4.7 REFINEMENT OF THE PUBLIC TRANSPORT SCENARIOS

In the previous scenarios we tested various combinations of new feasible MRT, LRT, tramway and busway corridors in Greater Cairo. The results are summarized in this chapter in order to filter the best options for the core network, which in return will be subject to a refinement where the principal aim is to reduce the capital costs.

In addition to the rail lines, the resulting core network includes a premium public bus network in the main transportation corridors in Cairo, as well as an area franchising system for private public transport (mainly shared taxis). These corridors are not already served by the rail system. The bus thus functions as a complementary high capacity system to the rail.

4.7.1 Main Findings of the Initial Screening

Table 4.7.1 summarizes the main socioeconomic and demand performance indicators for each corridor line from scenarios 1 through 4. On this basis we can select the best options for the core network. The performance indicators are the socioeconomic ratio (SR), the peak load (PL) and the number of passenger per km of line (PK), which have been calculated by the project's GIS and CREATS models. For each line, the best of each performance indicator is indicated in bold.

Table 4.7.1 Main Performance Indicators of Each Scenario

	SCENARIO															
	1				2				3				4			
Line	Type	SR	PL	PK	Type	SR	PL	PK	Type	SR	PL	PK	Type	SR	PL	PK
1	MRT	0.18	74	55	MRT	0.18	61	58	MRT	0.18	**68**	**61**	MRT	0.18	63	58
2	MRT	0.17	63	84	MRT	**0.19**	54	73	MRT	0.17	**58**	**82**	MRT	0.17	52	69
3	MRT	0.23	59	70	MRT	0.23	**53**	63	MRT	**0.26**	32	**65**	MRT	0.23	49	61
C4					MRT	0.10	39	46	MRT	0.10	**68**	**61**	MRT	**0.25**	67	**61**
C5					LRT	0.11	**29**	**47**	Bus	**0.12**	21	23	Bus	**0.12**	15	21
C6					LRT	**0.29**	**23**	**43**	Bus	0.13	7	13				
C7					MRT	0.46	**22**	**6**	Train	0.15	4	2	Train	**0.56**	0.7	0.1
C7*									Train	0.34	0.7	0.1				
C8									BUS	0.09	**9**	**15**	Bus	0.10	7	7
C9													Tram	0.12	5	7

Source: JICA Study Team

Rail MS : modal share, SR : Socioeconomic ratio, PL : Peak Load (1,000), PK : Passengers / km (1,000)

As it can be seen from the table above, corridor line 4 (Pyramid line) obtains the best overall results in scenario 4, as the peak load and number of passengers/km are similar to scenario 3 but the socioeconomic ratio is the highest by far. In fact, corridor line 4 of scenario 4 combines in one single line the best sections of corridor lines 4 and 6 in the "do maximum" scenario. In this way the best of two lines is obtained for the cost of one.

Corridor line 5 - the Heliopolis line - both has a strong traffic and partly unused right-of-way, which make the introduction of a LRT system very interesting. In fact, there is a strong traffic flow from Nasr City and Heliopolis towards Shobra, which could fully load a LRT system with a capacity of 30,000 passengers/hour/direction.

Corridor line 7, also called "the wings" – the link to 6th of October and 10th of Ramadan via Cairo – is only worthwhile in the configuration of scenario 2, however only for a conventional train or busway as the traffic is not sufficient for a MRT.

A busway is proposed in corridor line 8, with the optimal alignment of scenario 3.

Finally a modern tramway system is proposed in corridor line 9. This system can benefit from the already existing CTA infrastructure in Nasr City (existing lines 32 and 36 to 10th region) in addition to being ideal for an extension to New Cairo, thus connecting the latter with a direct line to the city center.

(1) Description of the "Core Network"

• *The MRT/LRT/Tram/Busway network*

The network is as follows :

- Metro line 1 remains as described in the committed projects.
- Metro line 2 is extended to Qalyob.
- Metro line 3 is extended to Behoos station on line 2 as described in scenario 3 in order to increase the ridership and to create a more integrated network.
- A MRT is proposed in corridor line 4 (Pyramid line), running from Giza Pyramids via CBD (East) and ending in Port Said Street by the ring road. In this way, line 4 reaches additional densely populated area with low-income households.
- A LRT is proposed in corridor line 5 (Heliopolis line), running from Nasr city via Heliopolis and ending in Shobra.
- A conventional train is proposed in corridor line 7 (the Wings), running from 6th of October via Cairo station, parallel to line 1 until Ain Shams, and ending in 10th of Ramadan.
- A busway is proposed in corridor line 8, running from Abaseya via Hammamat El Kobba and ending in Shobra.
- A modern tram is proposed in corridor line 9, running from Nasr City via Abaseya and ending in CBD (East).

The proposed core network is summarized in Table 4.7.2 and Figure 4.7.1.

Table 4.7.2 Core Network in 2022

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	27 km	Qalyob	CBD area	Giza – Moneeb
3	MRT	34 km	Cairo airport	CBD-Mohandiseen	Imbaba (branch 1) Boolaq (branch 2)
C4 (Pyramid)	MRT	27 km	Giza Pyramids	CBD (East)	Port Said Street
C5 (Heliopolis)	LRT	22 km	Nasr City	Heliopolis	Shobra el Kheima
C7 (Wings)	Train	96 km	6th of October	Cairo station	10th of Ramadan
C8	Busway	17 km	Abaseya	Hammamat El Kobra	Shobra
C9	Tram	15 km	Nasr City	Abaseya	CBD (East)

Source: JICA Study Team

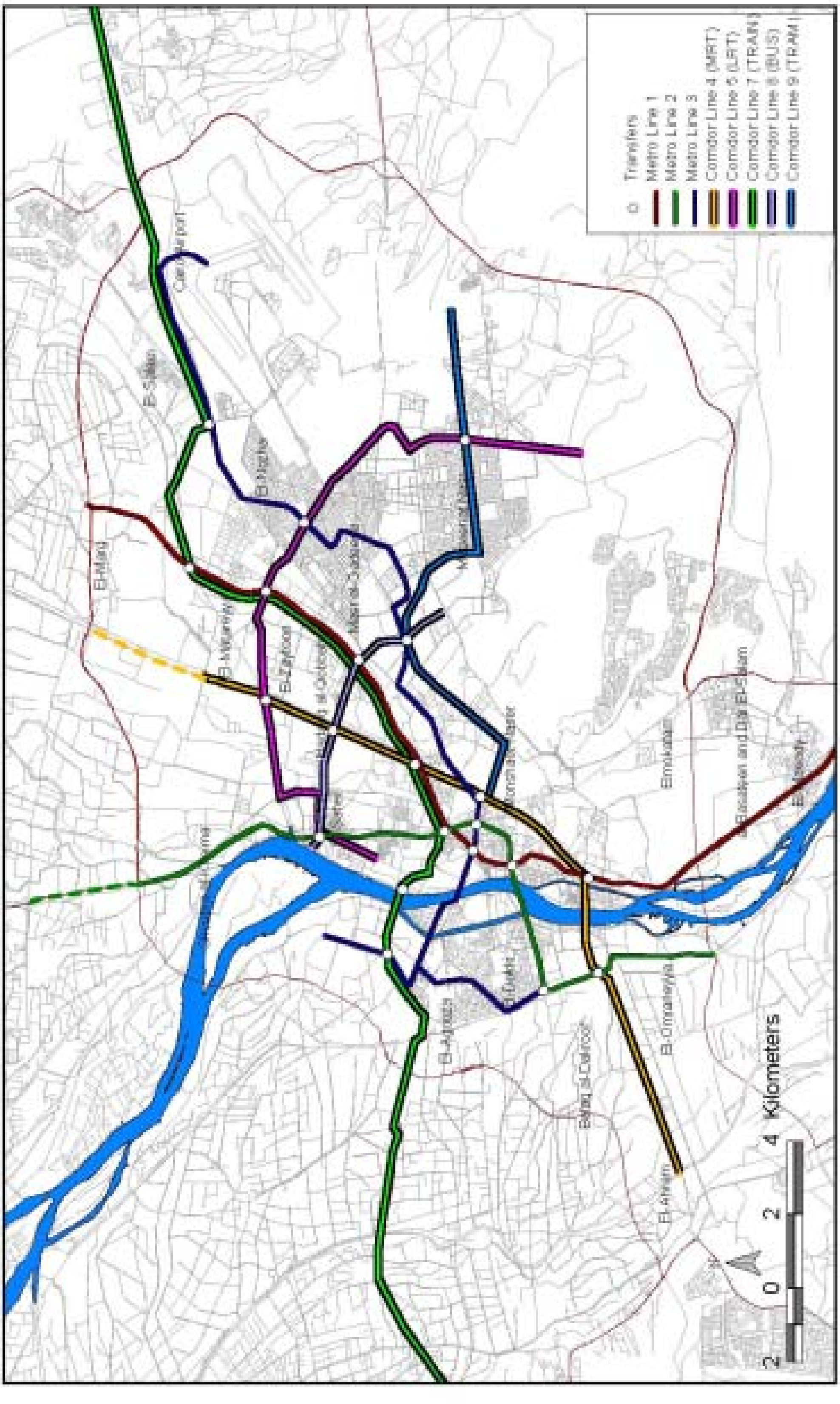


Figure 4.7.1 Core Network in 2022

• MRT/LRT/Tram/busway supply indicators

The network supply characteristics of the core network are shown in Table 4.7.3.

Table 4.7.3 Core Network Supply Indicators in 2022

Line	Mode	Terminals	Length	Headway (Peak period)	Average speed
1	MRT	• New El • Marg Helwan	44 km	2 min	34 km/h
2	MRT	• Qalyob • Giza – Moneeb	27 km	2 min	38 km/h
3	MRT	• Ain Shams 1 • Imbaba (branch 1) • Behoos (branch 2)	34 km	2 min	38 km/h
C4 (Pyramid)	MRT	• Port Said Street • Giza Pyramids	27 km	2 min	38 km/h
C5 (Heliopolis)	LRT	• Nasr City • Shobra el Kheima	22 km	2 min	30 km/h
C7 (Wings)	Express Train	• 6th of October • 10th of Ramadan	96 km	10 min	80 km/h
C8	Busway	• Nasr City • Shobra	17 km	10 min	20 km/h
C9	Tram	• Nasr City • CBD (East)	15 km	4 min	22 km/h
TOTAL			**282 km**	**4.3 min**	**38 km/h**

Source: JICA Study Team

• The tramway network

The tramway network in this scenario is identical to the one in scenario 2.

• The ENR suburban network

As in the previous scenarios we take into account the rehabilitation of the existing suburban lines with a decrease of the headway to 10 minutes. Corridor line 7 is included in the system (Table 4.7.4).

Table 4.7.4 Core Network, Suburban Rail Network Description in 2022

Line number	Length (km)	Starting at	Ending at
R1	14.0	Cairo	Qalyob (to Alexandria)
R2	23.5	Cairo	Qalyob / Qanater El Khayreya
R3	32.0	Cairo	Qalyob / Shebeen El Qanater
R4	20.0	El Marg	Shebeen El Qanater
Corridor line 7 (Wings)	96.0	6th of October	10th of Ramadan
R6	20.0	Cairo	Imbaba / El Manashi
R7	37.0	Cairo	El Maraziek
Total	**242.5**		

Source: JICA Study Team

- *ENR supply indicators*

The suburban rail network supply characteristics of the refined scenario are shown in Table 4.7.5.

Table 4.7.5 : Core network, Suburban Rail Supply Indicators in 2022

Line	Line Name (origin, intermediate, destination)	Length (km)	Average speed (km/h)	Peak hour headways (min)
R1	Cairo / Qalyob (to Alexandria)	14.0	40	10
R2	Cairo / Qalyob / Qanater El Khayreya	23.5	40	10
R3	Cairo / Qalyob / Shebeen El Qanater	32.0	40	10
R4	El Marg / Shebeen El Qanater	20.0	40	10
C7	6th of October / 10th of Ramadan	96.0	80	10
R6	Cairo / Imbaba / El Manashi	20.0	40	10
R7	Cairo / El Maraziek	37.0	40	10
	Totals and Averages	**242.5**	**50**	**10**

Source: JICA Study Team

(2) Population, Employment and Student Densities

Table 4.7.6 summarizes the number of inhabitants, jobs and student students served within a distance of 800 meters from the network lines.

Table 4.7.6 Core network, Socio-economic Performance of Each Line in 2022

Mode	Population	Employed	Students	Total Ratio (*)
1	1 073 525	475 617	362 667	0.18
2	1 021 347	566 672	358 488	0.19
3	1 130 199	729 072	402 710	0.23
C4	1 447 209	484 984	420 532	0.21
C5	802 906	232 508	210 608	0.11
C7	2 155 915	773 200	473 338	0.46
C8	467 076	163 557	185 820	0.08
C9	373 459	379 952	262 608	0.12
Total network	**8 004 560**	**3 642 005**	**2 490 951**	
TOTAL study area	**20 721 175**	**6 966 250**	**5 771 269**	

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

The socioeconomic performance is similar to the one of scenario 4, which was the best of all the scenarios. However, corridor line 4 has a lower ratio in this scenario as it ends in Port Said Street instead of Ain Shams 1 and is shorter. This is also the case for corridor line 7 (the "wings" line) (Figure 4.7.2, 4.7.3 and 4.7.4).

