	1.21%	0.03%	0.42%	0.34%	0.38%	**4%**
	15%	**30%**	**25%**	**14%**	**8%**	**5%**	**4%**	

Based on this matrix, the following trip proportions were developed for each entry point:

Table 2-14: Trip proportions per entry/exit point

Entry Point		Proportion of Trips
1	Uhuru Highway (Mombasa bound side after the railway bridge)	17%
2	Bunyala Road Roundabout	8%
3	New Workshop Road (at Bunyala Road)	4%
4	New Enterprise Road (at Bunyala Road)	21%
5	Jogoo Road (at City Stadium Roundabout)	23%
6	Ring Road Ngara (at Landhies Road Roundabout)	27%

These trips were then distributed using the following weighted percentages, (determined by the percentage of trips generated by each precinct) with respect to the origin/destination and the entry/exit point.

Table 2-15: Trip distribution summary

Precinct	UH Entry	Bunyala	New Workshop	New Ent	Jogoo	RRNgara
	17%	*8%*	*4%*	*21%*	*23%*	*27%*
Street Commercial (SC) 1	0.59%	0.28%	0.16%	0.77%	0.84%	0.96%
Street Commercial (SC) 2	0.59%	0.28%	0.16%	0.77%	0.84%	0.96%
MICE Core	1.09%	0.51%	0.29%	1.41%	1.54%	1.76%
Centre Core (CC) 1	0.71%	0.33%	0.19%	0.92%	1.01%	1.15%
Centre Core (CC) 2	0.71%	0.33%	0.19%	0.92%	1.01%	1.15%

Precinct	UH Entry	Bunyala	New Workshop	New Ent	Jogoo	RRNgara
	17%	*8%*	*4%*	*21%*	*23%*	*27%*
East Core (EC)	0.19%	0.09%	0.05%	0.24%	0.26%	0.30%
International Office (IO)	0.29%	0.14%	0.08%	0.38%	0.42%	0.48%
Housing (H)	6.09%	2.82%	1.64%	7.89%	8.61%	9.84%
Hi-tech SME (H-Tech)	0.80%	0.37%	0.22%	1.03%	1.13%	1.29%
WMC Housing	0.26%	0.12%	0.07%	0.34%	0.37%	0.42%
WMC Commercial	1.59%	0.74%	0.43%	2.06%	2.25%	2.57%
WMC RF Commercial/Office	0.18%	0.09%	0.05%	0.24%	0.26%	0.30%
WMC Public	0.12%	0.05%	0.03%	0.15%	0.16%	0.19%
Kenya Railway (KR)	0.82%	0.38%	0.22%	1.06%	1.15%	1.32%
R&D Zone With TUK (RD)	0.38%	0.18%	0.10%	0.50%	0.54%	0.62%
New Central Station (NCS)	2.08%	0.96%	0.56%	2.70%	2.94%	3.36%

b) Trip Assignment

In order to present the peak hour volumes in AADT, it was necessary to calculate a conversion factor using previously collected traffic data for Haile Selassie and Uhuru Highway. The factor was calculated by taking the average of the ratio of peak hour traffic to average annual daily traffic for the two roads. An average factor of 7.89% was adopted.

The generated AADT was then calculated by scaling up the peak hour traffic, which represents 7.89% of the AADT to 100%. The Trips per precinct are shown in the table below:

Table 2-16: Trips per precinct

PRECINCT	PEAK HOUR (7.89%)		AADT (100%)	
	IN	OUT	IN	OUT
Street Commercial (SC)	69	92	879	1,171
MICE Core	64	107	805	1,350
Centre Core (CC)	83	125	1,050	1,581
East Core (EC)	11	37	138	468
International Office (IO)	17	26	217	324
Housing (H)	355	204	4,496	2,586
Hi-tech SME (H-Tech)	47	17	589	216
Wakulima and Muthurwa Commercial	125	183	1,590	2,320
Kenya Railway (KR)	48	50	603	628
R&D Zone With TUK (RD)	22	66	283	838
New Central Station (NCS)	121	134	1,537	1,704
TOTALS	**962**	**1,040**	**12,189**	**13,186**

These trips were then assigned using the respective precinct percentages shown in table 2-15 for both the IN and OUT scenarios.

Table 2-17: Peak Hour and AADT Volumes

Precinct	UH Entry		Bunyala		New Wkshp		New Ent		Jogoo		RRNgara	
	IN	*OUT*	*IN*	*OUT*	*IN*	*OUT*	*IN*	*OUT*	*IN*	*OUT*	*IN*	*OUT*
Street Commercial 1	72	97	34	45	20	26	94	125	103	137	117	156
Street Commercial 2	72	97	34	45	20	26	94	125	103	137	117	156
MICE Core	133	223	62	103	36	60	172	289	188	315	215	360
Centre Core 1	87	130	40	60	23	35	112	169	123	184	140	211
Centre Core 2	87	130	40	60	23	35	112	169	123	184	140	211
East Core	23	77	11	36	6	21	30	100	32	109	37	125
International Office	36	53	17	25	10	14	47	69	51	76	58	86
Housing	742	427	344	198	200	115	962	553	1,049	603	1,199	689
Hi-tech SME	97	36	45	17	26	10	126	46	138	50	157	58
WMC Housing	32	17	15	8	9	5	41	22	45	24	52	28
WMC Commercial	194	210	90	97	52	57	251	272	274	297	313	339
WMC RF Comm/Office	23	138	10	64	6	37	29	180	32	196	36	224
WMC Public	14	17	7	8	4	5	18	23	20	25	23	28
Kenya Railway	100	104	46	48	27	28	129	134	141	146	161	167
R&D Zone With TUK	47	138	22	64	13	37	61	179	66	195	76	223
New Central Station	254	281	118	130	68	76	329	365	359	398	410	454

The following schematic shows the IN and OUT volumes on the network within Railway City.

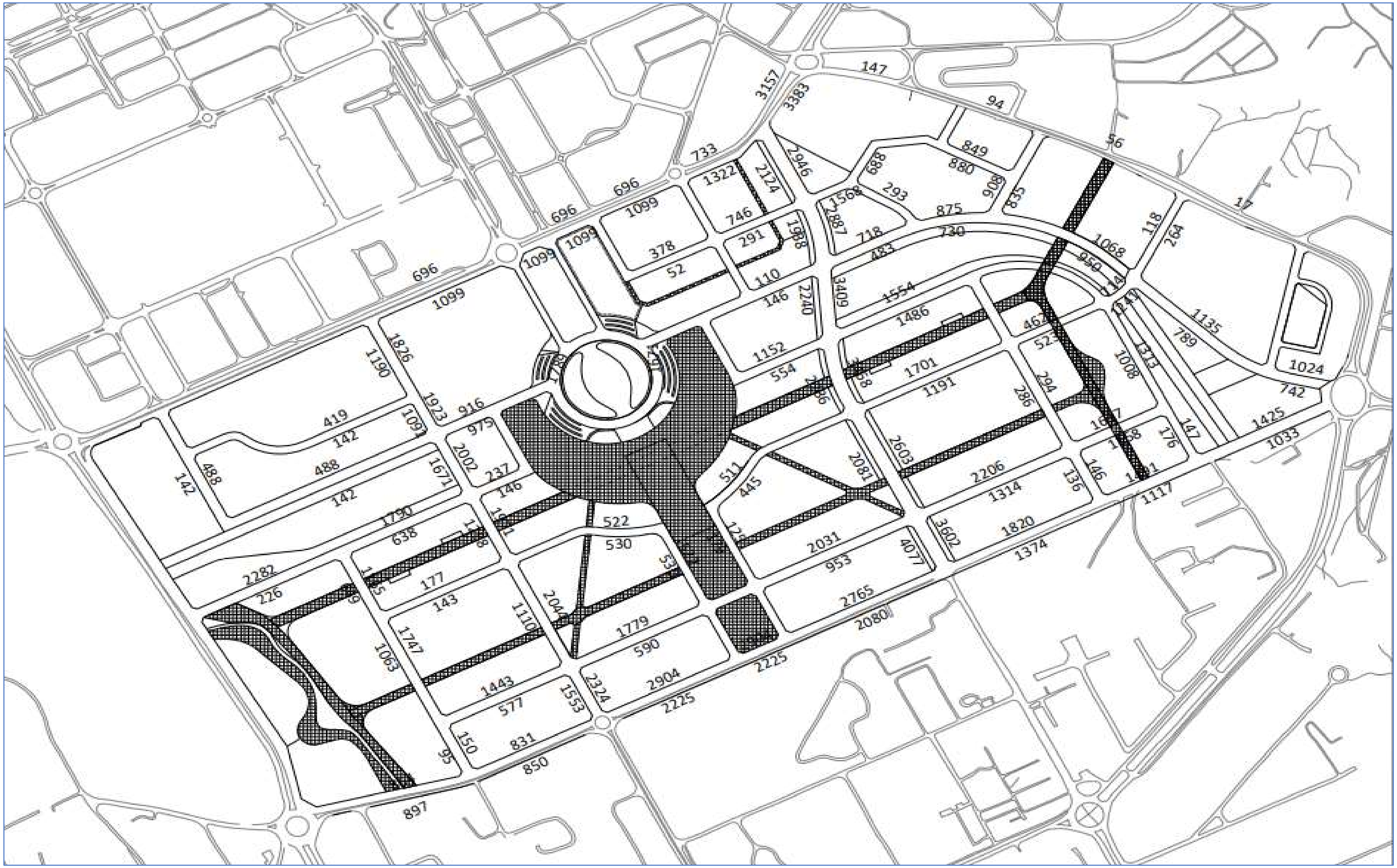


Figure 2-24: Schematic Layout of In and Out Generated AADT in 2030

Inorder to carry out a like for like comparison with the generated traffic, traffic volumes from scenario 2 (2030) of the Green Mall project were adjusted to incorporate BRT by applying the public transport percentages shown below and the respective vehicle occupancies for buses and BRT.

These percentages were established from classified traffic data previously collected by the Consultant. The average public transport percentage, 23%, was adopted as the minimum percentage on the assumption that BRT would have been fully implemented by 2030 on the surrounding network. It was also applied to the roads where traffic data was unavailable such as Bunyala Road.

Table 2-18: Public Transport

Road	% Public Transport
Uhuru Highway	13%
Haile Selassie Avenue	42%
Lusaka Road	7%
Landhies Road	29%
Jogoo Road	26%
Average	**23%**

The revised Green Mall scenario 2 (2030) volumes were then redistributed to incorporate New Workshop Road, after which they were combined with the generated traffic volumes. The schematic is shown in the figure below.