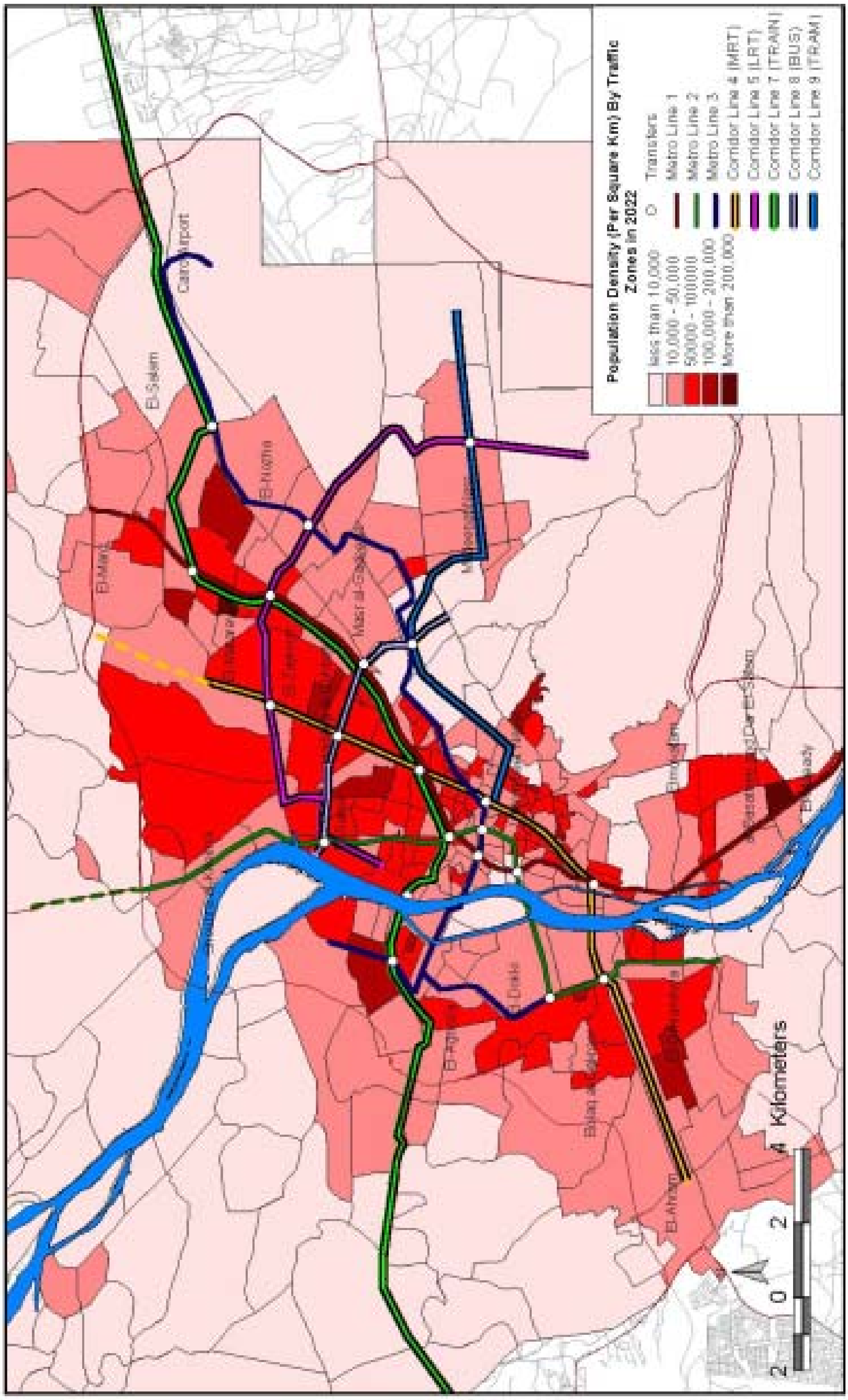


Figure 4.7.2 Core Rail Network and Population Densities

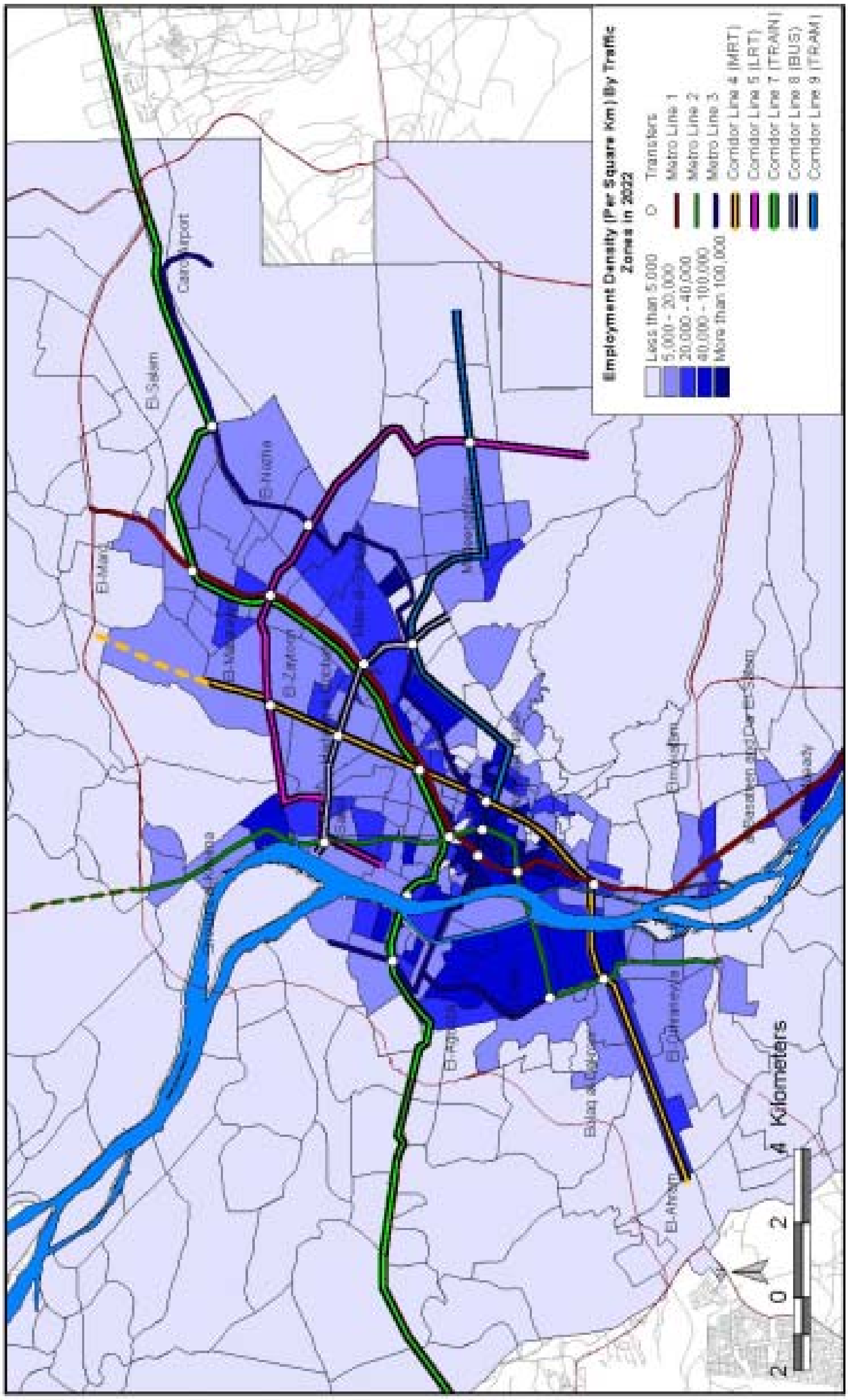


Figure 4.7.3 Core Rail Network and Employment Densities

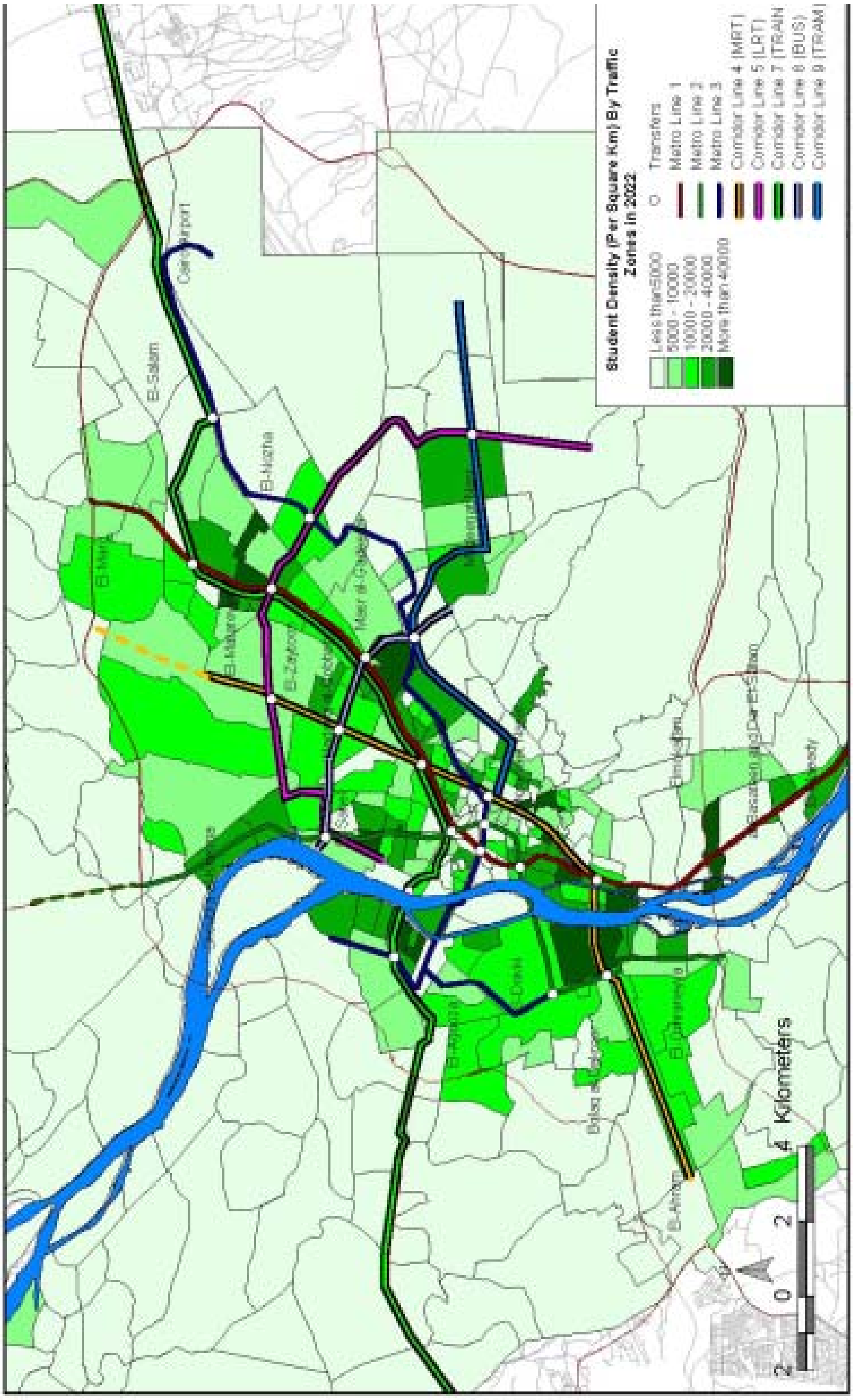


Figure 4.7.4 Core Rail Network and Student Densities

(3) Transport Demand

The results of the demand simulation for the core network are shown in Table 4.7.7.

Table 4.7.7 Core Network Demand Simulations in 2022

Mode	Average daily passengers (million)				
	2001	Modal Split (%)	2022	Modal Split (%)	% Increase
Formal PRT (*)	4.299	32.3	3.861	18.7	-10
Informal PRT (**)	6.696	50.2	4.573	22.2	-32
TOTAL PRT	**10.995**	**82.5**	**8.434**	**40.9**	**-23**
MRT/LRT	**2.021**	**15.2**	**9.999**	**48.6**	**395**
ENR	**0.132**	**1.0**	**1.409**	**6.8**	**967**
TOTAL TRAM	**0.171**	**1.3**	**0.755**	**3.7**	**342**
Ferry	0.010	0.1	0.002	0.1	-80
TOTAL	**13.329**	**100.0**	**20.599**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT : Public Road Transport.

- The core network improves all the tendencies observed in scenario 4. The formal bus network (CTA) ridership decreases less than the shared taxi. The total decrease is however stronger than before, to the advantage of the rail network in general.
- The total modal split for rail transport is 59.1% in this scenario, which is the highest ranking yet. The reason for this positive evolution is that the shared taxis and formal CTA bus networks have been rationalized so as to be complementary to and not in direct competition with the rail lines.
- The positive effect of the premium bus network can also be seen from the high loadings of each line.

The trip volume forecasts for the core network are shown in Table 4.7.8. Please note that the busway in corridor line C8 is not included in the table as the core network is evaluated separately from the underlying premium bus network.

Table 4.7.8 Core Network Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Max loaded section	Section one-way traffic
1	2.921	28.369	67.9	Helmeat El Zatoun	565,000
2	1.957	12.739	78.3	Mubarak	464,000
3	2.182	15.020	72.7	Mohandiseen	286,000
C4 (Pyramids)	1.675	10.587	83.7	Al Saiada Zienab	390,000
C5 (Heliopolis)	1.264	6.830	63.2	Ain Shams	355,000
C7 (Wings)	0.881	17.340	9.8	6th October	199,000
C9 (Tram)	0.463	4.211	30.8	Nasr City	195,830

All the lines obtain the highest riderships and loadings in this scenario thanks to the rationalization of the bus and shared taxi networks.

The Pyramids line obtains the highest loading per km of line and is the most cost efficient line.

(4) Low Income Areas

As it were the case in the previous scenarios, the low-income areas are fully served by the various corridors with the exception of the areas in El-Mokkatam and Dar El-Salam. This remaining area can however be served by a busway which provides the same fare advantage as a MRT system and in the same time is more appropriate in terms of demand on this section.

(5) Interfaces

The interfaces on the core network are summarized in Table 4.7.9. Due to the shortening of lines and cutting of extensions, the core network has fewer interfaces than scenarios 3 and 4.

(6) Physical Constraints

Again, all of the proposed corridor lines follow the main road corridors in Cairo with the least interference with underground facilities and buildings. Furthermore on various sections they employ already existing tracks or right-of-ways.

Table 4.7.9 Interfaces of the Core Network in 2022

Line	Number of connections by line (1)	Total
1	2 x M2, 1 x M3, 2 x C4, 1 x C5, 4 x C7, 1 x C8	11
2	2 x M1, 1 x M3, 1 x C4, 1 x C5, 1 x C7, 1 x C8	7
3	1 x M1, 1 x M2, 2 x C4, 1 x C5, 2 x C7, 1 x C8, 2 x C9	10
C4	2 x M1, 1 x M2, 2 x M3, 1 x C5, 1 x C7, 1 x C8, 1 x C9	9
C5	1 x M1, 1 x M2, 1 x M3, 1 x C4, 1 x C7, 1 x C8, 1 x C9	7
C7	4 x M1, 1 x M2, 2 x M3, 1 x C4, 1 x C5, 1 x C8	10
C8	1 x M1, 1 x M2, 1 x M3, 1 x C4, 1 x C5, 1 x C7, 1 x C9	7
C9	2 x M3, 1 x C4, 1 x C5, 1 x C8	5
TOTAL		**66**

(1) For example, Corridor Line 9 has one connection (joint station) point each with Corridor Lines 4, 5 and 8, as well as two connection points with Metro Line 3. The total number of connecting points with rail systems is five. Refer Figure 4.7.1 for line depiction.

Source: JICA Study Team

4.7.2 The Optimized Core Scenario

The finishing touches are put to the core scenario by comparing its main performance indicators with those of the "committed" and "do maximum" networks. In the following section we will focus on the rail lines.

(7) Description of the "Optimized Core Network"

• The MRT/LRT network

In order to reduce costs, the following optimization measures of the core network are proposed :

- The performance of corridor line 4 has been improved throughout the scenarios and its best version in terms of ridership, load and socioeconomics is obtained in the core scenario : a MRT running from the Pyramids to the CBD and ending by the Ring Road on Port Said Street.

- As the line 5 follows the same corridor alignment in scenario 2 and the core scenario, the results for this line are almost the same for the two scenarios. However, the section of corridor line 5 running from Port Said Street to Shobra is curtailed in order to reduce costs. This section is less interesting due to the relatively low density of population and jobs. Furthermore, this line is proposed to operate as a "super-tram", as described in the last point below.

- As the traffic in corridor line 7 connecting 6th of October and 10th of Ramadan to Cairo was not sufficient for the MRT system which was tested in scenario 2, the core network includes a conventional ENR train instead with lower capacity. For this reason the ridership is less. In the optimized core network, corridor line 7 will connect to Cairo station and Ain Shams instead of running parallel to MRT line 1. In this way the required infrastructure costs will be reduced considerably.

- In due consideration of the important ridership projected on Corridor line 9, the value of the existing tram infrastructure of the Heliopolis network, and the plans of CTA to extend the tram network to New Cairo, additional tram lines are elaborated in the optimized core scenario. These trams are called "super-trams" as they are planned to operate in entirely segregated tracks as LRT systems in order to have sufficient low headways and high speeds to meet the important demand in the main corridors. They should however use low cost rolling stock resembling that of conventional tram systems. The proposed lines are as follows :

  - ST 1 : existing Line 4 of Heliopolis Metro (Madinat Nasr – Roxi – Ramses Square) extended to New Cairo. ST 1 is thus a new alignment of corridor line 9.

  - ST 2 : Sheraton – Al Nozha – Al Uruba – Salem Salim – Attaba station.

  - ST 3 : Corridor line 5 (Nasr City – Heliopolis – Port Said Street).

The optimized core network is summarized in Table 4.7.10 and shown in Figure 4.7.5.

Table 4.7.10 Optimized Core Rail Network in 2022

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	27 km	Qalyob	CBD area	Giza – Moneeb
3	MRT	34 km	Cairo airport	CBD-Mohandiseen	Imbaba (branch 1) Behoos (branch 2)
C4 (Pyramid)	MRT	27 km	Giza Pyramids	CBD (East)	Port Said Street / Ring Road
C5 (ST 3)	Super-Tram	16 km	Nasr City	Heliopolis	Port Said Street
C7 (Wings)	Train	86 km	6th of October	Cairo station Ain Shams	10th of Ramadan
ST 1	Super-Tram	22 km	New Cairo	Nasr City, Roxi	Ramses Square
ST 2	Super-Tram	15 km	Sheraton	Al Nozha	Attaba Station

Source: JICA Study Team

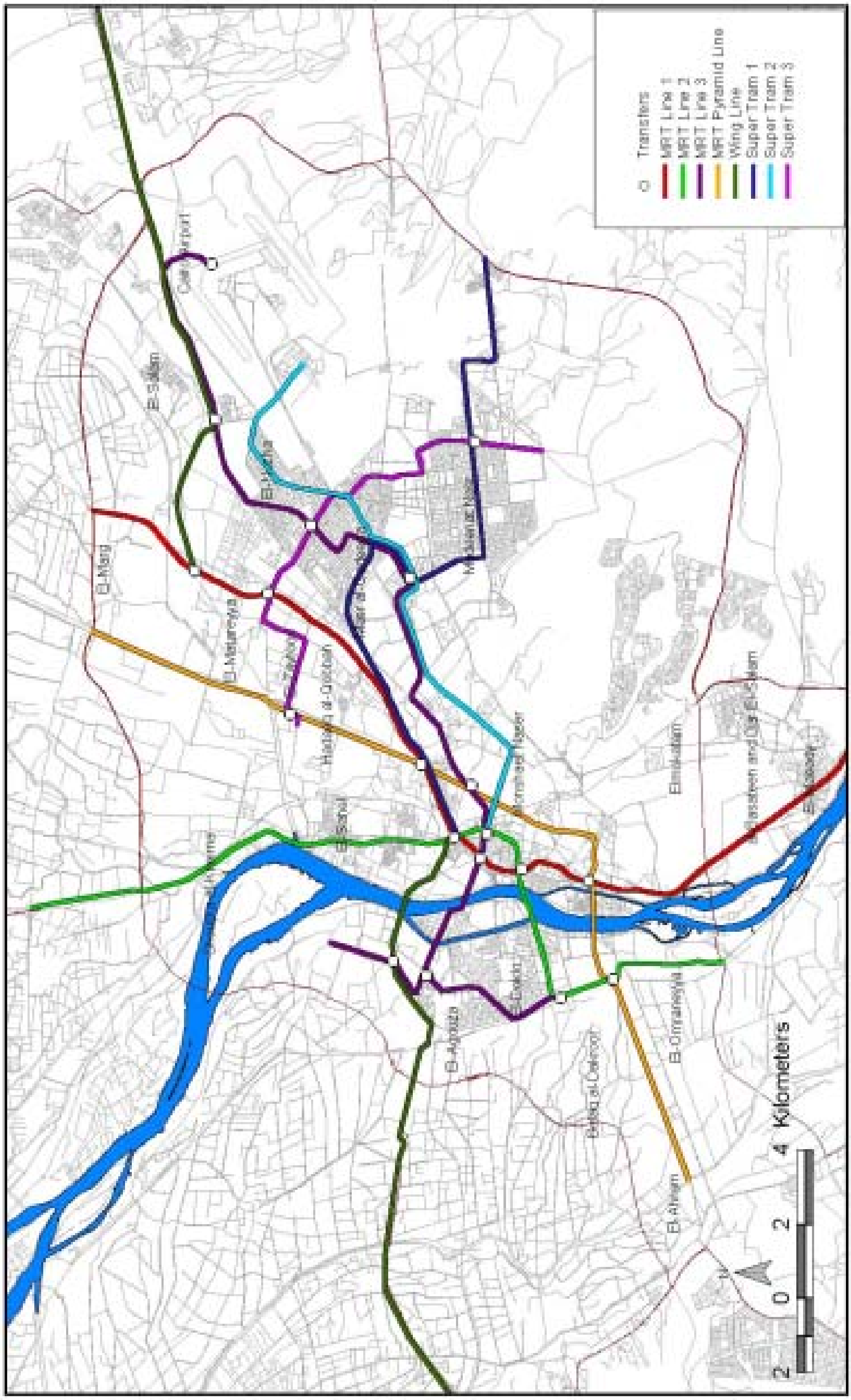


Figure 4.7.5 Optimized Core Network in 2022

• *MRT/LRT/Tram supply indicators*

The network supply characteristics of the optimized core scenario are shown in Table 4.7.11.