It should be noted that the purpose of this schematic is to show the potential improvements to the surrounding network and is only representative. The true impact of the improving the road links through implementation of railway city will require an update of the traffic model developed by the Green Mall Consultant.

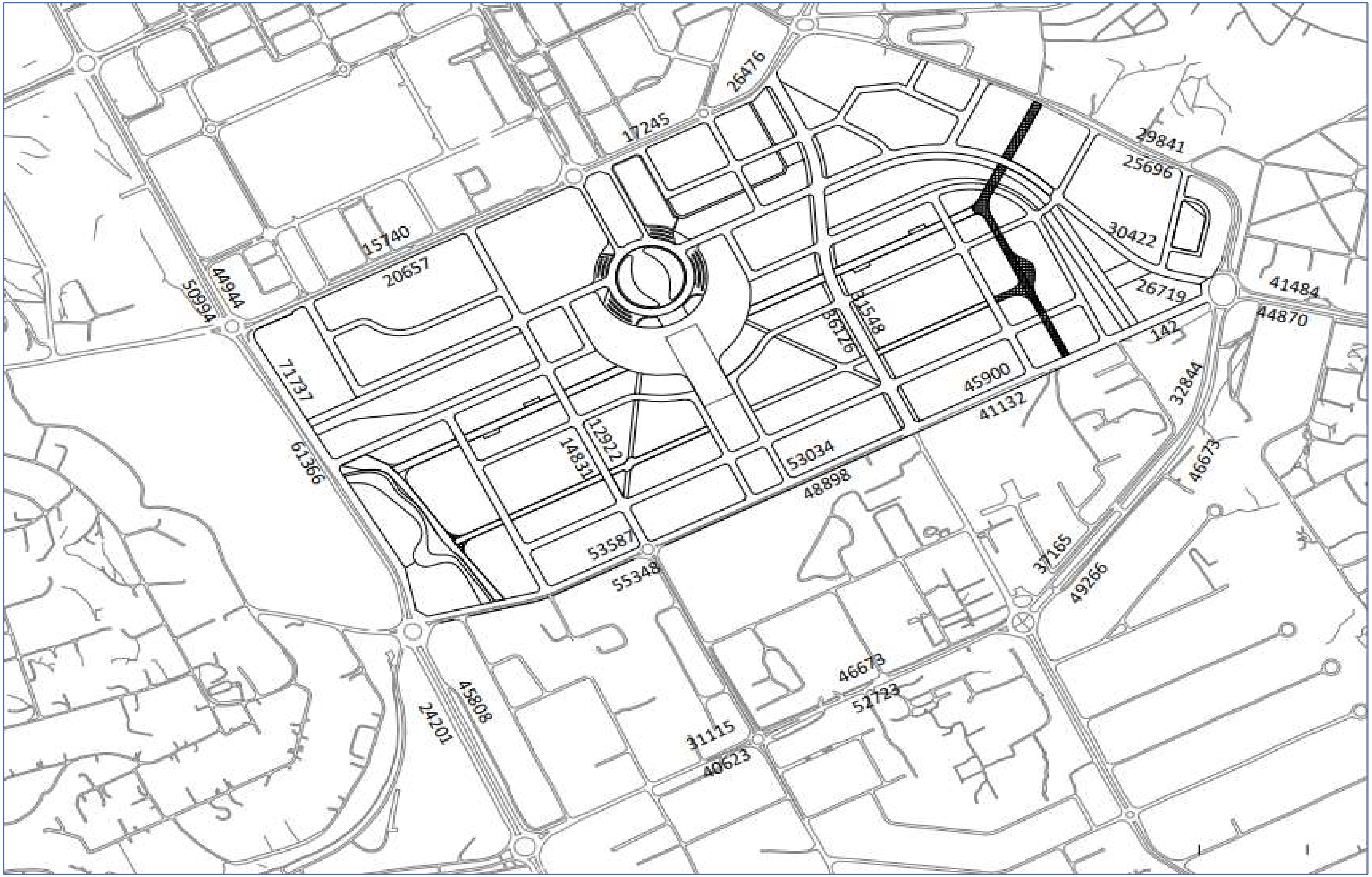


Figure 2-25: Schematic Layout of Adjusted Green Mall Traffic + Generated AADT in 2030

2.3.7 Capacity and Estimated Number of Lanes

The road capacity and estimated number of lanes was determined for the various roads within and around Railway City using the Kenya Draft Road Design Guidelines for Urban Roads (2001) and the Highway Capacity Manual HCM, 2010). As they roads are primarily urban, a design speed of 50 km/h was adopted, with the exception of Uhuru Highway, where 100km/h was adopted.

The Kenya Draft Road Design Guidelines for Urban Roads recommends the following capacities for Urban roads.

Table 2-19 : Practical capacities of two-way urban roads

Effective width of carriageway in metres (excluding refuges or central reservation)	2-iane		3-lane	4-lane	6-lane	
	7.0m	7.3m	10m	14m	20m	Remarks
Description	Capacity in pcu's per hour for both directions of flow			Capacity in pcu's per hour for one direction of flow		
All purpose roads with no frontage access, no parked vehicles permitted and negligible cross traffic	1350	1500	2200	2 200	3300	Appropriate to all-purpose distributors
All purpose streets with high capacity junctions and 'No waiting' restrictions	1000	1200	1800	1 350	2250 (or 2450 for dual carriageway	Applicable to distributors and access roads where accesses is frequent but capacity is not unduly restricted by junctions
All purpose streets with capacity restricted by parked vehicles and junctions	450 to 600	600 to 750	1100 to 1300	900 to 1000	1500 to 2000	Applicable to roads waiting vehicles and with heavy cross traffic limit capacity

The demand volumes shown in the table below were obtained by summation of the revised Green Mall data and the generated traffic volumes.

The capacities in the table above were applied in the calculation of the volume to capacity (V/C) ratio using the methodology from the Highway Capacity Manual. The volume to capacity ratio of a road link shows the relationship between the peak 15-minute flows to the lane capacity. As the value approaches one, the traffic flow conditions deteriorate. The table below summarizes the number of required lanes based on the v/c ratio.

Table 2-20: Road Capacity requirements for Road Network within and around the Railway City

	Direction	Demand Vol. (veh/h)	Peak 15-min Flow Rate (pc/h/ln)	Capacity (pc/h/ln)	PHF	N	f_{HV}	f_p	Avg PC Spd (km/h)	Density (pc/km/ln)	V/C Ratio
Link	*(a)*	*(b)*	*(c = b/(exfxgxh)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j = c/i)*	*(l = c/d)*
New Enterprise	EB	2,226	1,216	2,200	0.95	2	0.97	0.99	50	24	0.55
	WB	2,662	1,454	2,200	0.95	2	0.97	0.99	50	29	0.66
New Workshop	EB	1,057	1,155	1,350	0.95	1	0.97	0.99	50	23	0.86
	WB	1,175	1,284	1,350	0.95	1	0.97	0.99	50	26	0.95
Bunyala Road	EB	5,109	1,847	3,300	0.95	3	0.98	0.99	50	37	0.56
	WB	5,216	1,885	3,300	0.95	3	0.98	0.99	50	38	0.57
Haile Selassie	NB	0	0	3,300	0.95	2	0.98	0.99	50	0	0.00
	SB	1,831	993	3,300	0.95	2	0.98	0.99	50	20	0.30
Uhuru Highway	EB	6,640	2,400	3,300	0.95	3	0.98	0.99	100	24	0.73
	WB	5,680	2,053	3,300	0.95	3	0.98	0.99	100	21	0.62
Minor Arterials	EB	174	93	1,000	0.95	2	1.00	0.99	50	2	0.09
	WB	104	55	1,000	0.95	2	1.00	0.99	50	1	0.06
Minor Collectors	NB	134	72	1,000	0.95	2	1.00	0.99	50	1	0.07
	SB	94	50	1,000	0.95	2	1.00	0.99	50	1	0.05

N - Number of lanes; **f_{HV}** - heavy vehicle factor, **f_P** - proportion of driver population familiar with the road; **PHF** - Peak Hour Factor;; **v/c** - volume to capacity ratio

From the table above, we can see that 2 lanes in each direction are adequate for New Enterprise Road. The minor arterials and collectors have excess capacity with a single lane in each direction. Based on this analysis, we derived typical cross sections for the roads within Railway city, which are discussed further in section 2.4.2.

The consultant recommends capacity enhancement of Bunyala Road as the increased connectivity between and East and West greatly increases its attractiveness as an alternative route.

We also propose enhancement of Haile Selassie Avenue to ensure ease of crossing especially for pedestrians and cyclists moving to and from the existing CBD and the BRT Line 3 to the Central Railway Station. As previously stated, this will be possible if this area is part of the BRT exclusive zone.

2.4 Infrastructure plan

2.4.1 Site and Surrounding Area Infrastructure

The map below shows the existing infrastructure near the project area.

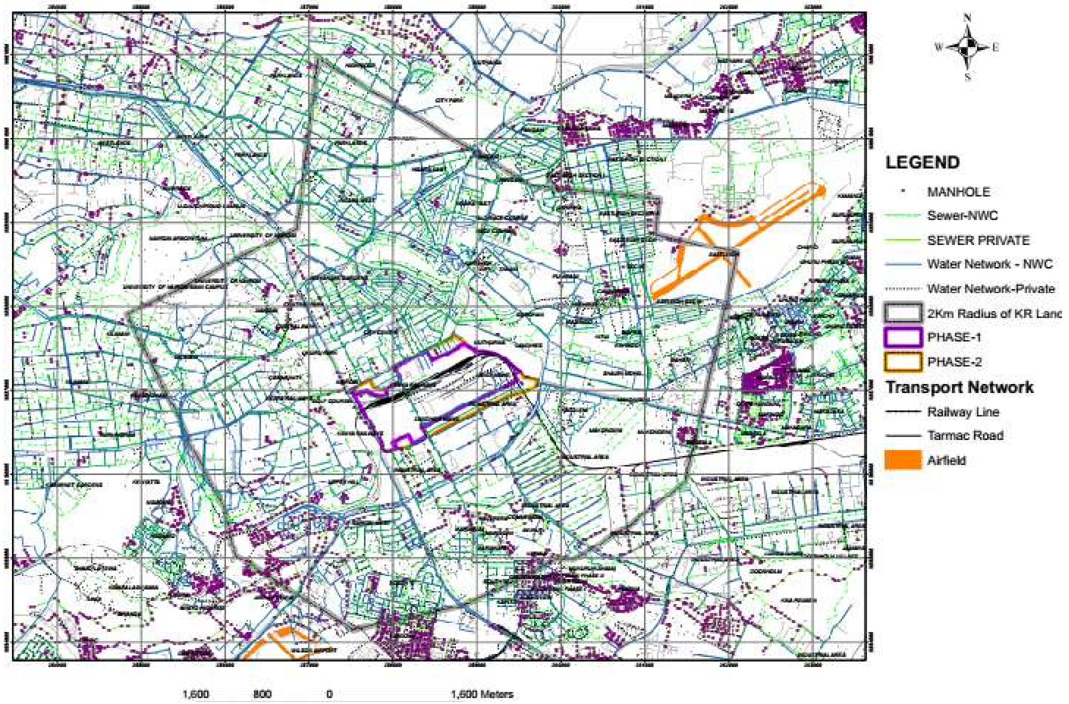


Figure 2-26: Infrastructure Within 2km Radius

2.4.2 Roads Network

2.4.2.1 Major roads around project area

- **Uhuru Highway Road A104**

Uhuru Highway (Road A1044) borders the project site to the west. The road is a class A road and therefore under KeNHA's jurisdiction. It is part of major highway from Kenya's main seaport of Mombasa to Malaba on the Kenya/Uganda border. The road is a 4-lane dual carriageway and is heavily trafficked roads in the city. The road pavement is in a fairly good condition. The section of road along the project site is approximately 890m.

KeNHA is currently undertaking a project to increase enhance capacity of the road and rehabilitate the highway from JKIA Turn –Off to Rironi. The project also includes the construction of the pilot BRT system for Nairobi City.

-
- **Haile Selassie Avenue**

This road borders the project site to the north and heavily trafficked road. It is part of one of the major arterial road into Nairobi CBD linking the western side to Eastern side of Nairobi. It is also a major public transport corridor; many public transport vehicles to the city use this road to get to access their termini within the CBD. The road is a 3-lane dual carriageway and the road pavement is in a fairly good condition. The section of road along the project site is approximately 1,200m.

- **Bunyala Road**

To the south of the site, there is Bunyala road. This road services traffic from Industrial area and Nairobi South areas and is also heavily trafficked. It links Industrial area and Upper Hill. The road is a 2-lane dual and is heavily trafficked. The section of the road running along the project site is approximately 1,700m and the road pavement is in a fairly good condition.

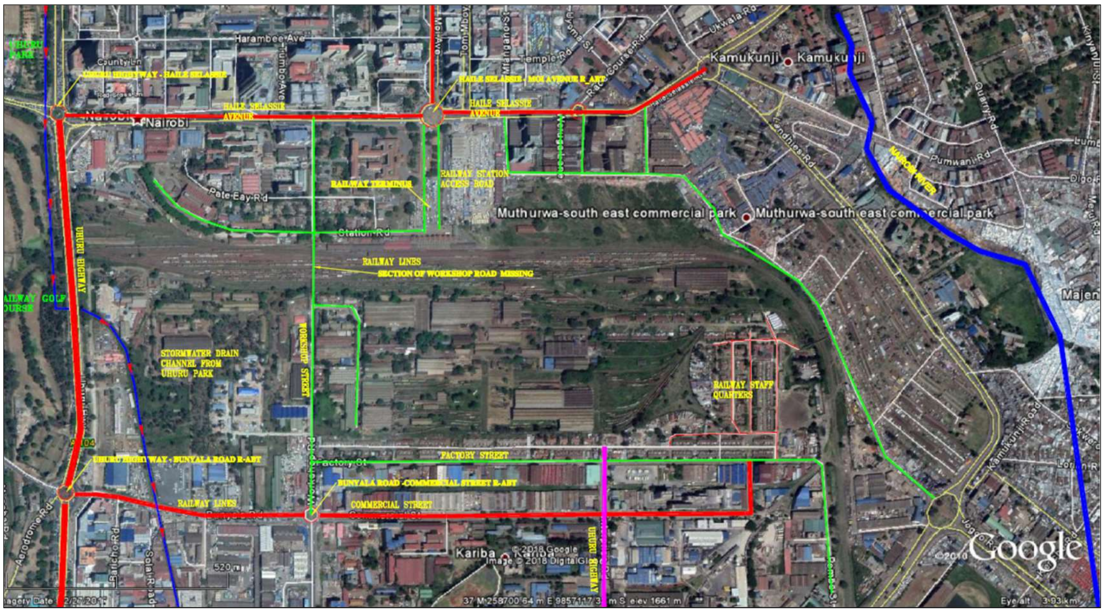


Figure 2-27: Existing road network at the project site

2.4.2.2 Major intersections

Around the project site there are three major intersections:

(i) Uhuru Highway (road A104) _ Bunyala Road Roundabout;
(ii) Uhuru Highwya (Road A104) – Haile Selassie Road Roundabout;
(iii) Haile Selassie- Landhies Road Roundabout;
(iv) Haile Selassie – Moi Avenue Roundabout.

The Haile Selassie – Moi Avenue Roundabout provides the main access to the project site and it can get congested during peak hours. The access road to the Railway Station also serves as matatu termini for various public transport vehicles for the city. This area can get quite congested and chaotic

.

2.4.2.3 Minor roads

Some of the minor roads within the project site are as follows;

- Workshop Road;
- Station Road;
- Factory Street;
- Station Access road;
- Exchange Lane;
- Werunga Lane
- Express Lane;
- Railway Lane.

2.4.2.4 Proposed roads

New roads and reconstruction of the existing roads have been proposed on the site to suit the expected traffic in the new city as determined from the ongoing traffic study, the geological conditions as determined from the ongoing geological study and hydrological requirements as determined from the ongoing hydrological study as well as the transportation aspirations for the new city.

The roads scheme and hierarchy that has assumed a lowered rail option is as shown below.

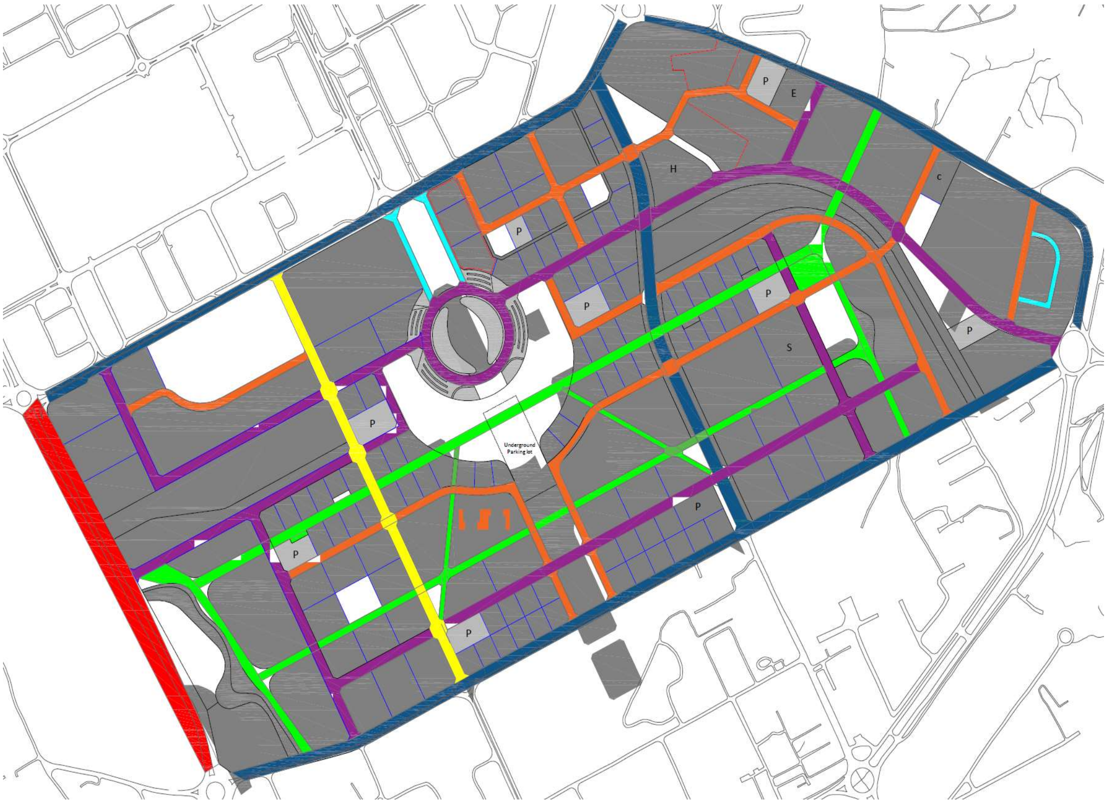
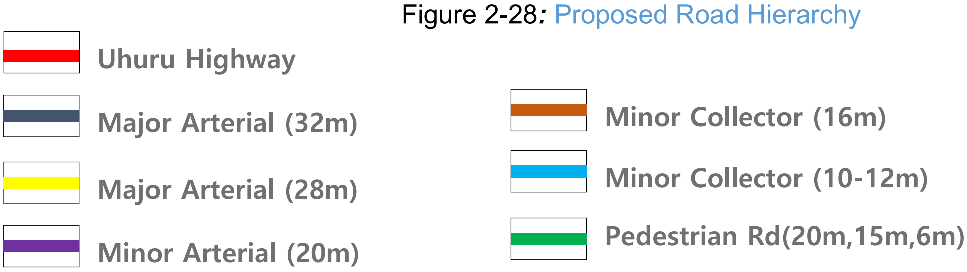
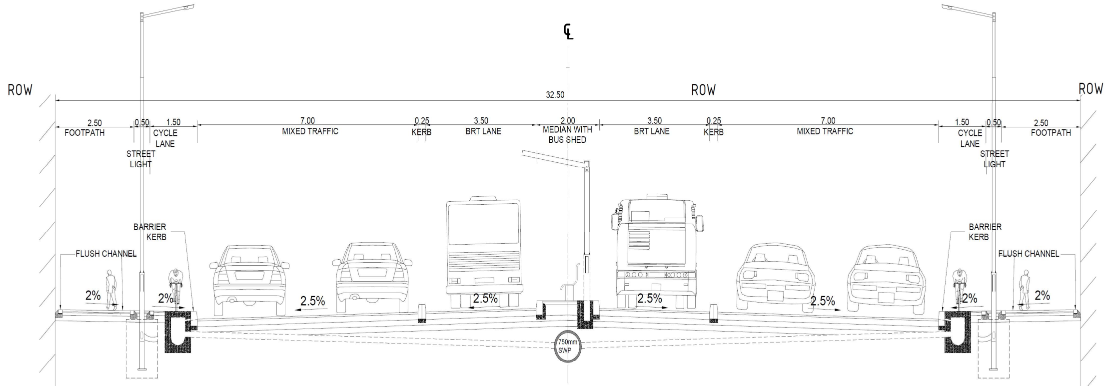