Table 4.7.11 Optimized Core Rail Network Supply Indicators in 2022

Line	Mode	Terminals	Length	Headway (Peak period)	Average speed
1	MRT	• New El Marg • Helwan	44 km	2 min	34 km/h
2	MRT	• Qalyob • Giza – Moneeb	27 km	2 min	38 km/h
3	MRT	• Ain Shams 1 • Imbaba (branch 1) • Behoos (branch 2)	34 km	2 min	38 km/h
C4 (Pyramid)	MRT	• Port Said Street • Giza Pyramids	27 km	2 min	38 km/h
C5 (ST 3)	Super-Tram	• Nasr City • Port Said	16 km	4 min	25 km/h
C7 (Wings)	Express Train	• 6th of October / Cairo Station • 10th of Ramadan / Ain Shams	40 km 46 km	10 min	80 km/h
ST 1	Super-Tram	• New Cairo • Ramses Square	22 km	4 min	25 km/h
ST 2	Super-Tram	• Sheraton • Attaba	15 km	4 min	25 km/h
TOTALS and AVERAGES			**271 km**	**3.8 min**	**32 km/h**

Source: JICA Study Team

• *The tramway network*

The 3 super-tram lines will require an important upgrading of the existing tram infrastructure in Heliopolis so as to achieve a complete right-of-way. The remaining infrastructure of lines T5 and T6 should be rehabilitated in order to improve speeds and to provide a more comfortable service.

• *The ENR suburban network*

As in the previous scenarios we take into account the rehabilitation of the existing suburban lines with a decrease of the headway to 10 minutes. Corridor line 7 (Wings line) is added instead of line 8 (Table 4.7.12).

Table 4.7.12 Optimized Core Rail Network, Suburban Rail Network Description

Line number	Length (km)	Starting at	Ending at
R1	14.0	Cairo	Qalyob (to Alexandria)
R2	23.5	Cairo	Qalyob / Qanater El Khayreya
R3	32.0	Cairo	Qalyob / Shebeen El Qanater
R4	20.0	El Marg	Shebeen El Qanater
C7 (Wings line)	40.0 46.0	6th of October 10th of Ramadan	Cairo Station Ain Shams
R6	20.0	Cairo	Imbaba / El Manashi
R7	37.0	Cairo	El Maraziek
Total	**232.5**		

Source: JICA Study Team

• *ENR supply indicators*

The suburban rail network supply characteristics of the refined scenario are given in Table 4.7.13.

Table 4.7.13 Optimized Core Rail Network, Suburban Rail Supply Indicators

Line	Line Name (origin, intermediate, destination)	Length (km)	Average speed (km/h)	Peak hour headways (min)
R1	Cairo / Qalyob (to Alexandria)	14.0	40	10
R2	Cairo / Qalyob / Qanater El Khayreya	23.5	40	10
R3	Cairo / Qalyob / Shebeen El Qanater	32.0	40	10
R4	El Marg / Shebeen El Qanater	20.0	40	10
C7	6th of October/Cairo St. 10th of Ramadan/Ain Shams	40.0 46.0	80	10
R6	Cairo / Imbaba / El Manashi	20.0	40	10
R7	Cairo / El Maraziek	37.0	40	10
	Totals and Averages	**232.5**	**46**	**10**

Source: JICA Study Team

(8) Population, Employment, Student Densities and Low Income Areas

As in the previous chapters, Table 4.7.14 summarizes the number of inhabitants, jobs and student students served within a distance of 800 meters from the network lines.

Table 4.7.14 Optimized Core Network, Socio-economic Performance in 2022

Line	Population	Employed	Students	Total Ratio (*)	Households (Inc < 300 LE)
1	1 073 525	536 640	362 667	0.19	25 385
2	982 845	637 994	355 254	0.20	26 677
3	1 155 934	873 762	502 711	0.27	22 751
C4 (Pyramid)	1 467 159	507 198	419 988	0.22	40 001
C5 (ST 3)	353 823	168 111	108 741	0.06	7 354
C7 (Wings)	2 155 915	773 200	473 338	0.30	49 810
ST 1	375 775	221 332	166 979	0.08	5 516
ST 2	272 041	378 583	168 104	0.10	5 953
Total network	**7 837 018**	**4 096 821**	**2 557 781**	**1.41**	**183 446**
TOTAL study area	**20 721 175**	**6 966 250**	**5 771 269**		**582 954**

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.

The optimized core scenario obtains the best overall results from a socioeconomic perspective, considering number of served population, jobs and students. The total ratio is higher than in any other scenario although corridor lines 5 and 7 have been shortened. The shortening of these lines is compensated by the introduction of super-trams 1, 2 and 3 (Figures 4.7.6 through 4.7.9).

In terms of number of poor households that are served, the optimized core scenario is better than the committed scenario and the "do maximum" scenario, but does less well than the core scenario. This is due to the curtailment of corridor lines 5 and 7, where the loss in the number of served poor households is not sufficiently compensated by the super-tram lines which above all serve wealthy areas of Cairo.