Figure 2-28*:* Proposed Road Hierarchy



2.4.2.5 Road sections

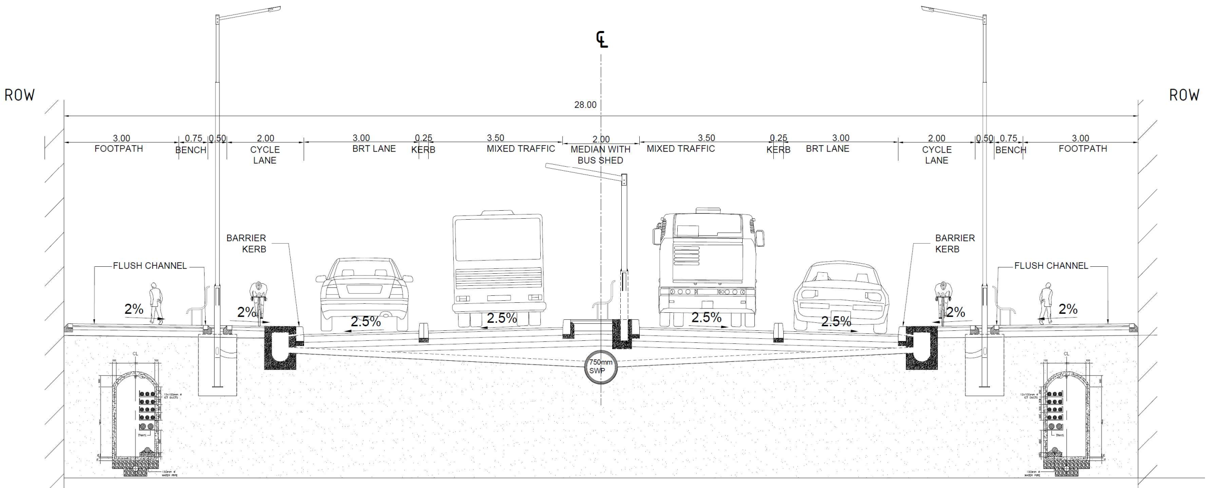
The following sections have been proposed for the roads that have been identified in section 2.4.2.4 above and include provision for storm water drainage and common utility tunnels The applicable pavement structures will be provided to suit results of the ongoing traffic and geological studies.



NEW ENTERPRISE ROAD: 32.5m WIDE ROAD CROSS SECTION WITH BUS SHED

SCALE 1:50

1:50



NEW WORKSHOP ROAD: 28m WIDE ROAD CROSS SECTION WITH BUS SHED

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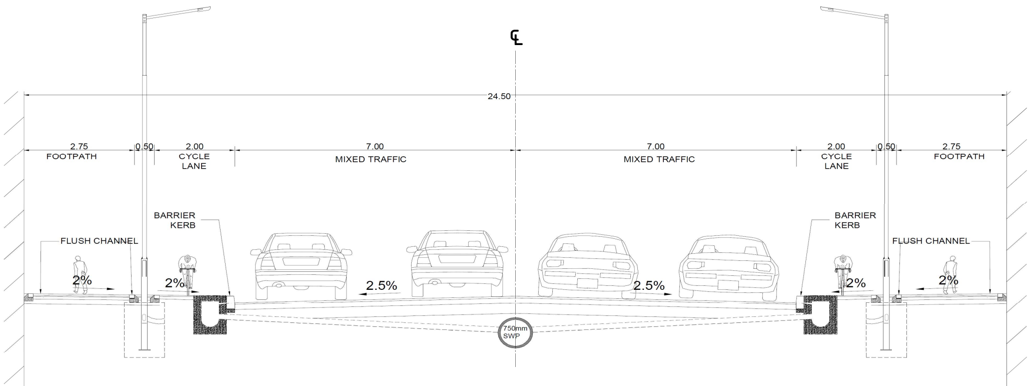
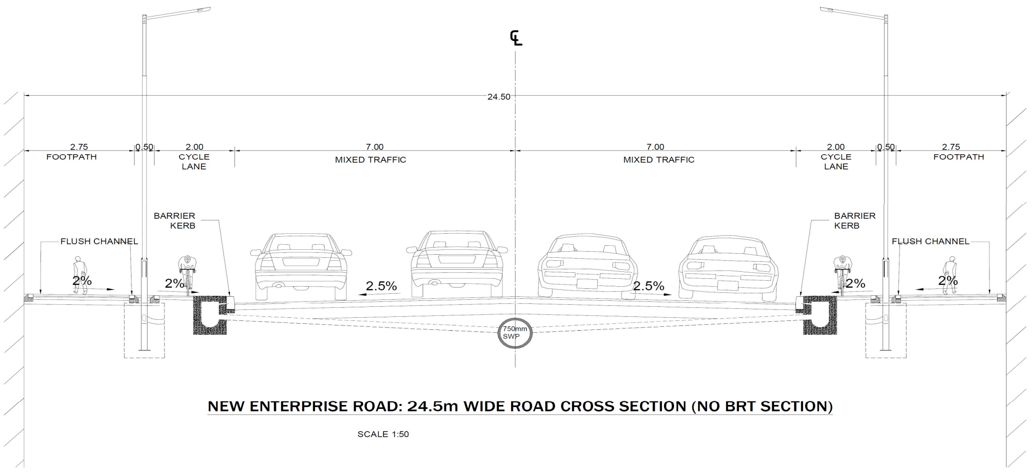


NEW ENTERPRISE ROAD: 24.5m WIDE ROAD CROSS SECTION (NO BRT SECTION)

SCALE 1:50



NEW ENTERPRISE ROAD: 24.5m WIDE ROAD CROSS SECTION (NO BRT SECTION)

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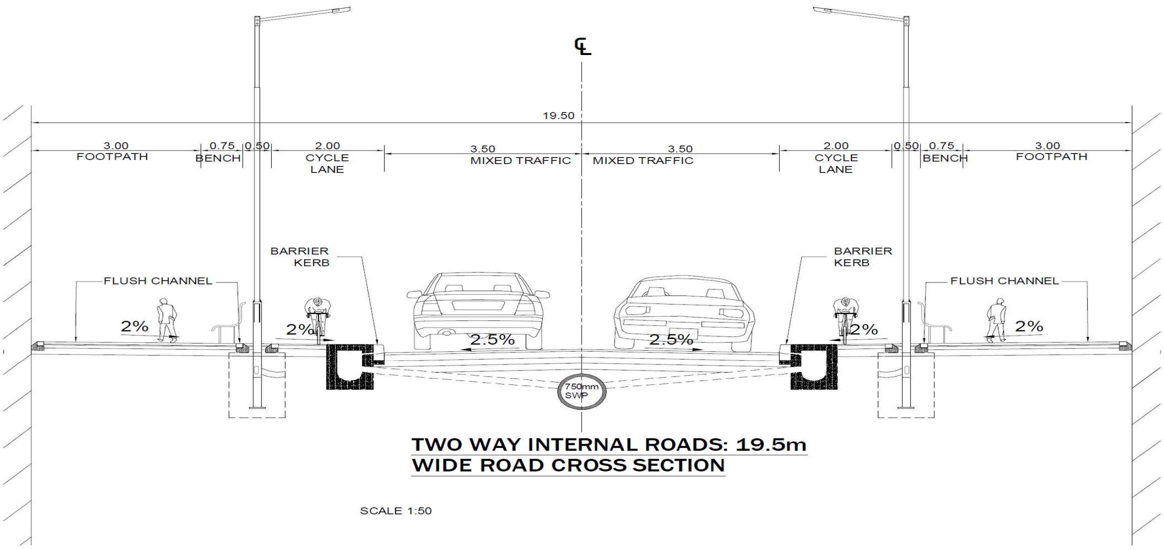

TWO WAY INTERNAL ROADS: 19.5m WIDE ROAD CROSS SECTION

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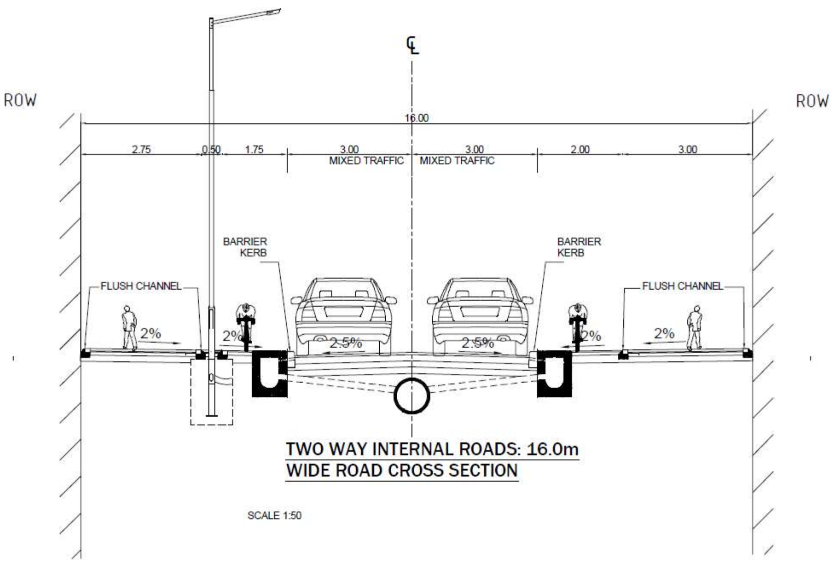
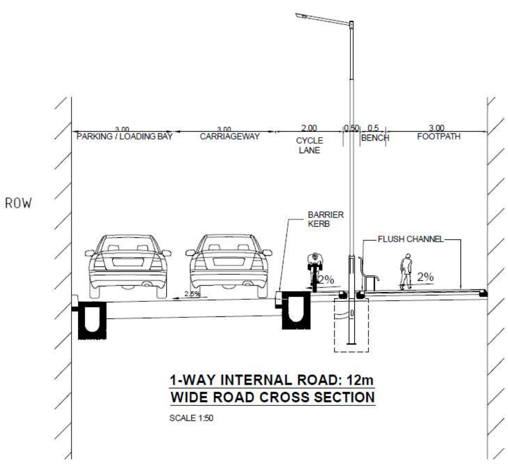
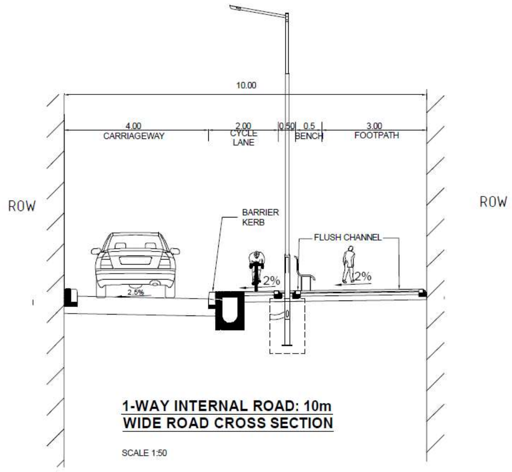


TWO WAY INTERNAL ROADS: 16.0m WIDE ROAD CROSS SECTION

SCALE 1:50





2.4.3 Storm water and drainage facilities

There is a major storm water drain that runs along Uhuru Park and drains southwards through the Railway Golf Course, it passes under the railway and then turns under Uhuru Highway through a semi-circular arch culvert and continues through the industrial area and then onto Nairobi river. It is evident that during heavy rainfall that the lined sections of the channel were overtopped because vegetation on its flanks had been flattened by storm flows.