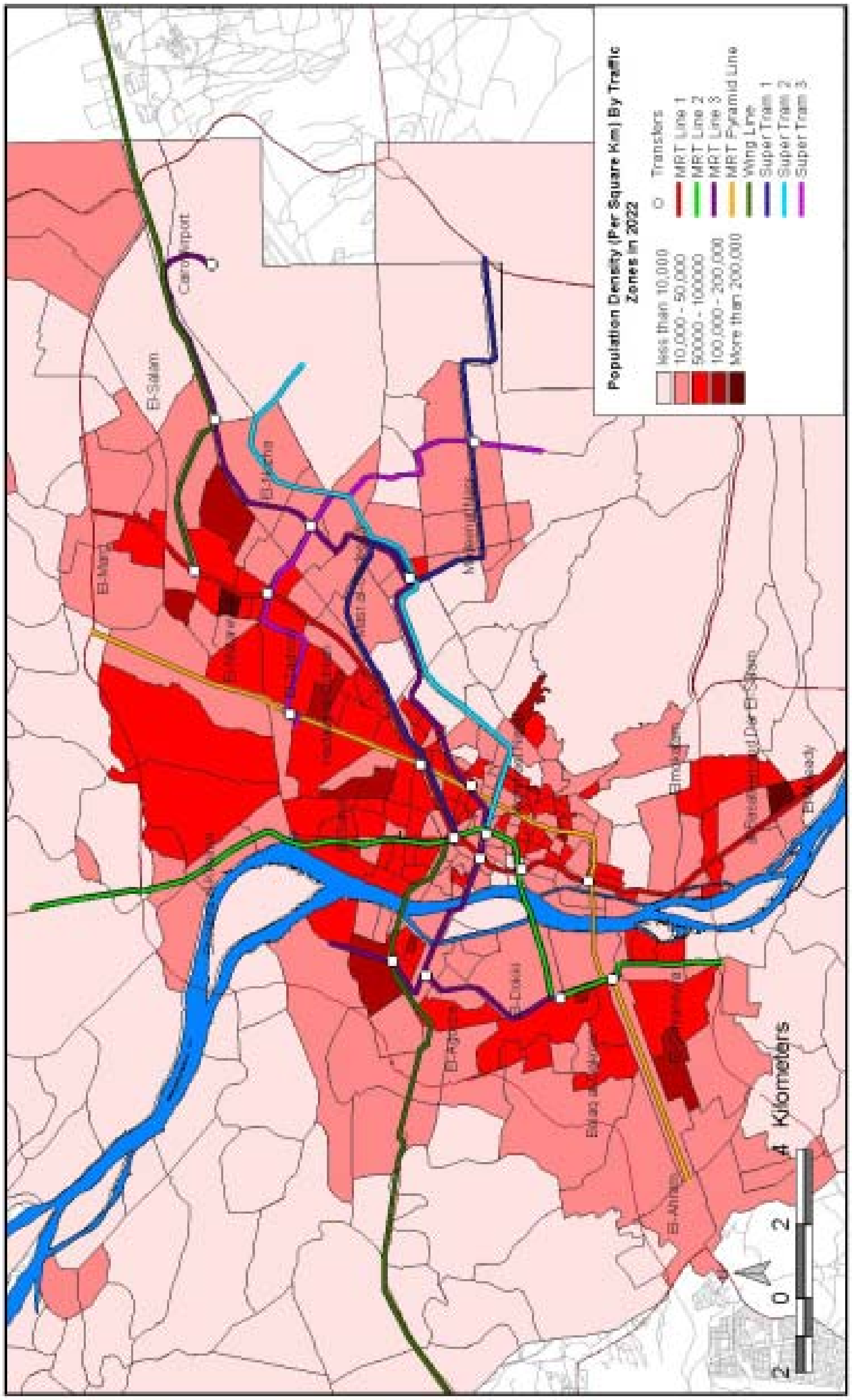


Figure 4.7.6 Optimized Core Rail Network and Population Densities in 2022

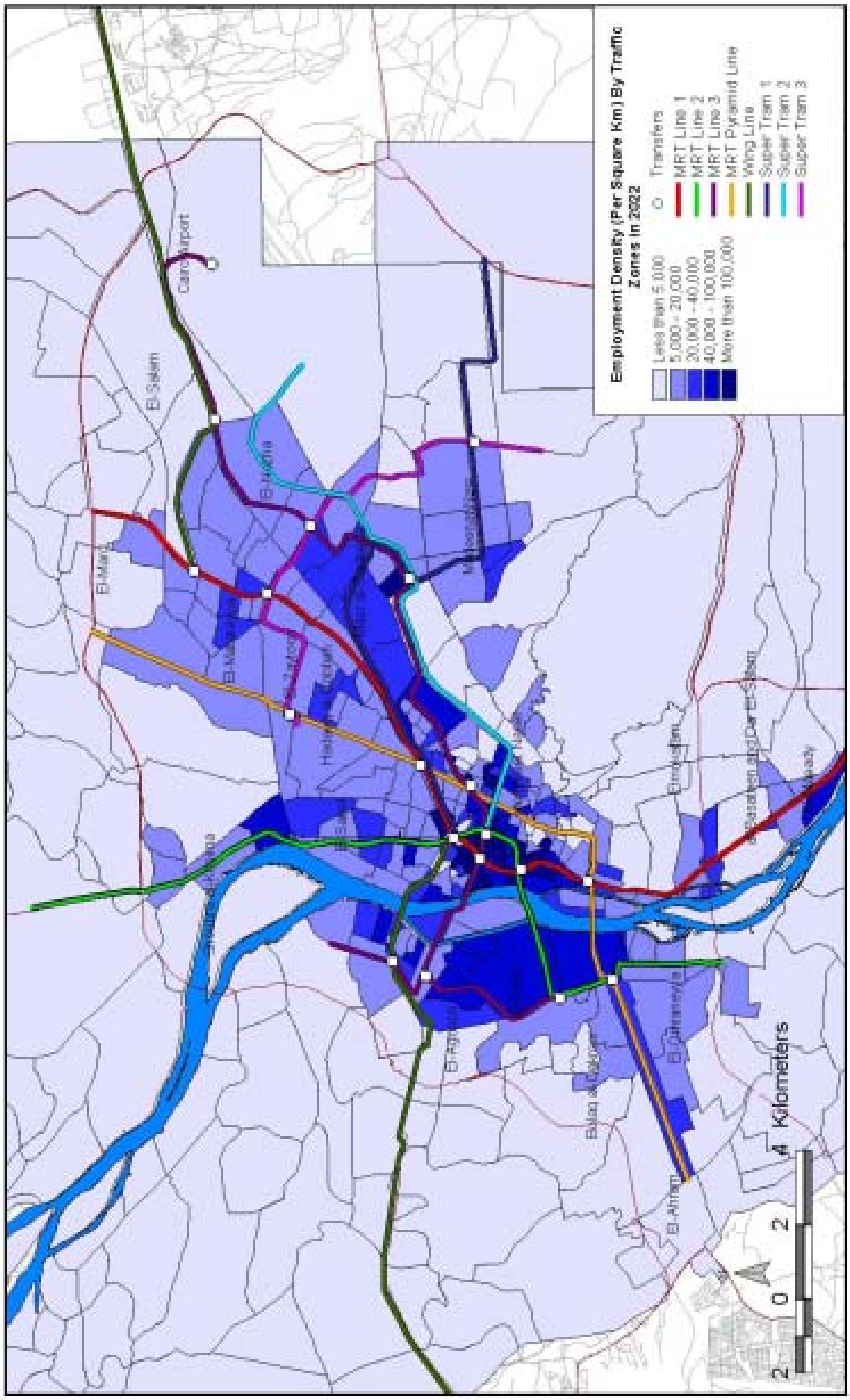


Figure 4.7.7 Optimized Core Rail Network and Employment Densities in 2022

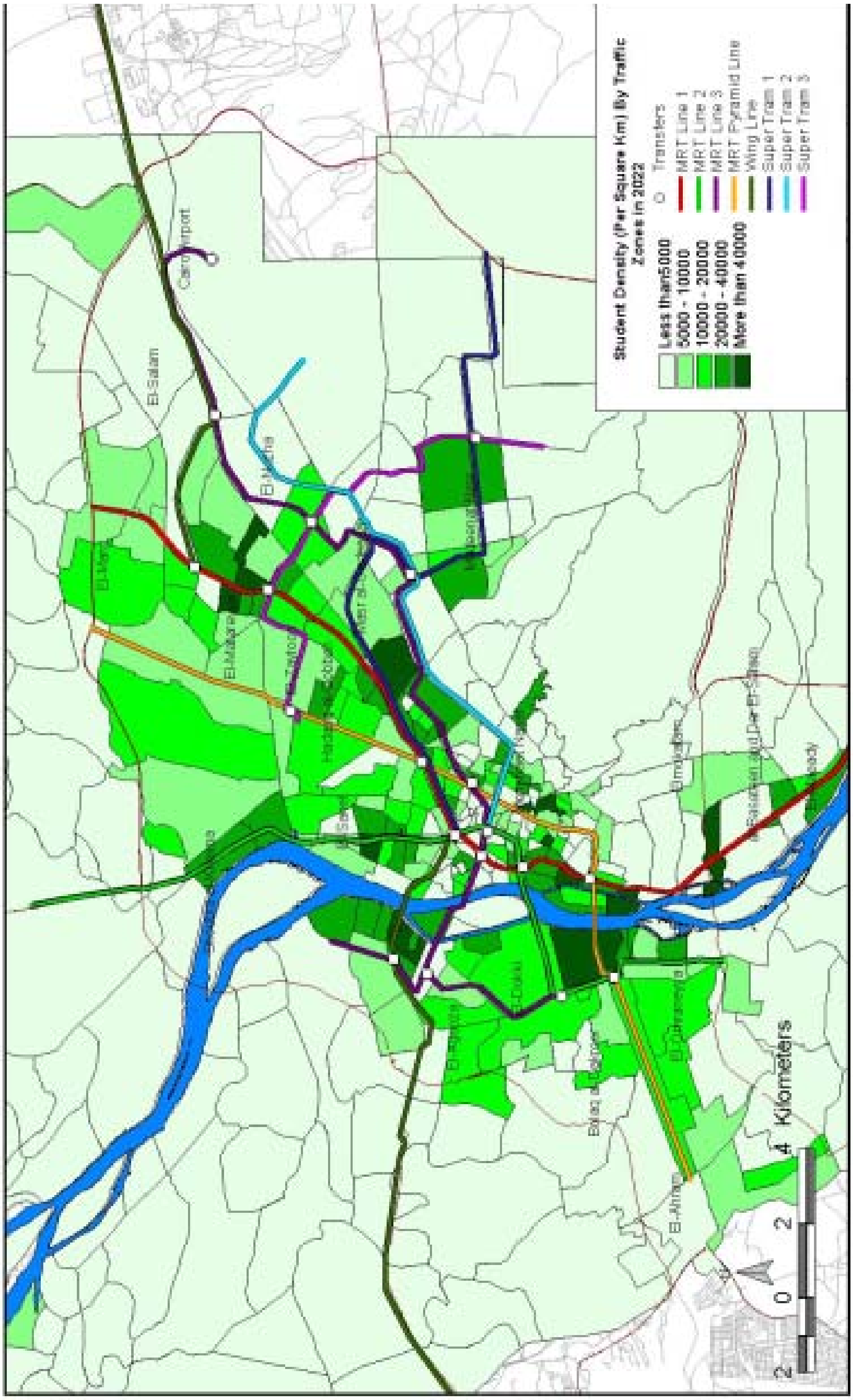


Figure 4.7.8 Optimized Core Rail Network and Student Densities in 2022

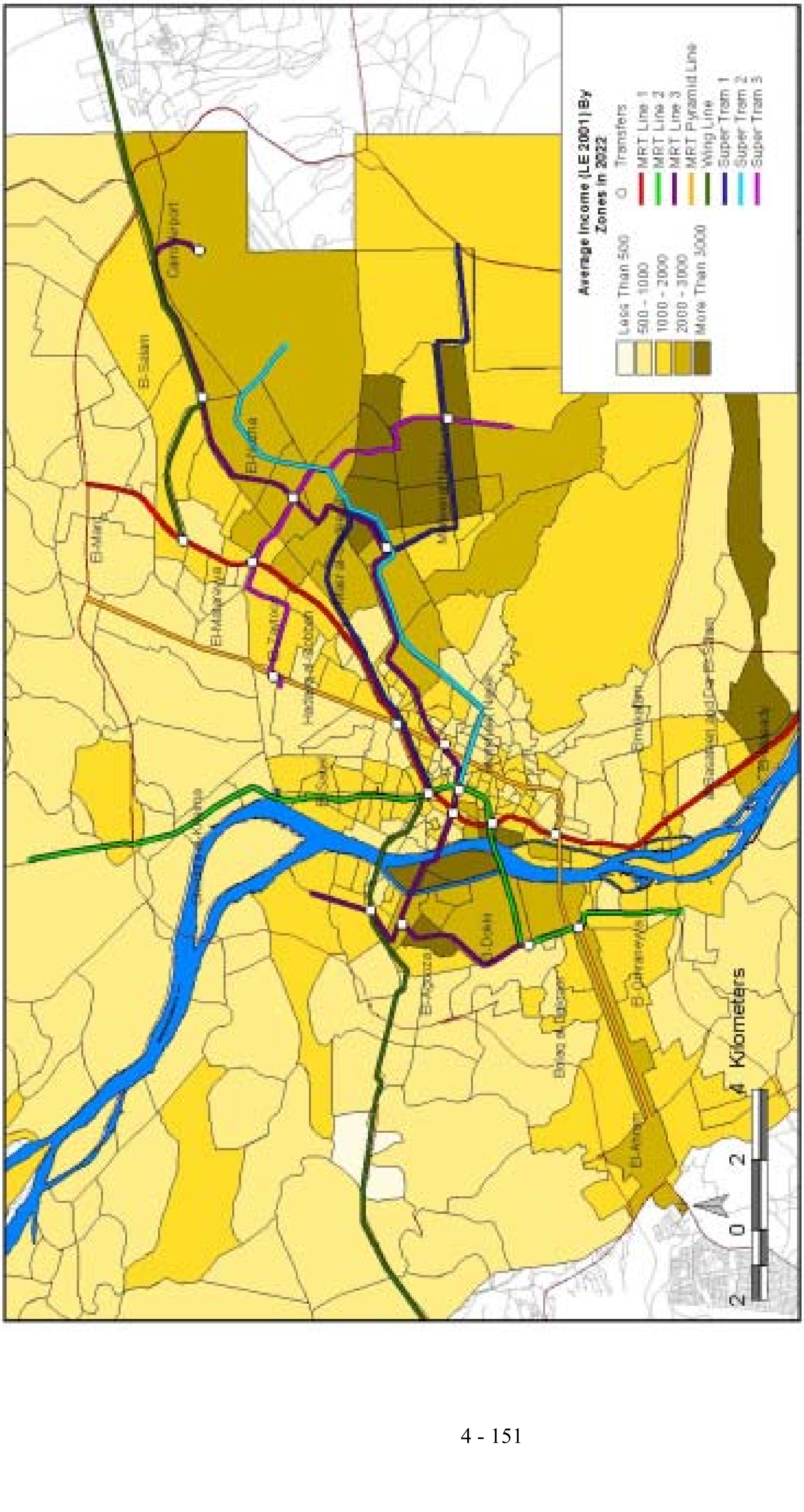


Figure 4.7.9 Optimized Core Rail Network and Low-income Areas in 2022

(9) Transport Demand

The results of the demand simulation for the optimized core network is shown in Table 4.7.15.

Table 4.7.15 Optimized Core Network Demand Simulations in 2022

Mode	Average daily passengers (million)				
	2001	Modal Split (%)	2022	Modal Split (%)	% Increase
Formal PRT (*)	4.299	32.3	4.791	23.8	11
Informal PRT (**)	6.696	50.2	4.275	21.2	-36
TOTAL PRT	**10.995**	**82.5**	**9.066**	**45.0**	**-18**
MRT	**2.021**	**15.2**	**8.599**	**42.6**	**325**
ENR	**0.132**	**1.0**	**1.703**	**8.4**	**1190**
TOTAL TRAM	**0.171**	**1.3**	**0.798**	**4.0**	**367**
Ferry	0.01	0.1	0.001	0.0	-87
TOTAL	**13.329**	**100.0**	**20.167**	**100.0**	

(*) CTA and GCBC (**) Shared taxis and private mini buses. PRT : Public Road Transport.

- In the optimized core scenario, the informal public road transport consisting of shared taxis and minibuses obtains its lowest ridership and market share of all the scenarios. The market share of the total rail is 55% compared to 61.8% in the "do maximum scenario", 59% in the core scenario, and 44% in the committed scenario.[1]
- The tram network obtains the highest ridership and market share in the optimized core scenario with 798,000 daily passengers and 4% respectively.
- The ENR network obtains the same important increase in its market share as in the "do maximum" scenario.

These positive results show the importance of creating an integrated public transport network consisting of high capacity rail, tram and bus lines that are complementary and have many interfaces.

[1] NB : For the sake of comparison , the "committed" and "do maximum" networks have been tested with the premium bus network and therefore have different riderships than described in chapters 4.6.3-4.

The trip volume forecasts for the core rail network are shown in Table 4.7.16.

Table 4.7.16 Optimized Core Network Daily Trips Demand in 2022

Line	Boarding Pass(million)	Pass-km (million)	Pass/km (1,000)	Max loaded section	Section one-way traffic
1	2.900	29.388	65.9	Mubarak	575,000
2	2.085	13.606	77.2	Mubarak	509,000
3	2.365	15.205	69.6	Al Mohandiseen	472,000
C4 (Pyramid)	1.725	10.884	63.9	Al Sudan St.	354,000
C5 (ST3)	0.540	3.043	33.8	Al Matareya	96,000
C7 (Wing - 6th of October)	0.492	10.274	12.3	6th of October	205,000
C7 (Wing – 10th of Ramadan)	0.434	6.852	9.4	Madenait El Salam	183,000
ST 1	0.630	6.451	28.7	Mostafa El Nahas St.	214,000
ST 2	0.225	1.268	15.0	Al Azhar	40,000

Source: JICA Study Team

- Thanks to the extension of lines 2, 3 and 4, and the creation of additional interfaces, the optimized core rail network obtains higher riderships and loads on these lines compared to the core scenario.
- In this scenario we compare the performance of the express train on its East and West section, i.e. 6th of October – Cairo Station and Ain Shams – 10th of Ramadan respectively. As it can be seen both sections perform well for this type of service, with loads that are both higher than for the entire line in the core scenario.
- Super-trams 1 and 3 obtain very high riderships, almost the same level as observed on MRT lines 1 and 2 currently. As super-tram 1 is a radial line, the loadings related to commuting accumulate as it the line approaches the center where it obtains a very high peak load. The tendency is the opposite on ST 3 which is a circumferential line.
- Super-tram 2 obtains lower loadings as it runs parallel to metro line 3 on long sections. It is however sufficient for this type of system but with smaller rolling stock than ST 1 and ST 2.

(10) Interfaces

The interfaces on the optimized core network are summarized in Table 4.7.17. Due to the division of the express rail line C7 into two sections and the curtailment of its urban section between Cairo Station and Ain Shams, there are less interfaces than in the core scenario. However, this scenario has 12 more interfaces than the "do maximum" scenario due to the introduction of the super-tram lines.

Table 4.7.17 Interfaces of the Optimized Core Network

Line	Number of connections x line	Total
1	2 x M2, 1 x M3, 2 x C4, 1 x C5, 2 x C7, 2 x ST1	10
2	2 x M1, 2 x M3, 1 x C4, 1 x C7, 1 x ST1, 1 x ST2	8
3	1 x M1, 2 x M2, 1 x C4, 1 x C5, 2 x C7, 2 x ST2, 1 x ST1	10
C4	2 x M1, 1 x M2, 1 x M3, 1 x C5, 1 x ST2, 1 x ST1	7
C5 (ST 3)	1 x M1, 1 x M3, 1 x C4, 1 x ST2, 1 x ST1	5
C7	2 x M1, 1 x M2, 2 x M3, 1 x ST1	6
ST 1	2 x M1, 1 x M2, 1 x M3, 1 x C4, 1 x C5, 1 x C7, 1 x ST2	8
ST 2	1 x M2, 2 x M3, 1 x C4, 1 x C5, 1 x ST1	6
TOTAL		**60**

(1) For example, Corridor Line 7 has one connection (joint station) point each with Metro Line 2 and Supertram 1, as well as two connection points each with Metro Lines 1 and 3. The total number of connecting points with rail systems is six. Refer Figure 4.7.5 for line depiction.
Source: JICA Study Team

(11) Physical Constraints

Again, all of the proposed corridor lines follow the main road corridors in Cairo with the least interference with underground facilities and buildings. Furthermore on various sections they employ already existing tracks or right-of-ways. There are less physical constraints in this scenario due to the curtailment of the urban section of corridor line 7.

4.7.3 Summary

In the following paragraphs we will compare the main results of the following refined scenarios :

A. the committed network

B. the do maximum network

C. the core network

D. and the optimized core network.

Please note that scenarios 1 and 2, i.e. the "committed" and "do maximum" networks, for the sake of comparison, include a comprehensive premium bus network identical to the one in the core network. The optimized core network contains a revised and less costly version of the premium bus network.

(12) Comparison of Socio-economic Performances

Table 4.7.18 summarizes the total ratios concerning the number of population, jobs and students that are served within a distance of 800 meters of the lines for each scenario. In addition to this is included the number of households with a monthly income below 300 LE, in order to compare the aptitude of each scenario of serving the poor.

Table 4.7.18 Socio-economic Performances of Each Refined Scenario in 2022

	NETWORKS							
	Committed		**Do maximum**		**Core**		**Optimized core**	
Line	Ratio (*)	HH Inc < 300 LE	Ratio (*)	HH Inc < 300 LE	Ratio (*)	HH Inc < 300 LE	Ratio (*)	HH Inc < 300 LE
1	0.18	25385	0.18	25,385	0.18	25,385	0.18	25,385
2	0.17	20920	0.19	26,570	0.19	26,677	0.19	26,677
3	0.23	22067	0.23	22,067	0.23	22,751	0.27	22,751
C4 (Pyramid)			0.10	11,935	0.21	39,229	0.22	40,001
C5 (ST3)			0.11	20,414	0.11	20,414	0.06	7,354
C6 (Maadi)			0.29	18,030	-	-	-	-
C7 (Wings)			0.30 (**)	50,017	0.30 (**)	49,810	0.30	49,810
C9 (ST1)					0.12	8,886	0.08	5,516
ST 2							0.10	5,953
Total network	0.58	68,372	1.40	174,417	1.34	193,131	1.39	183,446

(*) Total ratio = Pop./total pop. + Emp./total emp. + Stu./total stu.
(**) For the sake of comparison the through section on C7 is counted in line 1 only, and C9(ST2) and ST2 are excluded
Note: indicated lines consist of segregated track projects
Source: JICA Study Team

As it can be seen from the table, the "do maximum" is the most interesting from a socioeconomic perspective. However, in terms of the number of poor people served, the core scenario obtains the best results, above all due to the corridor line 4. This is the result of initial screening where poor income areas where identified the northern part of Cairo along Port Said street. Corridor line 4 was adapted and tested accordingly. The optimized core scenario does not serve as many poor due to the curtailment of a section of corridor line 5 between Port Said St. and Shobra.

(13) Comparison of Riderships and Market Shares

Table 4.7.19 summarizes the total demand and market shares by transport modes for each scenario.

Table 4.7.19 Transport Demand Performances by Scenario in 2022

	NETWORKS				
	2001	**2022**			
	Existing	**Committed**	**Do max**	**Core**	**Opt core**
Person trips	**Million**	**Million**	**Million**	**Million**	**Million**
Public sector bus	4.299	3.400	3.405	3.861	4.791
Private sector shared taxi and minibus	6.696	6.620	4.500	4.573	4.275
MRT/LRT	2.021	6.512	11.095	9.999	8.599
ENR	0.132	1.000	1.463	1.409	1.703
Tram	0.171	0.485	0.667	0.755	0.798
Total Motorized	**13.329**	**18.177**	**21.130**	**20.599**	**20.167**
Modal transport share	**%**	**%**	**%**	**%**	**%**
Public sector bus	32.3	18.7	16.1	18.7	23.8
Private sector shared taxi and minibus	50.2	36.3	21.3	22.2	21.2
Total public road transport	**82.5**	**55.0**	**37.4**	**40.9**	**45.0**
MRT/LRT	15.2	35.8	52.5	48.6	42.6
ENR	1.0	5.5	6.9	6.8	8.4
Tram	1.3	2.7	3.2	3.7	4.0
Total rail transport	**17.5**	**44.0**	**62.6**	**59.1**	**55.0**
Total	100.0	100.0	100.0	100.0	100.0

Source : JICA Study Team

Even though the core scenario has fewer heavy rail lines - and therefore requires less investment - it obtains almost the same results in terms of modal share as the "do maximum" scenario. This confirms that the methodology applied for screening the alternatives has worked well and that we have arrived at the most cost-effective solution. It should be noted that although the optimized core scenario leads to less demand on the MRT/LRT network, it is the most efficient in terms of informal public road transport activity.

Table 4.7.20 summarizes the riderships and loads of each line in each scenario.

Table 4.7.20 Transport Demand Performances by Line in 2022

	NETWORK							
	Committed		Do maximum		Core		Opt core	
Line	Pass. (million)	Pass/km (1,000)	Pass. (million)	Pass/km (1,000)	Pass. (million)	Pass/km (1,000)	Pass. (million)	Pass/km (1,000)
1	2.546	59.2	3.050	69.3	2.921	66.4	2.900	65.9
2	1.868	81.2	2.042	75.6	1.957	72.5	2.085	77.2
3	2.097	69.9	2.080	61.2	2.182	64.2	2.365	69.6
C4 (Pyramids)	-	-	1.460	54.1	1.675	62.0	1.725	63.9
C5 (ST3)	-	-	1.313	65.6	1.264	57.5	0.540	33.8
C6 (Maadi)	-	-	1.174	61.8	-	-	-	-
C7 (Wings)	-	-	0.910	9.5	0.881	9.2	0.926	10.8
C9 (ST1)	-	-	-	-	0.463	30.8	0.630	28.7
ST2	-	-	-	-	-	-	0.225	15.0
TOTAL and AVERAGE	**6.512**	**70.1**	**11.969**	**54.8**	**11.343**	**51.8**	**11.397**	**47.0**

Source: JICA Study Team

In terms of total ridership and average load, the "do maximum" scenario obtains the best results. The following two scenarios follow closely in terms of ridership but are less loaded on each line. The optimized core scenario loses an important ridership and load on corridor line 5 due to the curtailment of the section between Port Said and Shobra. However, lines 2, 3, 4 and the Wings obtain the best results in the optimized core scenario.

4.8 RECOMMENDATIONS

This section sets forth the final form of the recommended infrastructure plan for public transport services. Details are presented for each of the modes (MRT, tram/supertram, suburban rail, public bus and ferry) to include utilization, system needs, costs and staging.

4.8.1 Overview

Previous sections of this chapter have discussed the approaches used to cull and refine alternative public transport scenarios. In summary, the adopted approach consisted of several cascading and interlinked steps.

- Various policies and programs were presented in Sections 4.2 through 4.5 which address route structuring, sustainability, the urban poor and cooperative approaches between the public and private sectors. A key element of that discussion is that, in order to achieve a fully integrated and efficient public transport network, planning for future public transport systems has been carried out according to a clear functional hierarchy. Each mode is allocated to specific corridors or functions as deemed appropriate for meeting forecast demand at acceptable capacity and speed. Each mode thus has its own domain where it can operate under optimal conditions, in complement with other modes, as part of a multi-modal system.

- An initial screening of four public transport scenarios, including what is commonly termed the Systra plan, was carried out and described in Section 4.6. The initial screening focused on urban rail systems; underlying the various rail combinations was the base year public transport route structure. Testing was accomplished using a strategic corridor model, the CREATS GIS database as well as the comprehensive CREATS transport model under a year 2022 socio-economic framework as described in *Progress Report (2).* The principal output of the initial screening was a core urban rail network.