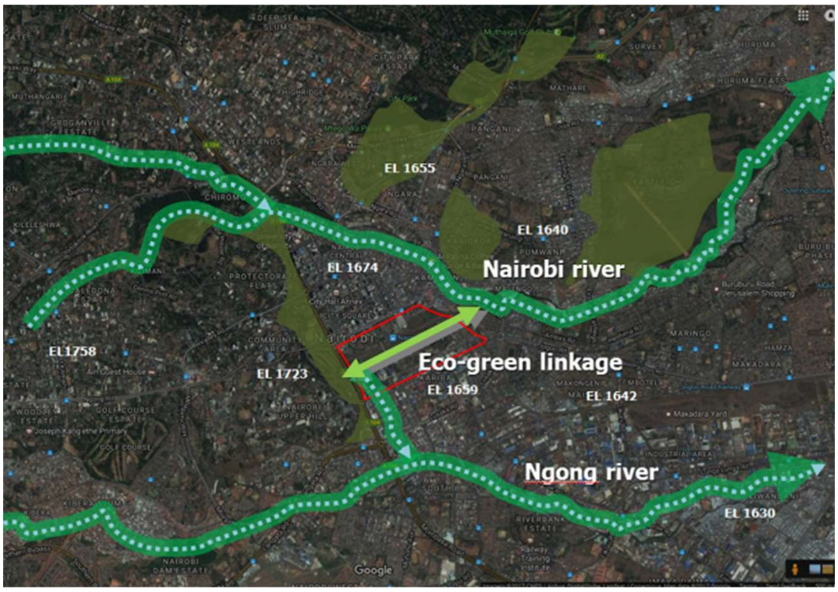


Figure 2-29: Site Drainage map

From previous studies and reports accessed, it was found that the level difference between Uhuru Highway and the Nairobi River is approximately 17 metres and the distance from the eastern edge of the site to a suitable outfall point on the river is approximately 1900 metres. In the report, the major proposal to sort the storm water flood problem is to the authorities construct a tunnel. The suggested route for such a tunnel is to have it pass under the railway marshalling yards, right through the project site providing a direct connection to discharge point on Nairobi River.

2.4.3.1 Existing drainage

The roadside drainage is mainly piped culverts, lined and unlined earth ditches. There is ponding on most sections of the road especially along the major roads especially during heavy downpour. The drainage infrastructure around the area is generally not functional and requires maintenance. It is mainly characterised by the following:

- Inadequately sized drainage channels and structures particularly at openings;
- Siltation due to obstruction of drainage channels;
- Blockage of drainage structures, manholes and catch pits;
- Encroachment of buildings/structures on waterways;
- Dumping of garbage along waterways.

Downstream, there several drainage structures including bridges, box culverts and pipe culverts as shown in the above map. The Green Mall report had sited some structures that are inadequate to pass the current flows while others are seriously clogged with debris. This was confirmed by our site visit and the same scenario was witnessed along the Nairobi river.

Figure 2-30: Site Drainage map

The structures along Ngong river and in the vicinity of the railway station are built across a trapezoidal concrete channel. This channel is approximately 3m wide at the top, 2m wide at the bottom and 2m deep. Though all structures are in use, there are signs of them being overtopped during high storm water discharge.

Figure 2-31: Bunyala road culvert

Figure 2-32: Lusaka road culvert

Figure 2-33: Hola road bridge

Figure 2-34: Shimo la tewa road bridge

Figure 2-35: Mukenia bridge

Figure 2-36: Blocked culvert

:

2.4.3.2 Proposed drainage measures

The two rivers namely Ngong and Nairobi should be retained as the main outlets for storm water originating from railway city. The ongoing hydrological study of the area will determine the current and expected peak flows and the flows that will be picked by the various channels taking into account the water that will be channelled to the proposed underground tank below the proposed New railway station and the various greening areas.

Storm water drainage facilities that will be sized on the basis of the hydrological and hydraulic studies have been proposed on both sides of all the roads within the development. The proposed side drains will be covered, concrete u-shaped drains, allowing for utilisation of the full width of the transit corridors. These will also reduce cases of blockage common with open channels.

New pipe and box culverts shall be provided at crossing points as determined by the hydraulic requirements. Relevant existing bridges, pipe and box culverts that are outside the site area will be assessed for both hydraulic and structural capacity to confirm the measures that had been proposed in earlier studies and/or propose new measures.

Utilize open greenspaces – e.g. attenuation ponds and swale for storage of surface runoff; infiltration boxes where water is temporarily stored and before moving through the soil or can be used for greening.

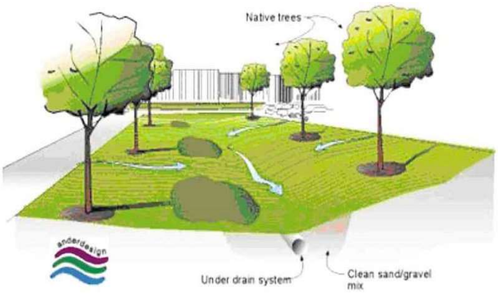


Figure 2-37: Water harvesting

Figure 2-38: Proposed Drainage Schem e

2.4.4 Water supply

The site lies in Zone 7 within the Nairobi County. This area is supplied with water from the Hill Tank which has a capacity of 18,000 m3 and is fed from the Kabete Reservoir and the Kabete Water Treatment Plant *(WTP)* which has a capacity of 27,000 m3 per day. The Kabete WTP is supplied with water from three sources viz Ruiru dam, Thika dam and Susumua dam all having a total capacity of 544,700 m3 per day

2.4.4.1 Water Demand Projection

Water Demand Projection Considering the appropriate water consumption per capita, the total estimated water demand is 7,479 m^3/day in for the Railway City. This is as calculated and tabulated in the table below.

Table 2-21: Water Demand

Zone	Land use	Resident Population			Non-Resident Population		
		Residents	per capita water demand (lpd)	Water demand (m3/day)	Users	per capita water demand (lpd)	Water demand (m3/day)
Street Commercial	**Sub Total**	**3,123**		**468**	**10,379**	**-**	**259**
	Mixed use (Commercial Dominant)	1,336	150	200	9,838	25	246
	Mixed use (Residential Dominant)	1,787	150	268	307	25	8
	Parking lot (Parking building)	-	150	-	234	25	6
MICE Core	**Sub Total**	**4,286**	**-**	**643**	**13,966**	**-**	**349**
	MICE	4,286	150	643	13,966	25	349
Center Core	**Sub Total**	**4,311**		**647**	**16,137**	**-**	**403**
	Mixed use (Office Dominant)	4,311	150	647	16,137	25	403
East Core	**Sub Total**	**1,501**			**3,525**	**-**	**88**
	Mixed use (Commercial Dominant)	227	150	34	1,673	25	42
	Mixed use (Residential Dominant)	1,274	150	191	219	25	5
	Public purpose	-	150	-	1,633	25	41
International Office	**Sub Total**	**-**	**-**	**-**	**25,817**	**-**	**645**
	Mixed use (Office Dominant)	-	150	-	25,817	25	645
Housing	**Sub Total**	**11,491**		**1,724**	**5,957**	**-**	**149**
	Residential	11,019	150	1,653	234	25	6
	Mixed use (Commercial Dominant)	472	150	71	3,475	25	87
	Public purpose	-	150	-	817	25	20
	School	-	150	-	1,390	25	35
	Parking lot (Parking building)	-	150	-	41	25	1
Hi-tech SME	**Sub Total**	**440**		**66**	**10,508**	**-**	**263**

Zone	Land use	Resident Population			Non-Resident Population		
		Residents	per capita water demand (lpd)	Water demand (m3/day)	Users	per capita water demand (lpd)	Water demand (m3/day)
	Hi-tech Industrial	440	150	66	10,358	25	259
	Parking lot	-	150	-	150	25	4
Wakulima & Muthurwa Commercial	**Sub Total**	**2,684**		**403**	**23,497**		**587**
	Mixed use (Commercial Dominant)	2,684	150	403	19,774	25	494
	Public purpose	-	150	-	3,650	25	91
	Parking lot (Parking building)	-	150	-	73	25	2
Kenya Railway	**Sub Total**		**-**	**-**	**10,367**		**259**
	Public purpose	-	-	-	10,367	25	259
R&D Zone with TUK	**Sub Total**	**337**		**51**	**14,538**		**363**
	Mixed use (Office Dominant)	337	150	51	7,255	25	181
	Public purpose	-	150	-	7,283	25	182
New Central Station	**Sub Total**	**-**	**-**	**-**	**4,445**		**111**
	Station	-	-	-	4,445	25	111
	Transportation Facilities	-	-	-	-	25	-
Total		**28,173**		**4,001**	**139,136**		**3,478**
			Total demand for the Project				**7,479**

2.4.4.2 Final Design Directions

The current demand for Nairobi City stands at 669,888m^3 /day against a production capacity of 528,100 m^3/day. The Nairobi City Water Supply Master Plan Study provides the future water supply systems as presented in the table below.

Table 2-22: Future Water Supply Systems

Implementation Period	New Sources	Capacity (m^3/sec)
2012-2013	Kyunyu Well fields	0.4
2012-2013	Ruiru Well fields	0.35
2013-2016	Northern Collector Phase I	1.6
2017-2021	S Mathioya transfer +Maragua 4 Dam	1.53
2022-2026	Northern Collector Phase II	1.39
2025-2029	Ndarugu I Dam	2.5
TOTAL		7.77

From the above, a combined source capacity of 671,328 m3/day would be achieved after the development of all the above sources. In addition to the above, at the time of preparing this report, Athi Water Services Board was in the process of procuring for the development of, Maragua and Karemeno dams. Procurement for Ruiru II dam has already been finalised. It is however noted that the demand for Nairobi City is unlikely to be fully met in the near future.