- The core network was then subjected to a series of refinements involving both public transport and road facilities, as discussed in Section 4.7. The comprehensive CREATS transport model was used under a year 2022 refined socio-economic framework. The underlying road based public transport network was modified to provide integrated service; public bus route structure is allocated to main roads, while shared taxi and cooperative minibus operations are allocated under an area franchising scheme. To ensure consistency of effort, the “do minimum” and “do maximum” scenarios (Scenarios A and B, respectively) were again also compared to the core network, or what is referenced as Scenario C.

- The core network is optimized and termed Scenario D (the recommended year 2022 plan presented in this Section 4.8). While MRT strategies are largely unchanged from Scenario C, tram technology is, based on demand, upgraded to LRT (Supertram), and bus priority facilities are defined based not only on forecast patronage demand, but also to mesh with rail-based public transport proposals to ensure that a continuous and logical system of integrated public transport services is provided, particularly in principal corridors where demand does not, during the course of the CREATS planning horizon, warrant higher-order rail modes. The CREATS comprehensive transport model is again utilized to develop both year 2022 and intermediate year 2012 forecast levels of demand.

- The CREATS transport model was applied to test the sensitivity of year 2022 public transport utilization to three stimuli; namely, conversion of public modes fare structure to a single, common system; changes in the absolute amount of fare levied; and, adjustment of route structure from competitive to enhanced intermodal status. Findings of these simulations are presented in *Chapter 7: Intermodality*, of this volume.

Following this overview, five sections present detail as to recommendations for MRT (Section 4.8.2), tram/supertram (Section 4.8.3), suburban rail (Section 4.8.4), public bus and bus priority (Section 4.8.5) and Nile ferries (Section 4.8.6).

In summary, the cornerstone of the recommended year 2022 plan consists of high-capacity, segregated urban rail systems including four MRT lines (among them the existing metro lines 1 and 2, as well as committed metro line 3), three supertram lines as well as the "wings", that is, services to 6th of October and 10th of Ramadan satellite cities (Table 4.8.1).

Table 4.8.1 Optimized Core Urban Rail Network in 2022

Line	Type	Length	Starting at	Going through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	27 km	Qalyob	CBD area	Giza – Moneeb
3	MRT	34 km	Cairo airport	CBD-Mohandiseen	Imbaba (branch 1) Behoos (branch 2)
4 (Pyramid)	MRT	27 km	Giza Pyramids	CBD area	Port Said Street / Ring Road
Supertram 1	Super-Tram	22 km	New Cairo	Nasr City, Roxi	Ramses Square
Supertram 2	Super-Tram	15 km	Al Nozha	Heliopolis	Attaba Station
Supertram 3	Super-Tram	16 km	Nasr City	Heliopolis	Port Said Street
Wings West	Train	40 km	6th of October	Sheikh Zayed	Rames Station
Wings East	Train	46 km	10th Ramadan	Shorooq	Ain Shams Station

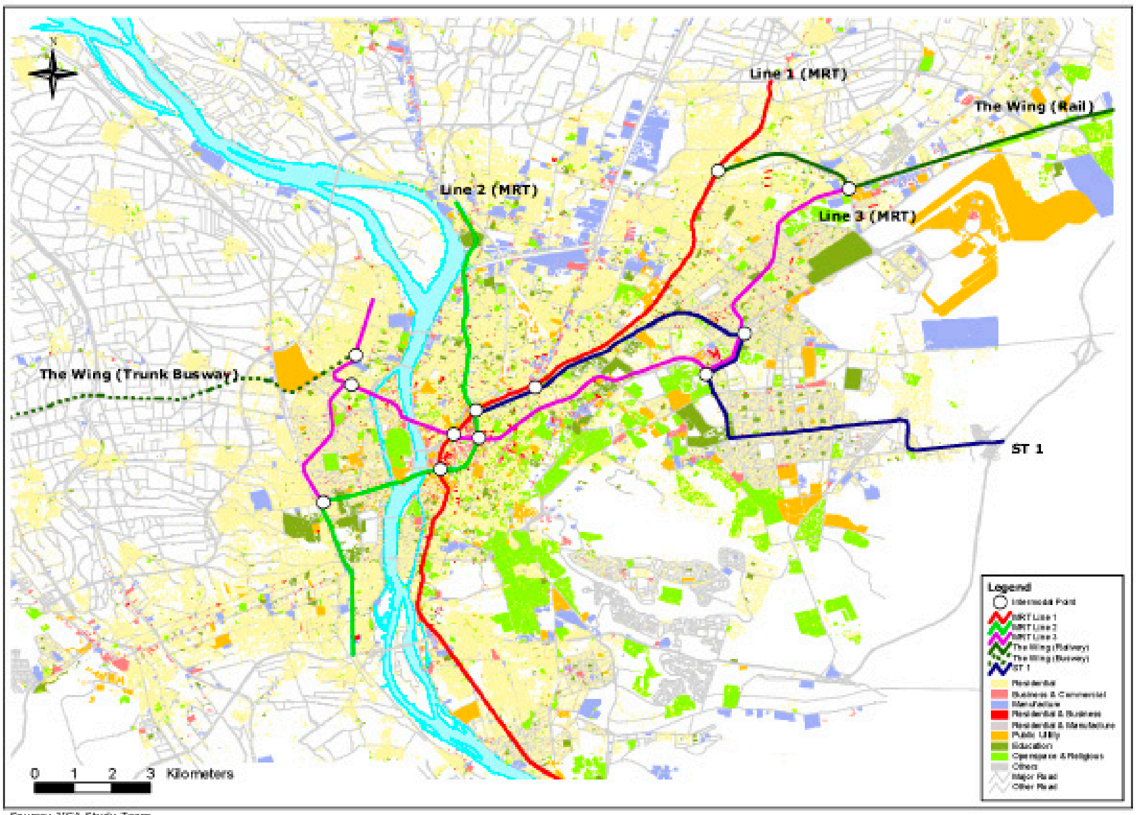
The composite year 2022 public transport plan provides excellent coverage to areas of high population, employment and student densities via an interconnected and intermodal system (Figure 4.8.1).

Figure 4.8.1 Year 2022 Public Transport Infrastructure Plan

The realization of the recommended transport plan will happen in stages according to construction constraints developed later in this chapter. In 2012, the network will consist of three MRT lines, one supertram line and services to the satellite cities (Table 4.8.2, Figure 4.8.2).

Table 4.8.2 Optimized Core Network in 2012

Line	Type	Length	Starting at	Going through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	21 km	Shobra	CBD area	Giza – Moneeb
3	MRT	22 km	Ain Shams	CBD-Mohandiseen	Imbaba (branch 1) Behoos (branch 2)
Supertram 1	Super-Tram	19 km	Nasr City	Roxi	Ramses Square
Wings West	Trunk Busway	34 km	6th of October	Sheikh Zayed	Doqy
Wings East	Train	46 km	Ain Shams Station	Shorooq	10th of Ramadan



Source: JICA Study Team

Figure 4.8.2 Year 2012 Core Infrastructure Plan

The total outlay for infrastructure implementation will require some 48.4 billion constant year 2001 LE, including 15.0 billion LE for committed projects. Costs are allocated by five year periods paralleling plan periods used by the Government of Egypt (Table 4.8.3). Further costing detail by mode is provided in following sections.

Table 4.8.3 Staged Public Transport Infrastructure Investment Program

Mode	Period Investment (Million Constant Year 2001 LE)				
	2002-2007	2007-2012	2012-2017	2017-2022	Total
Mass Rapid Transit	0	0	2,851	8,049	10,900
Tram and Supertram	1,041	1,923	1,469	1,474	5,907
ENR Suburban, Wings	571	1,927	1,994	5,674	10,166
Bus Fleet	1,154	1,009	1,154	1,009	4,326
Priority Bus Facilities	762	738	267	277	2,044
Nile Ferry	25	25	0	0	50
Committed Projects	2,356	6,683	5,675	300	15,014
CREATS Plan Total	5,909	12,305	13,410	16,783	48,407

Source: JICA Study Team

4.8.2 The MRT Network

Rail-based MRT is the cornerstone for moving large volumes of persons in the highest demand corridors. Metro Line 3, which is planned to run from the Airport through Heliopolis to the center of the city, and end in branches to Imbaba and Bulak, as well as the extension of Line 2 to Moneeb, are considered committed projects whose implementation is currently being actively pursued by the Government of Egypt. The primary elements of the Master Plan are, in addition to construction of the committed Line 2 extension and Line 3, further extensions of Metro Lines 2 and 3, and the realization of Metro Line 4 (the Pyramid Line). Line 2 is extended from Shubra Station to Qalyub in order to relieve the heavily loaded Alexandria Agricultural Road and to provide enhanced mobility for residents of southern Qalyobeya Governorate. The proposed southward extension of the Line 3 Bulak branch reaches Metro Line 2 at Behoos station. Metro Line 4 satisfies a massive person trip demand corridor along El Malik Faysal Street to central Giza and Cairo, and on to Port Said Street and the Ring Road. This line is seen as being particularly beneficial as it reaches a broad range of the population in very dense areas of the city. The construction of some 70 kilometers of new MRT lines is proposed, including committed projects. The MRT is mainly underground but can also partially be constructed at or above grade to reduce costs.

(1) Description and Implementation Staging

In 2022, there will be four MRT lines in total as shown in Table 4.8.4.

Table 4.8.4 Recommended Infrastructure Plan, 2022 MRT Network Description

Line	Type	Length	Starting at	Passing through	Ending at
1	MRT	44 km	New El Marg	CBD area	Helwan
2	MRT	27 km	Shobra el Kheima (ring road)	CBD area	Giza - Moneeb
3	MRT	34 km	Ain Shams	CBD-Mohandiseen	Imbaba (branch 1) Boolaq (branch 2)
4	MRT	27 km	Port Said street	Roda Island	Giza Pyramids

The total line length of the MRT network amounts to 127 kilometers, including existing MRT lines 1 and 2.

The proposed implementation staging is shown in Table 4.8.5.

Table 4.8.5 Recommended Infrastructure Plan, MRT Implementation Staging

CREATS Project		Length (km)	Remarks	Implementation Period			
				02-07	08-12	13-17	18-22
PTM-1	Line 1 improvements	43.7	Fleet increases	O	O	O	O
PTM-2	Line 2 extension to Moneeb	2.1	Fleet included	O			
PTM-3	Line 2 extension to Qalyob	7.0	Fleet included			O	
PTM-4	Line 3 (Giza - Airport)	34.0	Fleet included	O	O	O	
PTM-5	Line 4 (Pyramid-Port Said St.)	27.0	Fleet included			O	O

(2) Service Performances

a) Trips demand per line

The trip demand forecast was carried out for the years 2012 and 2022 considering the depicted implementation staging.

The results of the CREATS trip forecast model are shown in Table 4.8.6.

Table 4.8.6 Recommended Infrastructure Plan, MRT Trip Demand Forecast

Metro Lines	Length (km)	Daily passengers	Trips flow on the busiest section (one direction; peak hour period)
2001/2002			
Line 1	44	1,320,000	45,000
Line 2	19	750,000	35,000
Total	***63***	***2,070,000***	
2012			
Line 1	44	2,220,000	56,200
Line 2	21	1,760,000	52,900
Line 3	*22*	1,690,000	44,900
Total	***87***	***5,670,000***	
2022			
Line 1	44	2,900,000	67,800
Line 2	27	2,080,000	61,000
Line 3	34	2,370,000	51,900
Line 4	27	1,730,000	41,400
Total	***132***	***9,080,000***	

The extension of line 2 to the South (Moneeb) by 2012 and then to the North (Qalyob) by 2022 will increase significantly the daily passenger trips.

In 2012, line 3 (Between Giza Bank and Al Ahram) is expected to carry 1.69 million daily passengers trips. It appears that the implementation of the first phase of line 3 will relieve lightly metro line 1 from overloading.

The completed line 3 is expected to carry 2.37 million daily passenger trips in 2022., while the completed line 4 is expected to carry 1.73 million daily passenger trips in year 2022.

b) Supply indicators and fleet requirement

In order to develop an operational scheme that will satisfy the predicted travel demand, the metro operations have been simulated. Assumptions to estimate the operation of the metro are as follows :

- MRT2 vehicle types of line 2 with an average capacity of 1,750 passengers (with an occupation rate of 7 passengers per m²) will also equip lines 3 and 4. The train consists of 8 cars.
- The average speed is set at 36 km/h according to the vehicle characteristics (acceleration and deceleration) and the inter-station distance.
- For metro line 1, the MRT1 vehicles considered are identical to the existing ones, and have an average capacity of 2,466 passengers. This type of rolling stock can be operated on the metro lines carrying between 50,000 and 70,000 passengers per hour per direction (train composed of 3 train sets of 3 coaches, each 64 meters long, and with overhead catenary traction system – 1500 V DC).
- Metro fleet requirements are calculated from the peak hour passenger flows on the busiest sections based on trip model forecasts, route length, end-to-end travel time, including shunting time in terminals, and time at terminals for possible delays.

The basic operational characteristics and fleet requirements of the metro lines are shown in Table 4.8.7 for the years 2012 and 2022, respectively.

Table 4.8.7 Metro Operational Characteristics in 2012 and 2022

Date	Line	Length	Fleet requirement	Minimum headway	Annual train-km	Annual vehicle-km
		km		Minute second	Million	Million
2001/2002	L1	44 km	48 MRT 1	3 mn 30 s	6.722	60.498
	L2	19 km	23 MRT 2	3 mn 00 s	2.429	19.432
			-	-	***9.151***	***79.930***
2012	L1	44 km	63 MRT 1[(1)]	2 mn 40 s[(1)]	7.300	65.700
	L2	21 km	45 MRT 2	2 mn 00 s	4.700	37.600
	L3	22 km	41 MRT 2	2 mn 20 s	4.600	36.800
						140.100
2022	L1	44 km	76 MRT 1	2 mn 10 s[(1)]	7.700	69.300
	L2	27 km	54 MRT 2	2 mn 00 s[(2)]	6.300	50.400
	L3	34 km	58 MRT 2	2 mn 00 s	6.300	50.400
	L4	27 km	44 MRT 2	2 mn 30 s	5.100	40.800
						210.900

(1) *The signaling system should be upgraded to satisfy this value.*
(2) *With 8 passengers per m2 instead of 7 passengers per m2 for the other metro lines.*

In 2012, metro line 3 will be in operation from Giza to Al Ahram and will require around 41 trains. In 2022, metro lines 3 and 4 will be completely operational and will require around 58 and 44 trains respectively. Line 2 will be quasi-congested in 2022. The rehabilitation of the existing ENR line from Qalyob to Cairo should therefore be considered in order to relieve line 2.

(3) Capital Cost

The metro capital cost is estimated from the past expenditure of lines 1 and 2.

These average costs include:

- Civil engineering works : Embankments, cuttings, bridges, tunnel, cut-and-cover structures, preparation of guideway bed, street and highway realignment**.** Relocations of utilities and sanitary services are taken into account in contingencies. The stations are assumed to be relatively simple and economical in function and design.

- Systems and equipment: Double track work, traction power (electrification, substation), signaling, communication, ticketing, and stations. The cost of traction power is based on recent construction experience. New rail is assumed to be with ballast, sub-ballast and other track materials

- Depot and workshop: Capital cost of tracks, maintenance, repair, energy and systems equipment.

- Rolling Stock : Cost of the vehicles required to ensure the service on the whole metro network.

These costs include insurance, engineering and construction management but also a general construction contingency based on previous experience regarding unforeseen events during construction (soil conditions and other types of known but for the moment non-quantifiable factors such as utilities relocation).

The capital cost breakdown used for the calculation of the total cost is shown in table 4.8.8. The indicated prices could be reduced if some works are undertaken by local contractors who have acquired sufficient experience during the execution of lines 1 and 2 works.

The estimated capital costs are shown in Table 4.8.9 for the line 2 extension, line 3 and line 4 implementation, and increase of the line 1 rolling stock.

The capital cost of the whole proposed 2022 metro network, including the rolling stock increases, reaches 25.9 billion of LE (2001 constant prices).

Table 4.8.8 Unit Capital Cost Breakdown of Metro Line 2 (Million LE 2001)

Items	Unit	Unit Cost
Tunnel *	Km	257
At grade civil work *	Km	37
Elevated *	Km	155
Track	Km	11
Equipment and systems	Km	55
Depot and workshop	Unit	200
Rolling Stock (8 cars)	Unit	50

(*) Station included

4.8.3 The Tram Network

In support of the MRT network, and to enhance transport between suburban sub-centers, the realization of three Supertram lines is proposed. These lines function as regular LRT systems in their own right-of-way, but use smaller rolling stock resembling that of a tram. Supertram Line 1 runs from Ramses Square to Nasr City and ultimately ends in New Cairo. Supertram 2 connects Attaba with El Nozha, and Supertram 3 is a circumferential line linking Nasr City and Heliopolis with Port Said Street, as well as intermediate intermodal points with ENR, buses and metro. A total of 53 kilometers of Supertram lines is planned using, whenever possible, existing Heliopolis Metro and CTA Tram rights-of-way (Figure 4.8.3). Supertram 2, via a proposed extension along Salah Salem Street (re-using rights-of-way previously used by trams) offers an interesting option along the Azhar Street corridor (Islamic Cairo). The planned closure of at-grade road facilities, and removal of the existing flyover, will offer an interesting opportunity for an at-grade integration of ST 2 into an attractive pedestrian precinct. Preliminary inspections suggest that, following removal of the Azhar flyover, considerable rights-of-way would be available for an at-grade ST 2. Construction of some viaducts or tunnels at road-crossings is required in order to ensure complete modal separation. The supertrams should be considered an exceptional opportunity to obtain a modern and efficient system at relatively low cost by re-using existing infrastructure and property. The supertram also has the advantage of boosting an environmentally friendly and more convivial image of Cairo.

The remaining tram lines in Heliopolis and Helwan are rationalized and rehabilitated so as to improve commercial speed and comfort. Upgrading is expected to include trackage, signaling, power supply and rolling stock.

The recommendations contained in the following section are at a Master Plan level of analysis, and should be reviewed in more detail during recommended follow-on project feasibility study.

Table 4.8.9 Recommended Infrastructure Plan, Metro Capital Cost

CREATS Project		Length (km)	Unit Cost (LE mil)	Cost (LE mil)	Remarks	Implementation Period				Agency
						02-07	08-12	13-17	18-22	
Metro network improvements		283.3		25,914		2,356	6,683	8,526	8,349	NAT/CMO
PTM1	Line 1 improvements	43.7	27.5	1,200	Fleet increases	O	O	O	O	NAT/CMO
PTM2	Line 2 extension to Moneeb	2.1	264.8	556	Fleet included	O				NAT/CMO
PTM3	Line 2 extension to Qalyob	7.0	216.4	1,515	Fleet included			O		NAT/CMO
PTM4	Line 3 (Giza - Airport)	34.0	389.9	13,258	Fleet included	O	O	O		NAT/CMO
PTM5	Line 4 (Pyramid-Port Said street)	27.0	347.6	9,385	Fleet included			O	O	NAT/CMO

Source : JICA Team

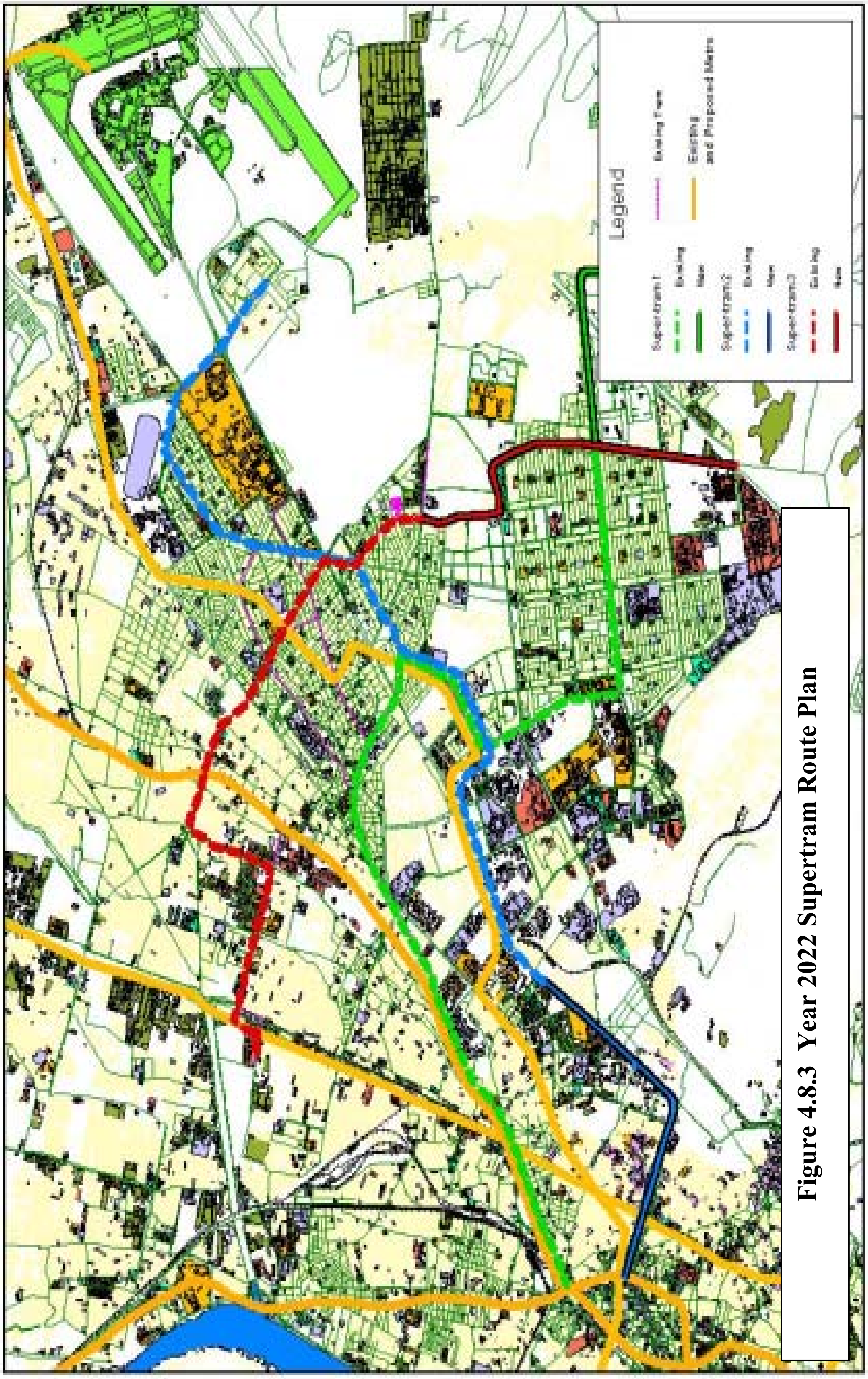


Figure 4.8.3 Year 2022 Supertram Route Plan

(1) Description and Implementation Staging

As mentioned, three new Supertram lines are implemented on largely existing sections of the tram network. The remaining tram lines are rehabilitated. There will be eight tram and supertram lines totaling 88 kilometers (Table 4.8.10).

Table 4.8.10 Recommended Infrastructure Plan, 2022 Tram Network Description

Name	Type	Length	Starting at	Passing through	Ending at
Line ST1	Supertram	22 km	Nasr City	Cairo Stadium Roxi	Ramses
Line ST2	Supertram	15 km	Sheraton	Cairo Stadium	Al Azar - Attaba
Line ST3	Supertram	16 km	Nasr City	Heliopolis	Matareya
Line T4	Tram	4 km	Alf Maskan	-	Roxi
Line T5	Tram	3 km	Al Nozha	-	Roxi
Line H1	Tram	14 km	15^{th} of May	-	Helwan
Line H2	Tram	11 km	Tebeen	-	Helwan
Line H3	Tram	3 km	Helwan University		Helwan

The proposed implementation staging is shown in Table 4.8.11.

Table 4.8.11 Recommended Infrastructure Plan, Tram Implementation Staging

CREATS Project		Length (km)	Remarks	Implementation Period			
				02-07	08-12	13-17	18-22
PTST-1	Supertram 1 (New Cairo - Ramses)	22,0	LRT	O	O		
PTST-2	Supertram 2 (Sheraton - Attaba)	15,0	LRT			O	
PTST-3	Supertram 3 (Nasr city - Matareya)	16,0	LRT				O
PTT-1	Helwan tram lines rehabilitation	28,0	3 Helwan lines	O	O		
PTT-2	Heliopolis tram line rehabilitation	7,5	2 Heliopolis lines	O	O	O	

(2) Service Performances

a) Trips demand per line

The trip demand forecast was carried out for the years 2012 and 2022 in due consideration of the implementation staging assumptions.

The results of the trip forecast model are shown in Table 4.8.12.

Table 4.8.12 Recommended Infrastructure Plan, Tram Demand Forecast

Tram Lines	Length (km)	Daily passengers	Trips flow on the busiest section (one direction; peak hour period)
2001/2002			
Whole network	***225****	***150,800***	-
2012			
ST 1	22	420,000	14,800
Helwan lines	28	92,000	<1,900
Others lines	31	83,000	<1,500
Total	***81***	***595,000***	
2022			
ST1	22	630,000	20,300
ST2	15	230,000	6,200
ST3	16	540,000	10,900
Heliopolis T4,T5	7	40,000	< 1,400
Helwan lines H1,H2,H3	28	99,000	<2,000
Total	***88***	***1,129,000***	

(*) Length of tram lines

The new supertram lines implemented on existing tram right-of-way will carry a significant volume of passengers. These lines should be considered as LRT type systems as they are fully protected at road crossings.

The whole tram network is expected to carry 1,129 million of daily passenger trips in 2022. With as many as 630,000 daily passengers, Supertram 1 is considered as an LRT system that is operated on exiting segregated right-of-way. The conflict at crossings with road traffic must be eliminated. The implementation of Supertram 1 will relieve metro line 1 from being overly congested, and will also involve operating cost savings on the line.

b) Supply indicators and fleet requirement

In order to develop an operational scheme for the tram that will satisfy the forecast travel demand, the tram operations have been estimated. As with the metro system, the data necessary for this task include:

- Tram average speed: a function of rolling stock acceleration, deceleration, maximum speed, alignment characteristics and level of priority at road crossings; and,
- Tram service headway: determined by rolling stock capacity and forecasted traffic flows.

Tram speed

The tram's average speed is assumed to be 22 km/hour for tram line rehabilitations and 28 km/h for supertram lines, when considering :

- The distance between stations is typically 500 to 1,000 meters, but can vary.
- A maximum speed of 70 km/h between stations.
- Good traffic management at crossing and implementation of road bypass under the supertram lines.

Currently the tram operates at an average commercial speed of 13 km/h for the CTA tram and 15 km/h for the Heliopolis Metro.

Selection of tram range of capacity

Further assumptions to estimate the operation of the tram are as follows :

- T160 : tram with an average capacity of 160 passengers (assuming a peak load of 6 passengers/m^2) and composed of 1 train set of 2 coaches with catenary traction system. A similar tram capacity is found on CTA tram rolling stock.
- T500 : tram with an average capacity of 500 passengers (assuming a peak load of 6 passengers/m^2) and composed of 1 train set of 3 coaches with catenary traction system. A similar tram capacity is found on the Heliopolis tram rolling stock.
- T1000 : Supertram/LRT with an average capacity of 1,000 passengers (assuming a peak load of 6 passengers/m^2) and composed of 2 train sets of 3 coaches with catenary traction system). This rolling stock which runs at a 2 minutes headway can carry 30,000 passengers per hour per direction.

Fleet requirements for Supertram lines are calculated from the peak hour passenger flows on the busiest sections based on trip model forecast, route length, end-to-end travel time, including shunting time in terminals, and time at terminals reserved for possible delays.

The remaining tram lines to be rehabilitated are supposed to be supplied by existing rolling stock coming from tram lines converted into supertram lines.

The basic operating characteristics and fleet requirements of the supertram lines are shown in Table 4.8.13 for the years 2012 and 2022.

Table 4.8.13 Tram Operating Characteristics in 2012 and 2022

Date	Network	Length	Metro fleet requirement	Minimum headway	Annual tram km	Annual vehicle km
		km		Minute second	Million	Million
2001/2002	Whole network	*CTA* *Heliop.*	205 (2 cars)* 49 (3 cars)*		12.2 7.1	24.4 21.3 ***45.7***
2012	ST1 H1 to H3 Other lines	22 km 28 km 31 km	32 T 1000 34 T 180 49 T 500 17 T 180	4 mn 05 s(1) > 4mn	2.7 3.5 2.3 8.1	16.2 7.0 6.9 16.2 ***46.3***
2022	ST1 ST2 ST3 T4,T5 H1 to H3	22 km 15 km 16 km 7 km 28 km	43 T 1000 24 T 500 36 T 500 10 T 180 36 T 180	2 mn 55 s 4 mn 50 s 2 mn 45 s >5 mn 00 >4 mn 00	3.6 2.3 2.9 0.8 3.6	21.600 6.900 8.700 1.600 7.200 ***46.0***

(*) 51 in operation (**)37 in operation

In 2012, Supertram line 1 will be in operation from Nasr city to Ramses Square and will require around 32 new trains.

In 2022, all supertram lines will be completely operational and will require around 103 trains in total.

(3) Capital Cost

The rehabilitation of existing lines (rolling stock included), is estimated to cost 20 million LE per kilometer based on international quality expectations.

For the supertram (considered as a LRT system), the construction cost estimates include:

- Civil engineering works. Cut-and-cover structures, preparation of guideway bed, street and highway modification. All possible relocations of utilities and sanitary services are taken into account in contingencies.
- Guideway renovation and equipment. At-grade double track work, traction power (electrification, substation), signaling, communication, ticketing, and stations. The cost of traction power is based on recent construction experience with catenary systems. The new rail is assumed to be a continuously welded rail embedded in pavement and laid on asphalt layer and concrete slab base. Nevertheless, on

non-urbanized corridors and out of the streets, welded rail is laid on concrete ties, and fastened by spring clips, with ballast, sub ballast and other track materials.

- Stations are assumed to be relatively simple and economical in function and design. A platform length of 70 meters has been considered in order to accommodate 6 car trains.

- Depot and workshop. Capital cost of rehabilitation of tracks, maintenance, repair, energy and systems equipment.

- Rolling stock cost of the vehicles required to ensure service on each line,

- An additional 7% is taken into account for insurance, engineering and construction management.

The estimated unit capital costs are shown in Table 4.8.14.

Table 4.8.14 Unit Capital Cost Breakdown of Supertram (Million LE 2001)

Items	Unit	Unit Cost
At grade civil work *	Km	5
Track	Km	9
Equipment and systems	Km	43
Depot and workshop	Unit	130
Rolling Stock (8 cars)	Unit	20

(*) Station included on existing right-of-way with crossing infrastructure

The capital cost of the whole proposed tram and supertram network reaches 5.907 billion constant year 2001 LE (Table 4.8.15). Some reductions in cost will be possible if further feasibility studies suggest that the re-use of existing properties or facilities is possible.

Table 4.8.15 Recommended Infrastructure Plan, Tram Capital Cost

CREATS Project		Length (km)	Unit Cost (LE mil)	Cost (LE mil)	Remarks	Implementation Period				Agency
						02-07	08-12	13-17	18-22	
		88.5		5,907	5,907	1,041	1,923	1,469	1,474	CTA
PTST-1	Supertram 1 (New Cairo - Ramses)	22.0	102.0	2,244	LRT	O	O			CTA
PTST-2	Supertram 2 (Al Nozha - Attaba)	15.0	84.9	1,273	LRT			O		CTA
PTST-3	Supertram 3 (Nasr City - Matareya)	16.0	92.1	1,474	LRT				O	CTA
PTT-1	Helwan tram lines rehabilitation	28.0	25.7	720	3 Helwan lines	O	O			CTA
PTT-2	Heliopolis tram lines rehabilitation	7.5	26.1	196	2 Heliopolis lines			O		CTA

4.8.4 The ENR Suburban Lines

The role of ENR suburban services is expected to strengthen in future in light of growing urban densities and gradual maturity of the satellite cities program. The existing suburban commuter rail lines are to be upgraded to provide enhanced service and comfort. This improvement is to focus on new rolling stock and upgraded stations. The implementation of more expansive projects within the traditional suburban services corridors, such as track replacement and electrification, is expected to originate at the national level, not from within an urban master plan.

Two new rail corridors are proposed linking Cairo with the 6th of October and 10th of Ramadan cities (the Wings). The 10th of Ramadan connection from Ain Shams station will, in the near term future, consist of single track upgrading with station turnouts, new stations, an extension to the 10th of Ramadan central area, and modern diesel rolling stock. In the longer term, and as warranted by demand, upgrading to double-track electrified service is possible. All improvements would maximize the use of existing ENR rights-of-way. The 6th of October service could also ultimately consist of dual-track operation between 6th of October city and Ramses station. However, all rights-of-way must be reserved immediately for this venture, with early indications favoring an alignment near Alexandria Desert Road. In the interim, and following reservation of rights-of-way, a cost effective and high capacity solution is the construction of a trunk busway whose design is so as to permit upgrading to rail once warranted by demand (refer Section 4.8.5).

(1) Description and Implementation Staging

Two new suburban railway lines are planned to link Cairo to the new cities 6th of October and 10th of Ramadan, from Ramses and Ain Shams stations respectively. The other suburban railway lines have to be rehabilitated in order to offer a better service performance. In total, there are eight suburban rail lines in the proposed infrastructure plan (Table 4.8.16).

Table 4.8.16 Recommended Infrastructure Plan, 2022 Suburban Railway Network

Name	Type	Length	Starting at	Passing through	Ending at
R1	Train	14 km	Cairo	Shobra	Qalyob
R2	Train	23 km	Cairo	Shobra/Qalyob	Qanater El Khayreya
R3	Train	32 km	Cairo	Shobra/Qalyob	Shebeen El Qanater
R4	Train	20 km	El Marg	-	Shebeen El Qanater
Wing East	Express Train	46 km	Ain Shams	Shorooq	10th of Ramadan
R6	Train	20 km	Cairo	Doqy	El Manashy
R7	Train	37 km	Cairo	Giza suburban	El Marazeeq
R8	Train	67 km	Giza Suburban	Moneeb	6th of October City
Wing West	Express Train	40 km	Cairo	Imbaba	6th of October center

The total line length of the suburban rail network amounts to 299 kilometers, including the two express rail links to 6th of October and 10th of Ramadan. The proposed implementation staging is shown in Table 4.8.17.