In order to supplement the mains water supply, the following shall be undertaken:

- Ground water development;
- Water recycling;
- Rain water harvesting

The proposed borehole locations, which will be subject, to conclusive hydrogeological studies will be in the following zones:

- Residential area, apartments;
- Commercial area;
- School area.

Water Connection and Distribution: The size of connection required was calculated using the simple formula Q=VA, as DN 250mm. Storage shall be provided at the various block developments to meet the peak demand. The proposed network ranges between DN 250mm and DN100mm.

Irrigation Water Plan: The proposed green area is 24ha and therefore the water requirement was estimated as 350 m3/day. The irrigation water demand will be met from the recycled water which will be supplemented by rainwater harvesting. The irrigation water requirement was estimated based on a water requirement of 1.0l/s/ha for 4hrs per day at the peak.

A 16,000 m^2 on plan underground tank has been proposed at the new railway station for collecting the rain water which will used as indicated above.

Figure 2-39: Water supply plan

2.4.5 Wastewater Collection and Disposal Plan

2.4.5.1 Wastewater Generation

The wastewater generation was estimated as 80% of 7,479 m^3/day (water demand) 5,984m^3/day or 0.07m^3/s. This flow will be conveyed to two existing trunk sewers namely DN 1200mm Nairobi River Trunk Sewer and DN 600mm Uhuru Highway Trunk sewer.

The wastewater collected shall be conveyed to Dandora Sewage Treatment Plant whose capacity has been recently upgraded to 160,000 m^3/day although it is still operating at 120,000 m^3/day and has adequate capacity for the new city.

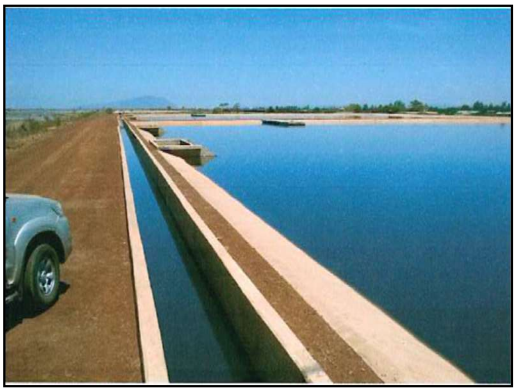


Figure 2-40: Dandora Sewerage Treatment Plant

2.4.5.2 Sewer reticulation Network

The entire CBD area is adequately served by piped sewerage system. However, the system is old and designed for a smaller population. It is noted that the proposed development will involve a redesign of the road network and therefore a new sewer system will also be designed to follow the new road alignments.

2.4.5.3 Sizing of the outfall Sub-trunk Sewers

Taking n for concrete pipes =0.013 and s=0.005 *(Poorest allowed slope),* assuming the pipe is flowing two thirds full, DN 375mm concrete pipe size was selected based on the Colebrook white formula.

2.4.5.4 Sizing of the Reticulation Sewers

The minimum size of reticulation sewers allowed is DN 225mm.

Figure 2-41: Wastewater collection and Disposal to Plan

2.4.5.5 *Water Recycling*

The recycled water will meet the irrigation water demand estimated as 350m3/day for the whole city as well as WCs flushing needs for the three zones namely:

- MICE Core;
- Centre Core;
- Housing

Three wastewater onsite treatment plants shall be considered at the above locations to treat wastewater for recycling as follows:

(i) Mice 800m3/day;
(ii) Centre core 850m3/day;
(iii) Housing area 1,500m3/day.

Figure 2-42: Wastewater recycling Plant

2.4.6 Power Supply

The new railway city shall be provided with high voltage electricity to supply the proposed development such as residentials, mixed use *(residential dominant),* mixed use *(commercial dominant),* mixed use *(office dominant),* MICE, high-tech industrial, public purpose, school, transport, railway utilities, buffer zone *(green),* open spaces *(park, plaza, pedestrian road)* with area coverage of 4,048,600 square metres.

2.4.6.1 Existing Power Supply

As part of the study, a survey was carried out to establish whether there is adequate power supply infrastructure within the project. The table below gives the utility provider's existing substations.

Figure 2-43: Existing substation

Table 2-23: Existing Substations Near the New City

S/No	Substation Name	Substation Capacity (MVA)	HT Line Capacity	Status
a	Ragati Road	2 x 45.00	66 / 11kV	In operation
b	Muthurwa	2 x 3.00	66 / 11kV	In operation
c	City Centre	2 x 200.00	220 / 66kV	Under Construction
d	Jivaji	2 x 23.00	66 / 11kV	In operation
e	South C	2 x 23.00	66 / 11kV	In operation

2.4.6.2 Railway City Power Demand Estimation

The estimated electric power demand for the new city is given in the table below.

Table 2-24: Railway City Power Demand Estimation

	Final Option	Buildings / Facilities Approximate Area	Demand in VA/Sq. M	Total Power Demand (MVA)
S/No	Development Buildings / Facilities Classification			
1	Residential Spaces	390,500	40.00	15.62
2	Mixed use (Residential Dominant)	190,000	40.00	7.60
3	Mixed use (Commercial Dominant)	1,186,400	70.00	83.05
3	Mixed Use (Office Dominant)	1,020,000	70.00	71.40
4	Hi tech Industrial Spaces	187,200	70.00	13.10
5	MICE	455,400	40.00	18.22
6	School (Education Centre) Spaces	6,950	40.00	0.28
7	Infrastructure Spaces	95,600	20.00	1.91
	Total Load	**3,798,050**		**211.18**
	Approximately 10% of the buildable area will be taken by lifts, shafts ways			**190.06**
	Assume Diversity factor of 70%			**133.04**

The City Centre 2x200MVA substation (see Table …..) reveals that there is adequate power capacity to support the new development.

2.4.6.3 Power Reticulation

The high voltage power shall be supplied to a new power substation to be constructed near the New Railway station. It shall then be reticulated to the development through underground cable installation via the common utility tunnels.

Power to the consumers shall be distributed by use of step-down transformers at 11kV/415V which shall be installed within each building depending on the load required for the building.

It is proposed to enhance power reliability through use of:

Figure 2-44: Transfomer

- Integrated solar lighting;
- Power saving appliances;
- Smart grid system technology – a self-healing technology.

2.4.7 Telecommunication and CCTV

Several communication service providers are with the vicinity of the proposed development including the following:

- Airtel Kenya Ltd;
- Safaricom Ltd;
- Wananchi Ltd;
- Liquid Telecom Ltd;
- Jamii Telecom Ltd;
- Orange Kenya Ltd;
- Access Kenya Ltd.

Telecommunication requirements shall be discussed with the private suppliers and communication infrastructure shall employ the use of fibre optic for connectivity. This will give easier connectivity to the proposed railway city with less communication media being installed which normally takes a large space due to their bulkiness.

Figure 2-45: Figure 2 45: Transfomer

The networks shall make use of the underground cable installation via the common utility tunnels.

Security installation shall be managed by the developers and the Railway city authorities. It will include use of CCTV and other monitoring equipment installed at strategic locations with a manned central command centr

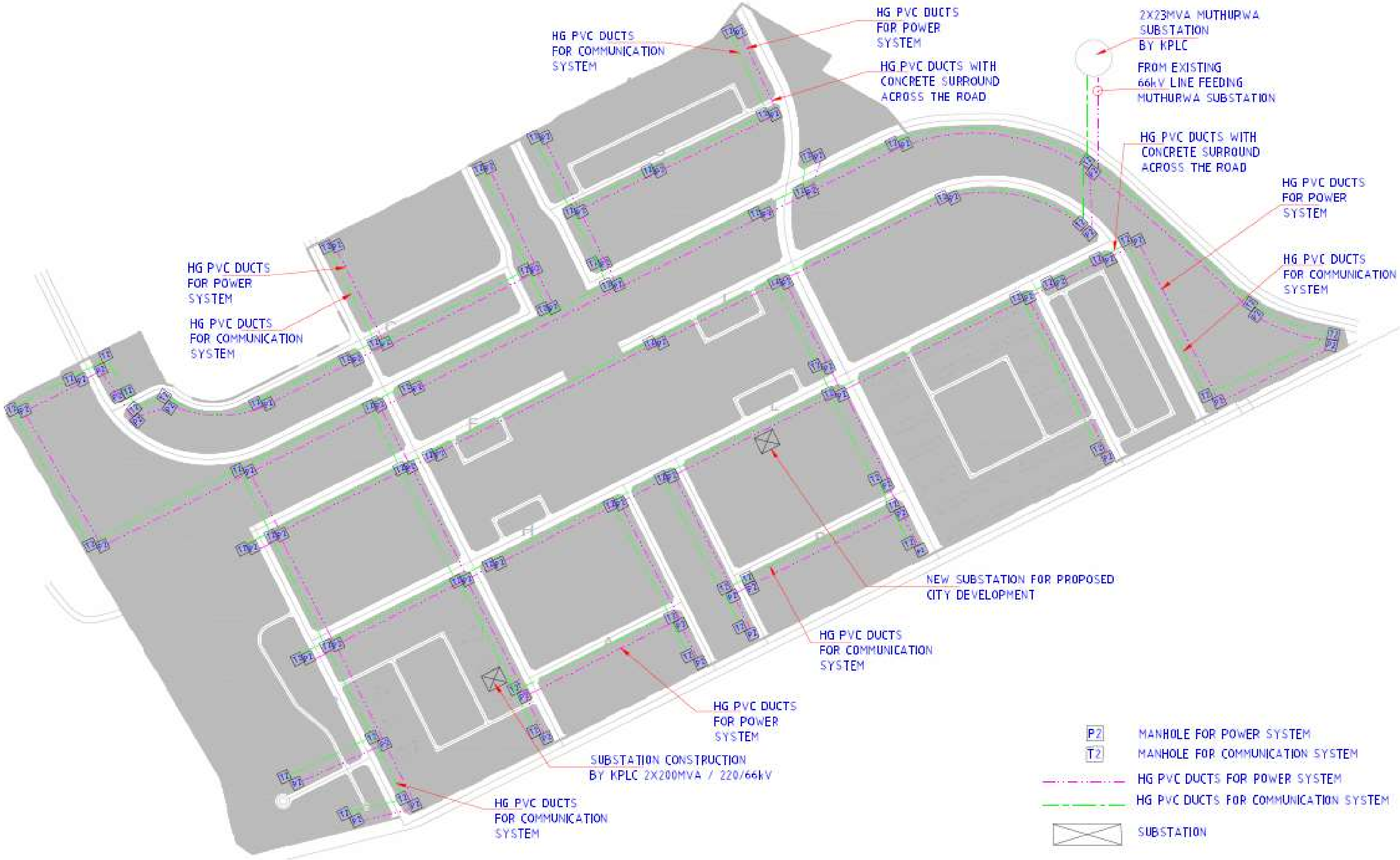


Figure 2-46: Master Plan for Power and Communication Main Network

2.4.8 State of Art infrastructure – Smart designs

Several smart alternatives have been considered in the design of the New city including the following:

- Common utility tunnel system where services are accommodated in one accessible tunnel. New services are installed easily without requiring new excavations and cutting. This enables easier tracing in case of faults and breakages;
- Use of water efficient fixtures including shower heads, taps, toilets;
- Water recycling and using for flushing of the toilets and greening;
- Use of sustainable energy solutions including integrated solar lighting system for street lighting and public places, power saving appliances and daylight natural lighting technology;
- Employing green building technology as a way of minimizing 100% dependence on grid power supply.

Figure 2-47: Solar lighting

2.4.9 Common Utility Tunnels

A utility tunnel is considered an optimal solution to avoid underground crowding of utilities in narrow right-of-ways. Shared infrastructure can save significant costs, especially with provision for maintenance, upgrade and growth over the lifecycle. This requires cooperation among stakeholders.

2.4.9.1 Advantages of Utility Tunnels

Utility tunnels offer the following advantages:

- They afford easier accessibility to utilities for maintenance, upgrading and tracing in case of faults and breakages;
- Environmental impacts including cutting of roads and clattering are minimized;
- Location information for the services is more accessible;
- They greatly reduce the surface area occupied by the service carriers;
- Adequate airflow in tunnels allows better heat transmission from electricity cables than in directly trenched/buried situations.

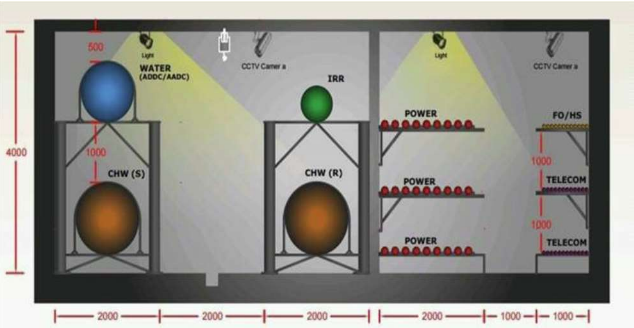


Figure 2-48: Utility Tunnel

2.4.9.2 Disadvantages of Utility Tunnels

Utility tunnels have the following disadvantages:

- They have initial construction cost compared to traditional open excavation methods;
- Compatibility between utilities housed in the tunnel can pose a challenge ie A defect in one system may adversely affect the other systems;
- There are concerns of people entering the tunnels to maintain one service when they are not experienced in services of other utilities

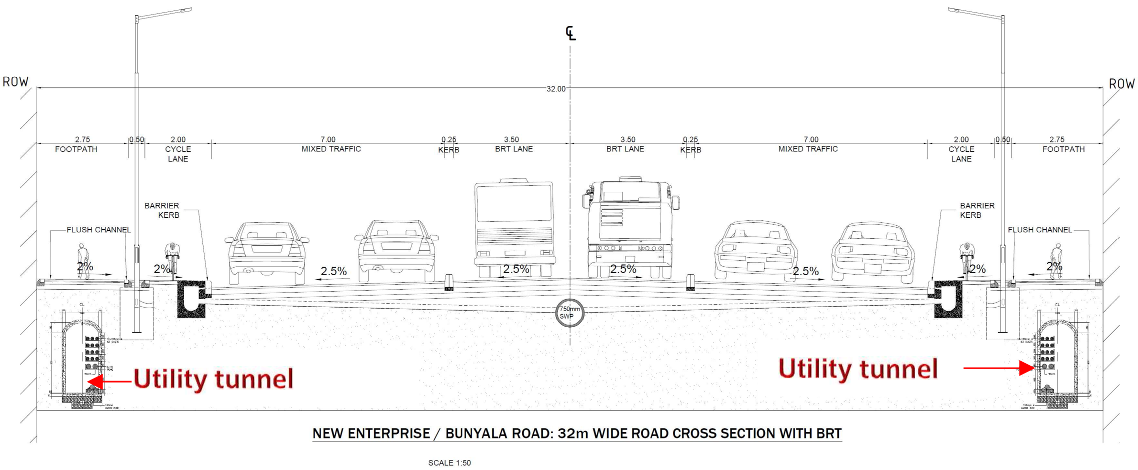


Figure 2-49: Road Cross Section Having Utility Tunnels on Both Sides

2.4.10 Preliminary Infrastructure Costs

Based on the final option proposals, the following preliminary costs have been arrived. These will be progressed further in the next stage of the study.

Table 2-25: Infrastructure costs

Item	Description	Cost (KShs)
1	General Earthworks	1,737,913,000
2	Roads and pavement	2,015,715,000
3	Railway infrastructure (Lowered tracks)	17,593,729,550
4	Water supply including underground water tank	3,912,327,095
5	Storm water pipelines	201,571,500
6	Sewerage	218,718,135
7	Main power supply infrastructure	1,596,250,000
8	Power and telecommunication ducting	377,000,000
9	Landscaping	264,800,000
	Total amount (Exclusive of taxes)	**27,918,024,280**

2.5 Strategic Environmental and Social Considerations

The following is the progress on the integration of strategic environmental and social issues within this phase of the planning process:

2.5.1 Densification of Land Uses

The proposed land use plan proposes densification of land use and a mixed land use approach as defined in NIUPLAN. The strategic recommendations provided in the SEA for NIUPLAN for the various components of the expansion of Nairobi CBD are as follows:

- Ensure that a phased expansion program be developed that is linked to the requisite public utilities' expansion;
- Ensure solid waste management strategies comply with and are aligned to the Solid Waste Master Plan developed for Nairobi County and integrated into NIUPLAN;
- Incorporate green cover within the land-use plans and promote green buildings to mitigate the risk of heat island effect in the expanded CBD;
- Compliance with the noise and excessive vibrations standards during the project level development phase of the components of the expanded CBD.

The Master Plan phase of the study is expected to propose the. The above consideration will inform the recommendations from the environmental and social assessment for the Railway City Master Plan.

At this stage however, the following has been realised in the proposed final option:

- Expansion of water supply, sewerage and storm water infrastructure;
- Incorporation of new roads connecting the north, south, east and western cores of the proposed Railway City. The proposed transport networks also incorporated multi-modal transportation systems to include bus rapid transit and commuter rail;
- Adoption of the proposed new power substation which in consideration of the existing sub-station in Muthurwa area, will be able to cater for the cumulative energy demand after realisation of the Railway City;
- Incorporation of underground power cables;
- Incorporation of green cover through the eco-green structure for the Railway City as well as design guidelines for street and residential area developments;
- Incorporation of a common duct for public utilities including telecommunication infrastructure;
- Collection and storage of storm water in an underground tank to be located within the new station. The storm water is to be re-used within the Railway City; and
- Promotion of green development at project level through incorporation of mechanisms to reduce over-reliance on the national grid and promote use of renewable energies.

The proposed plan provides for residential land uses through-out the railway city. Land uses that are considered to be unfriendly to residential uses are those that generate the following:

- Noise pollution;
- Air pollution;
- Security risks in the sense that they attract loiterers and idlers;
- Compatibility of uses requires a certain type of economic activities or businesses that would not interfere with the sense of place, safety and security of residential users, especially those with families, young children and the aged.

The proposed densification also has a constraint through the proximity of the Moi Airbase Flight path. By the time this report was going to print, the Kenya Civil Aviation Authority Ground Control Section had been provided with hard copy and digital versions of the maps outlining the proposed building heights and the proposed land uses to give their "no objection". This was with the full understanding by both the Consultant and KCAA that all subsequent developers would still be required to apply for development approvals from KCAA at project stage in compliance with the International Civil Aviation Authority requirements.

However, by the time this report was going to print, KCAA was yet to issue feedback on the specific question on the proposed building heights and land uses (See Appendix X). Deliberate efforts were made to communicate directly with the Authority and to request for one on one meetings in the immediate term to conclude on this item. Efforts will be made to follow up on the issue and provide the official response even as the client reviews this Report.
The following elements will be developed in the next phase:

- Integration of short-term and long-term strategies for solid waste management in consideration of the progress in implementation of the Nairobi Solid Waste Master Plan;
- Review of proposed phasing mechanisms for realisation of the railway city in view of the SEA recommendations.

2.5.2 Air Quality

Air quality in Nairobi is mainly impacted by anthropogenic activities in transport, energy and industrial sectors. The main pollutants for consideration for public health include particulate matter and nitrogen dioxide that have known to exacerbate asthma, bronchial symptoms, lung inflammation and reduced lung function through outdoor air pollution (Moorcroft and Barrowcliffe. Et al. 2017). Sulphur oxides, carbon monoxide and carbon dioxide are also critical indicators of air quality either due to their contribution as green-house gases or in depletion of the ozone layer.

Studies have also shown that there is a strong correlation between Particulate Matter (PM), Nitrogen Oxides (NOx) and motor vehicle density in Nairobi with vehicular emissions and mineral dust contributing most pollutants. Increasing number of cars in the city coupled with traffic snarl-up intensifies pollution problems.

Good practice requires that air quality be included as a prime consideration for long-term planning. Ideally, land use allocation should consider the levels of emissions vis a vis the sensitive receptors and the level of exposure to those receptors.

The areas within the Railway City that border Uhuru Highway and the industrial area are likely to experience point source pollution from traffic and industrial activities. Existing and proposed industrial activities are located in the southern area of the railway city and in the industrial area beyond while the predominant wind direction is downstream of this area.

Other risk areas include receptors downwind of major existing and proposed transport corridor intersections, as well as street level receptors in the proximity of industrial uses and transport corridors.

Strategies as presented in the Land Use Plan for the Railway City of relevance to management of air quality in land use planning are:

- Provision of public transport systems within the Railway City that have been linked to the existing CBD, the industrial area to the south and beyond through proposed BRT links in the Railway City, Haile Selassie, Uhuru Highway and Landhies Road;
- The proposed roads also provide alternative routes through the Central Railway Station thus dispersing traffic over a wider area with the aim of reducing congestion within the main corridors connecting to the CBD mainly, Uhuru Highway, Haile Selassie, Landhies Road, Tom Mboya Street and Moi Avenue;
- Increase of green cover within the railway city through the proposed eco-green corridor;
- Proposal of light industrial uses as a buffer between the current industrial area and the rest of the Railway City.