Table 4.8.17 Recommended Plan, Suburban Rail Implementation Staging

CREATS Project		Length (km)	Remarks	Implementation Period			
				02-07	08-12	13-17	18-22
PTXR-1	Express train (Ain Shams-10th of Ramadan)	46.0	Diesel-single track		O		
PTXR-2	Express train (Ain Shams-10th of Ramadan)	46.0	Electrified double tracks			O	O
PTXR-3	Express train (Cairo - 6th of October)	40.0	Electrified double tracks				O
PTSR-1	Rehabilitation (Cairo - Qalyob 3 lines)	69.0	New fleet included		O		
PTSR-2	Rehabilitation (El Marg - Shebeen El Qanater)	20.0	New fleet included	O			
PTSR-3	Rehabilitation (Cairo - el Manashy)	20.0	New fleet included			O	
PTSR-4	Rehabilitation (Cairo - El Marazeeq, 6th of October)	104.0	New fleet included	O	O		

The 10th of Ramadan railway link is to be opened before 2012 with diesel trains running on a single track. This involves track rehabilitation and extension to 10th of Ramadan city center.

Regarding 6th of October city, a direct service is first proposed with a busway system before 2012. This busway system will then be converted into a rail system before 2022.

(2) Service Performances

a) Trips demand per line

The trip demand forecast was carried out for the years 2012 and 2022 in due consideration of the implementation staging assumptions.

The results of the trip forecast model are shown in Table 4.8.18.

Table 4.8.18 Recommended Infrastructure Plan, Suburban Rail Demand Forecast

Metro Lines	Length (km)	Daily passengers	Trips flow on the busiest section (one direction; peak hour period)
2001/2002			
All network	258	141,350	
Total	***258***	***141,350***	
2012			
Express 10th of Ramadan	46	160,000	5,900
Lines R1,R2,R3 (North)	69	206,000	<4,000
Line R4 (North East)	20	108,000	<3,900
Line R6 (North West)	20	46,000	< 2,000
Lines R7,R8 (South)	104	40,000	<1,500
Total	***259***	***560,000***	
2022			
Express 10th of Ramadan	46	430,000	15,300
Express 6th of October	40	490,000	18,500
Lines R1,R2,R3 (North)	69	261,000	< 4,500
Line R4 (North East)	20	131,000	5,100
Line R6 (North West)	20	59,000	2,500
Lines R7,R8 (South)	104	67,000	<1,800
Total	***299***	***1,438,000***	

In 2022, the new express rail line, linking directly 6th of October to Cairo city center, is very interesting as it is shown as carrying 490,000 daily passengers. It is similar for the 10th of Ramadan Express line, which carries 430,000 daily passengers. The other rehabilitated railway suburban lines also become more attractive as they attract 518,000 daily passengers, almost four time more than the current situation..

b) Supply indicators and fleet requirement

In order to develop an operational scheme that will satisfy the predicted travel demand, the ENR train operations have been simulated. Assumptions to estimate the operation of the suburban train are as follows:

- T1600 vehicles type of existing SEMAF trains that have an average capacity of 1,600 passengers (with an occupation rate of 7 passengers per m²). The train consists of 7 units, with an average speed of 40 km/hr according to the vehicle characteristics (acceleration and deceleration) and the inter-station distance.

- EXP2400 vehicles type with an average capacity of 2,400 passengers. The train consists of nine-car units with an average speed of 80 km/h, according to the vehicle characteristics and large interstation distance.

- Train fleet requirements are calculated from the peak hour passenger flows on the busiest sections based on trip model forecast, route length, end-to-end travel time, including shunting time in terminals, and time at terminals reserved for possible delays.

The basic operating characteristics and fleet requirements of the suburban train lines are shown in Table 4.8.19 for the years 2012 and 2022 respectively. The number of ENR vehicles-kilometers will have to be multiplied by 2 in order to cope with the expected demand.

(3) Capital Cost

The average cost of the new suburban railway includes :

- Civil Engineering works : Embankments, cuttings, preparation of guideway bed**.** Relocations of utilities and sanitary services are taken into account in contingencies. The stations are assumed to be relatively simple and economical in function and design.

- Systems and Equipment : At-grade track work, traction power (electrification, substation), signaling, communication, ticketing, and stations. The cost of traction power is based on recent construction experience. New rail is assumed to be with ballast, sub ballast and other track materials

- Depot and Workshop : Capital cost of tracks, maintenance, repair, energy and systems equipment.

Table 4.8.19 Suburban Train Operating Characteristics In 2012 And 2022

Date	**Length**	**Train fleet requirement**	**Minimum headway**	**Annual train km**	**Annual vehicle km**
	km		Minute second	Million	Million
2001/2002	258 km	50 T1600	30 to 40 mn	14.67	***102.69***
2012					
Express 10th of Ramadan	46	10 T 1600	16 mn 15 s	1.5	10.5
Other lines	213	50 T1600	20 to 30 mn	18.3	128.1
Total	***259***				***138.6***
2022					
Express 10th of Ramadan	46	10 EXP2400	9 mn 30	2.8	25.2
Express 6th of October	40	11 EXP2400	7 mn 45	2.6	23.4
Other lines	213	78 T1600	15mn to 20 mn	22.0	154.0
Total	***299***				***202.6***

- Rolling Stock : Cost of the vehicles required to ensure the service on the Wings express lines.

These costs include insurance, engineering and construction management but also a general construction contingency based on previous experience regarding unforeseen events during construction (soil conditions and other types of known but for the moment non-quantifiable factors such as utilities relocation).

The capital cost breakdown used for the calculation of total cost is shown in Table 4.8.20.

Table 4.8.20 Capital Cost Breakdown
Double Track Electrified Wings Express Rail Lines (Million year 2002 LE)

Items	Unit	Unit Cost
At grade civil work	Km	16
Track	Km	11
Electromechanical equipment	Km	7
Power supply	Km	23
Low voltage	Km	25
At grade station	Unit	15
Depot	Unit	120
Rolling Stock (9 cars)	Unit	50

These prices could be reduced if some works were to be undertaken by local contractors who have acquired sufficient experience during the execution of earlier works.

The estimated capital costs are shown in Table 4.8.21 for new express rail lines to 6th of October and 10h of Ramadan and for the rehabilitation of existing lines (including stations, pedestrian access, fleet increase, track renewal).

The capital cost of the new express lines reaches 7.4 billion LE (2001 prices) and 2.8 billion for the rehabilitation of the existing ones (Extension to the 10th of Ramadan in single track included).

Table 4.8.21 Recommended Infrastructure Plan, Suburban Rail Lines Capital Cost

CREATS Proposal		Length	Unit Cost	Cost	Remarks	Implementation Period				Agency
		(km)	(LE mil)	(LE mil)		02-07	08-12	13-17	18-22	
		345.0		10,165		571	1927	1994	5674	ENR
PTXR-1	Express train (Ain Shams-10th of Ramadan)	46.0	21.4	986	Diesel-single track		O			ENR[(1)]
PTXR-2	Express train (Ain Shams-10th of Ramadan)	46.0	74.7	3,436	Electrified double tracks			O	O	ENR[(1)]
PTXR-3	Express train (Cairo - 6th of October)	40.0	98.9	3,956	Electrified double tracks				O	ENR[(1)]
PTSR-1	Rehabilitation (Cairo - Qalyob 3 lines)	69.0	10.8	746	New fleet included		O			ENR
PTSR-2	Rehabilitation (El Marg - Shebeen El Qanater)	20.0	18.8	376	New fleet included	O				ENR
PTSR-3	Rehabilitation (Cairo - el Manashy)	20.0	13.8	276	New fleet included			O		ENR
PTSR-4	Rehabilitation (Cairo - El Marazeeq, 6th of October)	104.0	3.7	389	New fleet included	O	O			ENR

(1) It is understood that project responsibilities for transport serving satellite cities are now jointly shared between the ENR, the MHUUC and the TPA.

4.8.5 Public Bus Requirements

This section presents the estimated capital needs of formal sector bus services to include fleet size, maintenance depots, and priority facilities.

(1) Recent Fleet Perspective

The year 2001 full-sized bus fleet consists of some 3,400 units. The CTA-designated fleet represented about 75 percent of that total, with the remainder being part of the GCBC fleet (a wholly-owned subsidiary of the CTA). Only about 120 units of the fleet are air conditioned, while a further 50 units are powered by compressed natural gas (CNG)[1]. The typical non-aircon bus has a capacity of near 35 seats; vehicle configuration can also accommodate some 50-55 standing passengers, or a crush capacity of about 90 persons. The CTA fleet's age profile confirms that some 70 percent of units are older than 10 years, and 42 percent older than 13 years; the average age lies near 13 years. This clearly points out one of the problems faced by the CTA, that is, an aging fleet with insufficient cash inflow from the Ministry of Finance to modernize buses. As indicated earlier, the CTA can only expect 100 new buses per year which must be allocated not only to fleet replacement, but also headway improvements on existing routes and the servicing of new routes.

The CTA also operates a fleet of some 1,100 minibuses. These have a capacity of near 25 seats; the vehicles also accommodate some five to ten standing passengers, or a total capacity of 30-35 persons. Minibuses were placed into operation during the mid-1980's in order to provide a more comfortable mode of transport and to introduce a more competitive services vis-à-vis shared taxis. At inception, minibuses were seen as a premium service with guaranteed seats. While initially seen as being very effective, minibuses have, in a sense, become a victim of their own success. Growing demand has exceeded supply, with the result that, at present, minibuses, like buses, must accommodate significant numbers of both standing and seated patrons. No units of the minibus fleet are air-conditioned and, of the total minibus fleet, and 54 percent are older than 10 years. Thus, as is the case with the bus fleet, aging vehicles are a concern.

The full size bus fleet has only grown some 15 percent over the decade ending year 2000 from some 3,000 to 3,400 buses. Thus, fleet size has not kept pace with network expansion, whose kilometer extent grew by some two-thirds. The operational fleet, as a percent of total fleet, approached 80 percent during the early 1990's, but by year 2000 had dropped to near 75 percent. The underlying reason is the very heavy workload placed upon the existing fleet to meet established route obligations. A

[1] These were obtained during latter 2001 under a joint financing arrangement with the USAID. In general, engine and chassis are imported, while body and fittings are manufactured locally. Other elements of this program include outfitting two depots for the CNG fleet, and, as part of the *Cairo Air Improvement Program*, assistance in enhanced system-wide monitoring of vehicle emissions.

vehicle is typically in operation 18-20 hours per day, with greatly reduced opportunity for maintenance. Hence, more breakdowns and down times are inevitable.

(2) Fleet Size and Utilization Adequacy

It is of interest at this point to focus on a key question, that is, can the extent and use of formal urban bus services be considered adequate when compared to overseas experience?

A comparison of road-based public transport operators among world cities is difficult as data are compiled in different manners or using varying definitions. For example, questions as to whether or not all operators are included, both public and private, and the status of paratransit services, make accurate data collection difficult. Nevertheless, some global contexts may be examined to obtain relative comparisons to Cairo. Based on pre-1990 data, a cumulative distribution of relative operator service, measured in terms of buses per thousand persons, suggests that the 50th percentile lies near 0.5 buses per 1,000 persons, and the 80th percentile near 1.25 buses per 1,000 persons. Post-1990 data implies that the 50th percentile of services using standard vehicles lies near 0.8 buses per 1,000 persons, and the 80th percentile again near 1.25 buses per 1,000 persons. (Figure 4.8.4). The Cairo operational fleet totaled some 2,600 standard size buses, and 680 mini buses. The local ratio therefore lies near 0.25-0.30 buses/minibuses per 1,000 persons. This places Cairo at approximately the 15th percentile of previously-prevented post-1990 global data, thus implying that the formal fleet is modest vis-à-vis the Greater Cairo population.

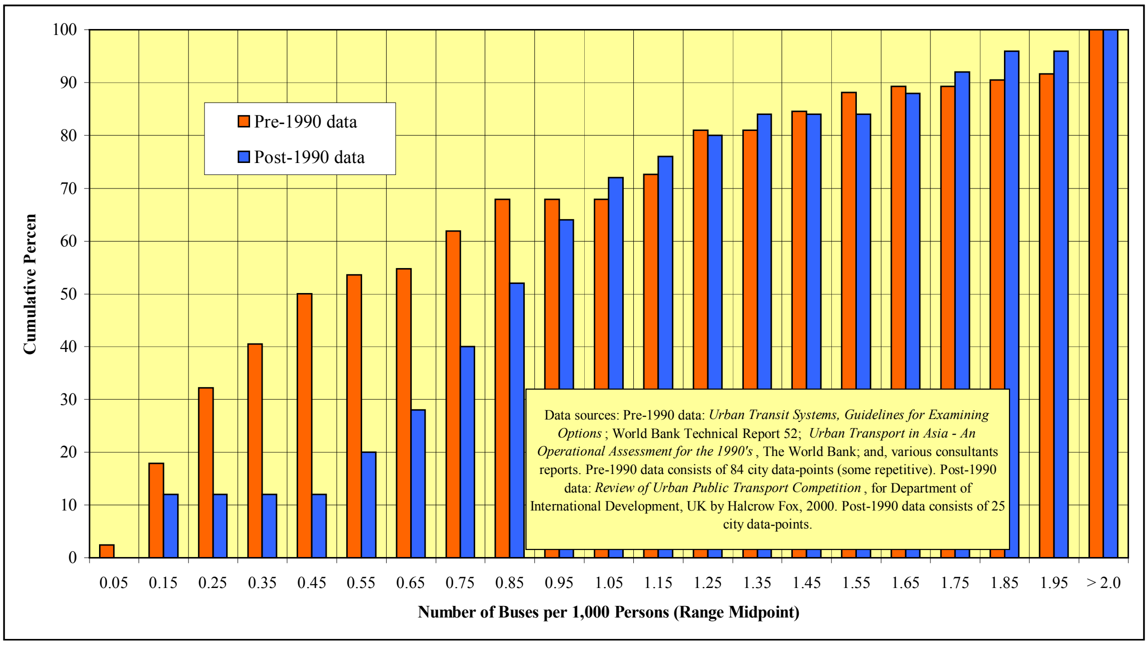


Figure 4.8.4 International Overview of Bus Supply in Urban Areas

Similarly, pre-1990 bus operator data imply that average use of public operator vehicles is some 1,000 persons per bus per day, while private operators carried an average of about 700 persons per bus per day (It may concurrently be surmised that private operators rely more on smaller vehicles than do public operators). Post-1990 data depicts an average of some 750 persons per bus per day for all operators (Figure 4.8.5). In Cairo, April, 2001 operator-provided data suggest that CTA carried a daily average of between 1,500 and 1,600 passengers per day per CTA standard bus, between 900 and 1,000 passengers per day per GCBC bus, and about 650 passengers per mini bus. Casual observations would confirm the apparent conclusion; that is, crowding on some elements of the formal fleet has reached intolerable levels. A contributing factor in this regard is that CTA buses typically operate for two daily shifts, travel over long routes and are subject to a high number of standees per vehicle.

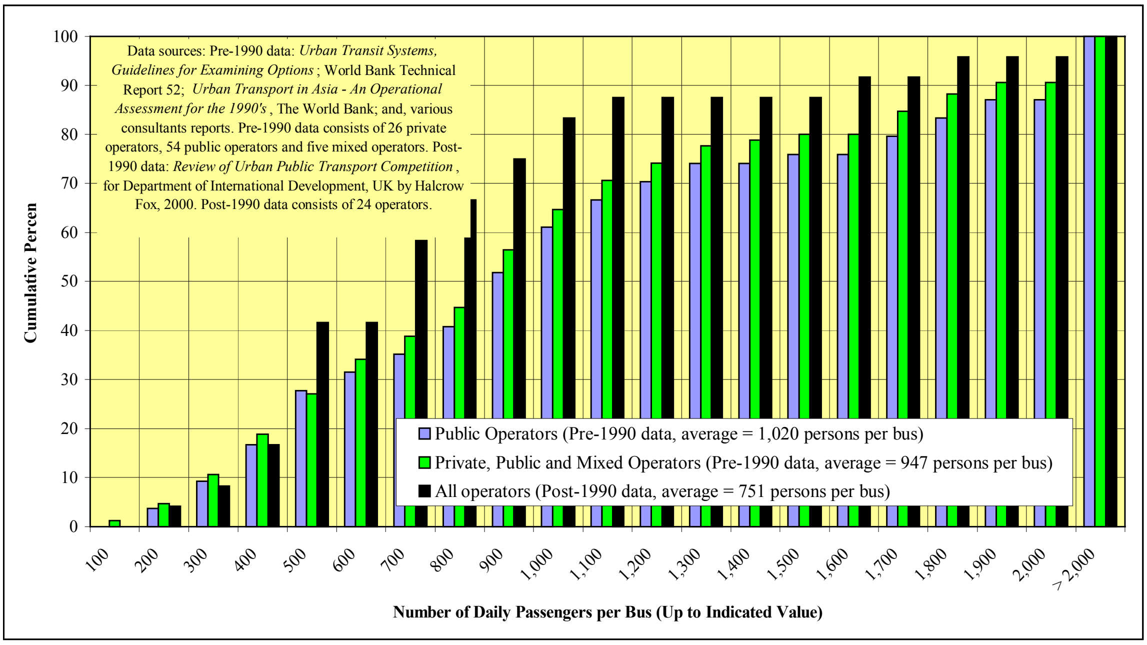


Figure 4.8.5 International Overview of Relative Bus Utilization in Urban Areas

These considerations will need to integrated with the derivation of future fleet requirements to ensure that adequate comfort standards are maintained.