The SEA for NIUPLAN required the following items specific to management of air quality as a strategic environmental issue in the expansion of the Nairobi CBD:

- As much as is possible, influence the ratification of the Air Quality Regulations which were in draft form at the time;
- As far as is possible, influence the National Environment Management Authority (NEMA) to define air quality zones and air quality thresholds for various parts of the expanded CBD;

- Identification of strategic air quality sampling points around the city. The key partners identified for this strategic issue was the NCCG and NEMA.

Since then, the Air Quality Regulations were gazetted and were in effect by the time of the preparation of this report. The outstanding strategic consideration is therefore on the determination of the air quality zones, thresholds and sampling points of relevance to the expanded CBD and more specifically, the Railway City.

Key authorities for involvement in this issue are:

- Nairobi City County Government (NCCG);
- National Environment Management Authority (NEMA);
- Directorate of Metropolitan Planning, Investment and Environment;
- Kenya Industrial Research and Development Institute (KIRDI);
- Nairobi Metropolitan Area Transport Authority (NAMATA);
- Kenya Railways (KR);
- Kenya National Highways Authority (KeNHA);
- Kenya Urban Roads Authority (KURA);
- National Transport Safety Authority (NTSA).

Potential non-state actors include:

- United Nations Environment Program (UNEP);
- UN-Habitat;
- Town and County Planners Association of Kenya;
- Kenya Association of Manufacturers (KAM);
- Nairobi Central Business District Association (NCBDA);
- Kenya Alliance of Residence Associations (KARA);
- Mobilised groups of businesses, residents and bodaboda operators in Landimawe Estate;
- Muthurwa Residents Association;
- Matatu Owners Association;
- Association of Matatu Operators.

From an ecological perspective, the protected tree species that are already within the boundaries of the Railway City that should be promoted where feasible, to enhance the green cover are as follows:

Common name	Scientific name	IUCN Classification	WCMA Classification
Jacaranda	*randa mimosifolia*	erable	isted
Red stinkwood	*us africana*	erable	erable
Croton	*on megalocarpus*	ly threatened	isted

IUCN-International Union for Conservation of Nature
WCMA-Wildlife Conservation and Management Act (Kenya)

2.5.3 Road Safety

One of the key community health and safety issues in Nairobi's CBD is the risk of traffic accidents involving pedestrians and other road users who use non-motorised transport modes such as bicycles.

According to the National Transport Safety Authority about 65% of all accidents in Nairobi involve pedestrians. Nairobi also accounts for the highest number of pedestrian deaths in the country at 42%. (NTSA, 2017).

The reasons for these fatal accidents were identified as

- High speed traffic;
- Motorcycles operate in the midst of darkness with no right gear –reflective jackets hence not seen by fast flowing traffic;

- Pedestrians cross at the non-designated areas and easily get knocked by speeding vehicles;
- Drunken driving, drunken riding and drunken walking;
- Poor driving/riding habits & skills at night;
- Reduced visibility.

Use of motorcycle taxis as a public service vehicle locally known as *bodabodas* also presents additional road safety challenges. According to the Bodaboda Safety Association, challenges faced by riders include lack of driving licenses and road safety skills. The association also notes that many drivers lack knowledge on road safety which leads to the high rate of accidents.

The proposed Railway City has provided walkable green spaces for pedestrians and NMT through extension of the proposed NMT corridor from the current CBD into the Railway City. This raises the need for a paradigm shift in the behaviour of all road users within and around the Railway City.

To support realisation of the objectives of road safety, a civic education program will be integrated into the Railway City Master Plan to support the proposed land use guidelines and related interventions.

The SEA for NIUPLAN required the development of behaviour change communication strategies that were aligned with the proposed public transport systems.

2.5.4 Identification and Protection of Heritage Sites

The Railway City stakeholder engagement process and the land use guideline development process proposes the following:

The Nairobi Railway Station Building	Relocation to a new area adjacent to the Railway Headquarters
The Railway Headquarters	Conservation and change of use to a public anchor program
Nairobi Railway Museum	Relocation of exhibition material to the area next to the Railway Headquarters
Wakulima Market Stalls	Protection as historical structures and change of use to a public park with green cover
Easy Coach Building	Protection as a historical building without change of use
Kahawa House	Protection as a historical building without change of use
Sikh Temple at Landimawe	Protection as a historical building without change of use
Muthurwa Social Hall	Protection as a historical building without change of use

During the county level workshop on disclosure of the proposed final option, stakeholders also recommended that one of the houses in Landimawe be preserved in-situ as a monument to the history of railway housing in colonial Kenya. This recommendation has been taken into consideration and the modalities for delivery on this item will be presented in the Master Plan phase.

The SEA for NIUPLAN required collaboration with the National Museums of Kenya in identification of new heritage sites and development of modalities for their conservation. From consultations with NMK, they do not have any immediate plans for expansion of heritage sites within the Railway City.

However, NMK is represented as one of the key stakeholders in the thematic working groups for Railway City Planning and is therefore expected to contribute to the recommendations for the proposals on heritage sites or buildings within the Railway City.

2.5.5 Surface Water Quality

The proposed land-use plan will require reclamation of the riparian and enhancement of water quality and quantities within the tributary of the Ngong River that passes through the project site. The enhancement of the river aesthetics and conservation of its ecological value is of importance to the enhancement of the proposed MICE facility within the vicinity of the river channel.

For sustainable reclamation and enhancement of the tributary however, the reclamation program will have to extend to the Ngong river system upstream and downstream of the site. The invocation of the Nairobi River Basin Improvement Program, at the very least for the Ngong River System will therefore be a strategic consideration for the realisation of the proposals within the Railway City.

Key government actors for this component will be NEMA, NCCG, WRA, Athi Water Service Board (AWSB), Nairobi City Water and Sewerage Company (NCWSC) and KRC. Potential non-state actors are likely to include UNEP, UN-HABITAT, NCBDA. KAM and the Kenya Private Sector Alliance (KEPSA).

2.5.6 Impacts on Land Tenure

Proposed land uses will result in changes in land tenure and / or ownership of land as a result of the following:

Land acquisition for public right of way for roads;
Transfer of land public to private land to allow for investment by private parties within railway city;
Amalgamation of land parcels to accommodate the new design guidelines;
Transfer of public land among government agencies for public purpose use such as schools, health facilities, heritage sites and bus parks or for public right of way.

With the adoption of the final option into the Railway City Master Plan, the modalities to provide an enabling environment for management of the impacts arising from the above will be developed in collaboration with stakeholders' and the project social safeguards as well as the governance and institution experts.

2.5.7 Proposed Interventions arising from the Environmental and Social Assessment for Railway City

From the scoping study, the following additional interventions are proposed to enhance the SEA Requirements for NIUPLAN focussing on Railway City Interventions.

Aspect	Strategic Considerations for further study
Institutional Arrangements	Institutional arrangements that would facilitate implementation of a Sustainable, Integrated City for All as envisioned by various stakeholder groups
Ecosystem Services	Rehabilitation / restoration of polluted natural resources within the planning area
	Measures to enhance ecosystem services within and around the project areas
Zoning and Land Uses	Harmonisation of the above land uses with the proposed land uses within the planning area is critical for environmentally and socially sustainable land uses.
Green Spaces	Integration of green spaces in the planning area as well as specific measures to influence an increase of green spaces in the larger eastern area and the CBD.
Surface Water Resources	Determination of the causes of pollution as well as development of mechanisms / programs for clean-up of the river for the long term
Energy	Promotion of efficient and renewable energy use
Green spaces	Adequate green spaces for recreation, aesthetics and to act as carbon sinks
Food Supply	Provision of markets for fresh agricultural produce
Water Supply and Waste Water Management Infrastructure	Need for planners to develop solutions for increased water supply, storm water management, sewerage infrastructure / services to the Railway City and its surroundings.
Solid Waste	Mechanisms for Integrated solid waste management for railway city as required by NIUPLAN
Efficient water use	Application of appropriate technology for efficient use of scarce water resources, re-use of waste water and rain water harvesting
Education facilities	To avoid a strain on the existing primary school facilities therefore, provision of public primary schools is important to serve the low-income primary school level population that may be introduced in the planning area.
Child Safety	Considerations for safe spaces, related child safety / protection services and facilities as well as child friendly walkways for children who walk to school should also

	be integrated to promote child safety within the planning area.
Inclusive Planning	Integration of the needs of vulnerable groups including low income households, the urban poor, children as well as persons with disability in City Planning.
Economy and Informal Businesses	Measures for formalisation of informal business and integration of this group into mainstream economic activities in the proposed railway city
Housing	Provision of affordable housing for low income households and students
Physical cultural resources	Show case existing physical cultural resources and further enhance them with spaces and monuments that demonstrate the identity of Nairobi and unique aspects of Kenyan Culture, for the benefit of future generations and visitors from foreign countries.
Public Participation	Meaningful and responsive public participation for the Railway City Planning Process.

2.5.8 Additional Compliance with the SEA Approval for NIUPLAN

Other strategic issues in the SEA for NIUPLAN of relevance to Railway City for incorporation in the master plan phase are:

- Development of employment policies to encourage employment of the local youth, women and vulnerable groups as unskilled labour. The SEA also recommends application of "best efforts" to promote hiring of local labour for skilled opportunities so as to mitigate the risk of uncontrolled influx of immigrant workers;
- Establishment of programs for management of HIV/AIDS and STIs;
- Enhancement of community policing in new commercial and residential centres;
- Provision of low-income housing to mitigate the risk of mushrooming slums around the development areas. The demand for low cost housing is likely to arise due to the new income streams in the development areas for low income earners;
- Integration of short-term interventions to meet the gap that would arise prior to the finalisation of the proposed landfill and Material Recovery Centres for Nairobi County;
- Formulation of a City Transport Policy that encourages use of public transport over private vehicles;
- Prioritisation of use of public land for public transport infrastructure;
- Preparation of Resettlement Action Plans at project level where land acquisition is necessary;
- Liaison with National Land Commission (NLC) to fast track formulation and adoption of laws and regulations to guide land acquisition in line with the Constitution;
- Enforcement of policy requirements for management of riparian reserves. The key partners identified for this were the Water Resources Authority (Water Resources Management Authority at the time), NEMA and NCCG;
- Mechanisms for management of non-ionising radiation from base transceiver stations (BTS) and electrical infrastructure. The lead for this was identified as the Communications Authority of Kenya (Communications Commission of Kenya at the time);
- Mechanisms and interventions for management of visual impacts from the proposed structures within the built environment;
- Due to the promotions of mixed uses in NIUPLAN, integration of mechanisms for management of air quality and community health and safety risks within the areas fringing industrial land uses;
- Actively seeking the views of persons with special needs in the development of detailed phases on NIUPLAN