(3) The New Fleet

Demand forecasts, depending on scenario, suggest that some 3.5 to four million daily boardings can be expected on the public bus fleet. Based on international norms, each bus should be expected to carry some 900-1,000 persons per day under acceptable crowding conditions. This implies an operational fleet of roughly 4,000 buses or, assuming the operational ratio can be improved from the current 75 percent to 90 percent, a total fleet of some 4,400 buses.

Several desirable goals and assumptions should concurrently be integrated:

- The public bus fleet will gradually evolve to exclusively using full-size, air conditioned units (The CTA is already, at present, reviewing options for privatizing the minibus operation).

- The age profile of the fleet should change to ensure that no vehicle in the fleet is older than 10 years, and that staged updating the fleet profile will take precedence over short-term fluctuations in ridership trends.

- This fleet expansion and modernization will take place during the first decade of the planning period, while during the second decade the purchase program focus will shift to maintaining the age profile.

- The current exercise has been carried out under the assumption that standard size buses will be the norm. There is an argument that the use of articulated buses on heavily traveled routes will reduce the number of buses required. This, however, depends on the adopted service standards. Further, articulated buses are more expensive than standard buses.

Costing of the fleet expansion program is based on constant year 2001 LE. Base year costs for the purchase of an air-conditioned full size bus, locally assembled, is on the order of 340,000 LE. The cost of a CNG powered full-size bus is considerably more: On the order of 900,000 LE. However, the predominant portion (743,000 LE) is based in US Dollars, shown that the engine and chassis are imported from abroad. It remains, of course, a goal that bus propulsion in the future gradually evolves to more environmentally friendly systems such as CNG. Such procedures have been implemented successfully in other places, among them India. However, such a transition will invariably require the establishment of local expertise for converting diesel engines to CNG propulsion, or the building of CNG engines at Egyptian assembly plants. Either option is eminently possible, which would radically reduce the price of CNG powered buses over current conditions. In the absence of more rigorous information, and for costing purposes, the typical bus cost has been increased to 400,000 LE to take account of CNG conversion procedures.

Thus, during the initial ten years of the public bus program, near 1,000 buses must be purchased for fleet expansion purposes, and a further 3,400 buses for fleet modernization purposes. The fleet will gradually expand to near 4,400 buses, and average age will decrease dramatically over ten years from the current 12.7 years to 5.6 years. This purchase program catalyzes a ten-year capital cost of 1,757.6 million year 2001 LE (Table 4.8.22). During the second ten years of the planning horizon, the entire fleet must again be replaced shown that all vehicles will, during that period, exceed their allocated ten-year life. This will require a second purchase of some 4,400 buses, again at 1,757.6 million LE. The composite cost of the 20-year Master Plan public bus fleet expansion and modernization program is therefore estimated at approximately 3.52 billion constant year 2001 LE.

Some 20 depots at present maintain the combined full-size bus fleet at present. Three considerations are likely valid over the planning horizon:

Table 4.8.22 Estimated Extent and Cost – Initial Ten Years Public Bus Fleet Expansion and Modernization Program

	Full-sized Bus Fleet		Annual Bus Purchases		
Year	Number	Average Age (Years)	Fleet Expansion	Fleet Modernization	Total Cost (Million LE)
0	3,444	12.7	*	*	*
1	3,539	11.6	95	290	154.0
2	3,634	10.4	95	329	169.6
3	3,729	8.6	95	495	236.0
4	3,824	7.9	95	330	170.0
5	3,919	6.9	95	425	208.0
6	4,014	6.2	95	363	183.2
7	4,109	6.0	95	249	137.6
8	4,204	5.6	95	337	172.8
9	4,299	5.5	95	329	169.6
10	4,394	5.6	95	297	156.8
Total	4,394	*	950	3,444	1,757.6

Data source: JICA Study Team

- Some form of consolidation of depots will likely take place as route structures are adjusted;
- Periodic modernization of the consolidated depots will be required; and,
- Some new depots will be needed to absorb the additional fleet.

At present, a new 200-bus depot requires an outlay on the order of 12 million LE. CNG depots are considerably more expensive, totaling 27 million LE but including some nine million LE for fueling facilities. If the fleet is to transition to CNG, then gradually changes will be required in the deport arrangement and technical activities performed at the depots. It is likely that depot cost differences will also gradually narrow as local capabilities are enhanced. However, the cost of depots is, relative to the cost of fleet expansion and modernization, modest. For example, 20 new depots at a unit cost of 15 million LE would total some 300 million LE, or less than ten percent of the 20-year fleet expansion and modernization cost. From a planning perspective, it is reasonable to adopt a 15 percent lump sum as being representative of capital outlay for depots, stations, stops, administrative facilities and other contingencies. This implies 264 million LE per decade, or roughly 530 million LE over the planning horizon.

The total cost of the improvement, including an allowance for contingencies, is estimated at 4,325.5 million constant year 2001 LE (Table 4.8.23). It should be stressed that a basic prerequisite for such an outlay is the commercialization of the CTA, to include a rationalization of the services provided by that organization. Various approaches in this regard have been presented in previous sections of this chapter.

- **The optimum and sustainable use of any new asset must be guaranteed before the considerable funds required for such acquisitions are committed.**

Table 4.8.23 Estimated Twenty Year Cost
Public Bus Fleet Expansion and Modernization

Item	Amount (Million Constant Year 2001 LE)
Bus Purchases	3,515.2
Depots, Stations, Stops, Fixed Assets	527.3
Contingency (7 Percent)	283.0
Total	4,325.5

Source: JICA Study Team

(4) Bus Priority Facilities

The application of bus priority facilities can take several forms, from exclusive trunk busway, to busway integrated with higher-order road facilities, to bus lanes along urban roads. The master plan contains provision for all three[2]. **The allocation of bus priority facilities reflects, of course, forecast patronage demand, but is also intended to mesh with rail-based public transport proposals to ensure that a continuous and logical system of integrated public transport services is provided, particularly in principal corridors where demand does not, during the course of the CREATS planning horizon, warrant higher-order rail modes.** The provision of busways along higher-order road facilities is also closely coordinated with recommendations regarding the future CREATS urban expressway system. Thus, the anticipated expressway cross section along those portions of the system identified as exhibiting bus priority potential includes provision for two integrated bus lanes (Figure 4.8.6). On-going monitoring of demand is important to decide when the actual bus priority facility is implemented. For example, segments along the Ring Road will only require separation from general traffic at such time as Ring Road volume to capacity ratios approach undesirable levels. Prior to that point, buses can operate acceptably in mixed traffic.

[2] Refer *Technical Report (3): Urban Public Transport Perspectives*, op. cit., for a more detailed discussion of bus priority systems and their application.

The proposed bus priority corridors, in addition to the 6th of October Trunk Busway, include strategic segments of the proposed urban expressway system as well as regional and urban primary road facilities (Figure 4.8.8). The priority facilities absorb considerable passenger volumes, all carrying up to 20,000 two-way persons per hour, with one segment along Expressway 3 in Giza carrying more than 20,000 two-way persons per hour (Figure 4.8.7).

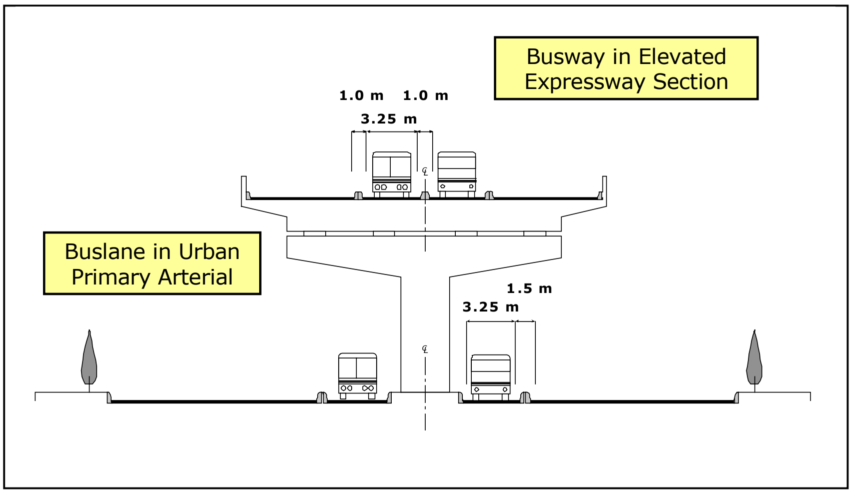


Figure 4.8.6 Potential Bus Priority Applications

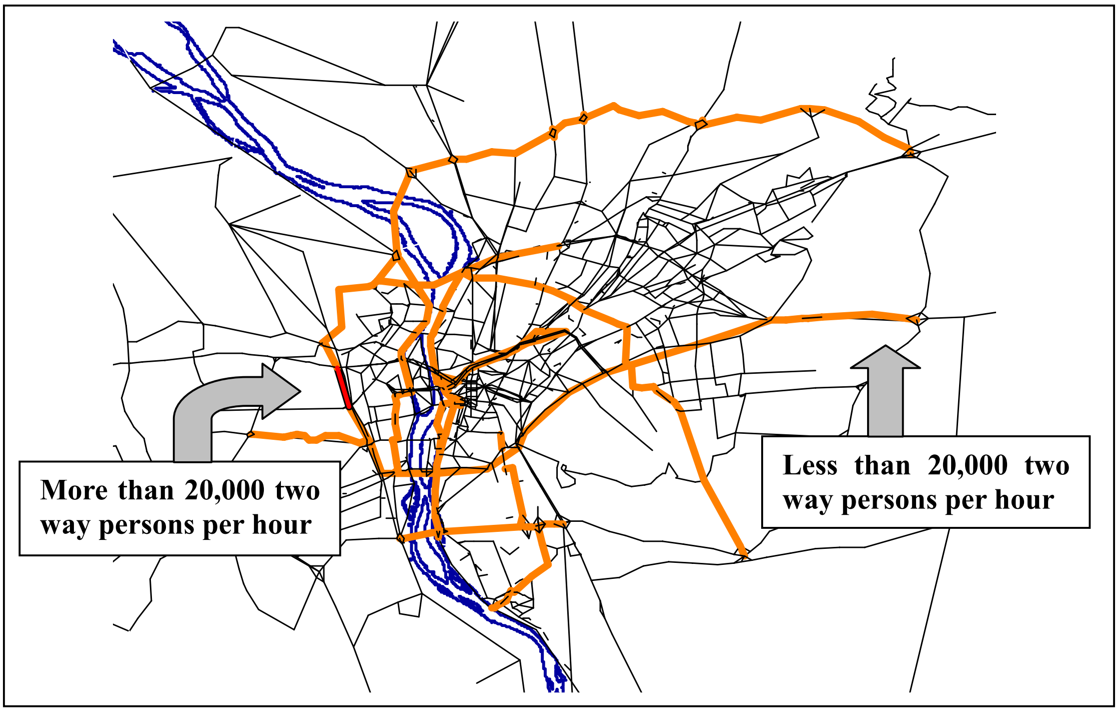


Figure 4.8.8 Year 2022 Demand: Bus Priority Facilities

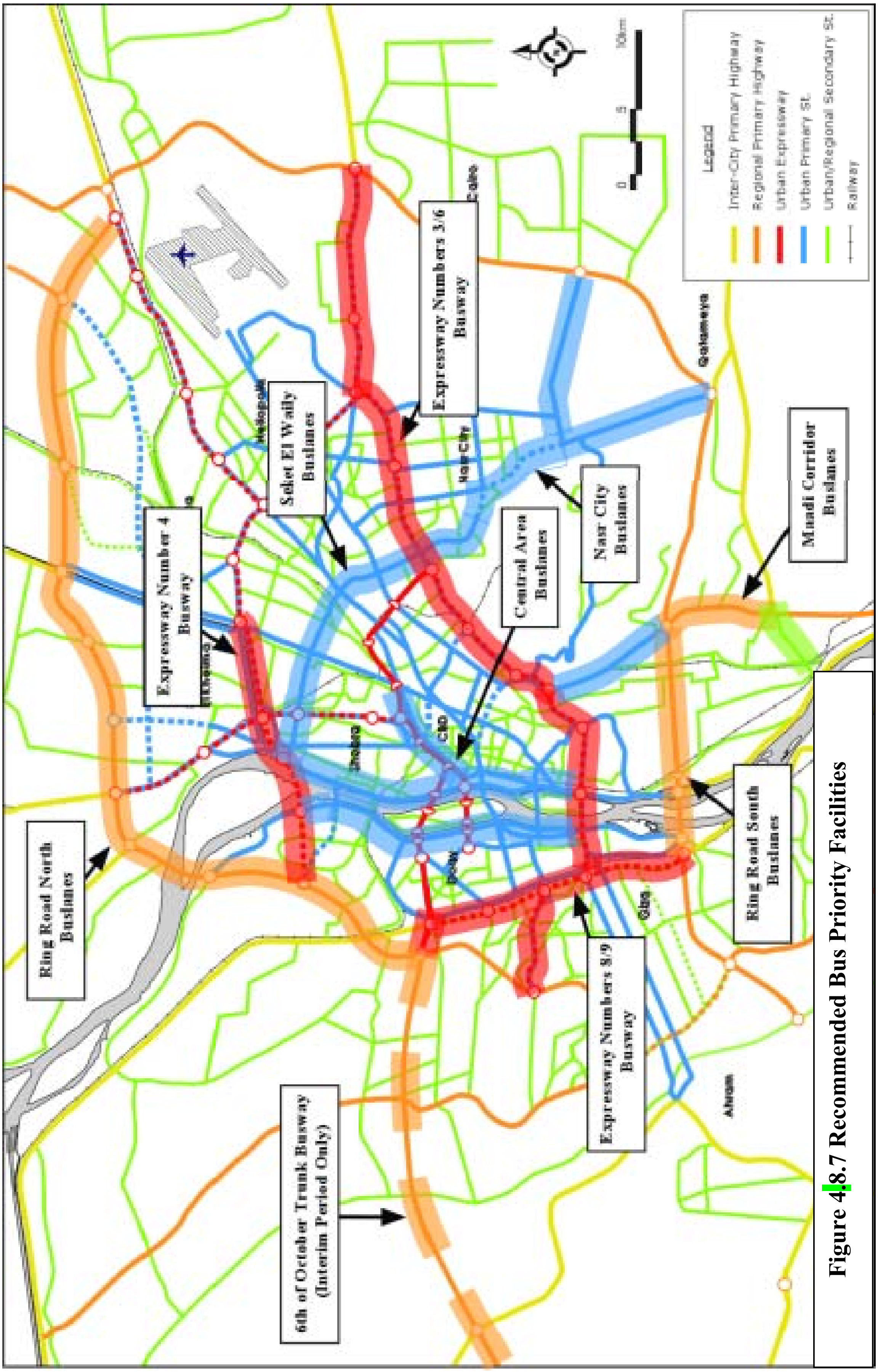


Figure 4.8.7 Recommended Bus Priority Facilities

Trunk Busway Alignment

Bus Stop

Station Entrance

Station Interior

Ticketing Counter

Turnstiles

Figure 4.8.9 General Features – Bogota Trunk Busway System

Ticket Processing Machine

Fare Card

Waiting Area

Articulated Bus

Bus Interior

Pedestrian Bridge to Median Bus Stop

Figure 4.8.9 General Features – Bogota Trunk Busway System (Cont'd)

The various subsystems include:

- 6th of October Trunk Busway: This facility is visualized as consisting of two bus lanes (With bypass opportunities at stations) within an exclusive alignment connecting 6th of October City, Sheikh Zayed City and metro lines 2 or 3. High-order service is to be provided via over-size, articulated buses operating at frequent headways. For illustrative purposes, Figure 4.8.9. provides a pictorial overview of a Bogota, Colombia trunk busway (This system is, at present, carrying some 34,000 persons per hour, total both directions of travel). Similar design principles could readily, depending on conclusions of further technical reviews as well as liaison with local experts and organizations, be incorporated into the 6th of October transit corridor. The linkage between 6th of October City and Cairo will possibly (but not certainly) follow the general alignment of the 15th of May corridor. Preliminary discussions with representatives of the MHUUC suggest that right-of-way may well be available within this corridor. Further, more detailed, JICA-sponsored feasibility studies have been proposed to clarify such issues immediately follow the completion of the Master Plan. These studies will consider alternative route alignments and technology options in seeking an optimum solution. In principle, based on current investigations, the 6th of October transit corridor will likely only require higher-order (And more expensive) rail-based solutions in the longer term future. Yet, certain priorities exist immediately, with the most pressing being the reservation of right-of-way. Once this is achieved, and shown forecast levels of demand (Which are expected to hover in the 25,000 person per hour per direction range), the intermediate construction of a trunk busway offers several advantages among them speed of implementation and modest cost (vis-à-vis rail). Trunk busway alignment and design must be so to ensure that, when warranted by demand, the busway proper would be replaced by some form of rail system within the same right-of way.

  The service scheme under either busway or rail scenario is identical: fast, convenient and corridor-oriented operation. The number of stations would be minimal, thus allowing speedy mainline service. Operation would essentially be a loop with turn-backs at system end points. System access would be via road based feeder operations. During the initial stage, a transfer would be required in the Doqi - Western Giza area with metro lines 2

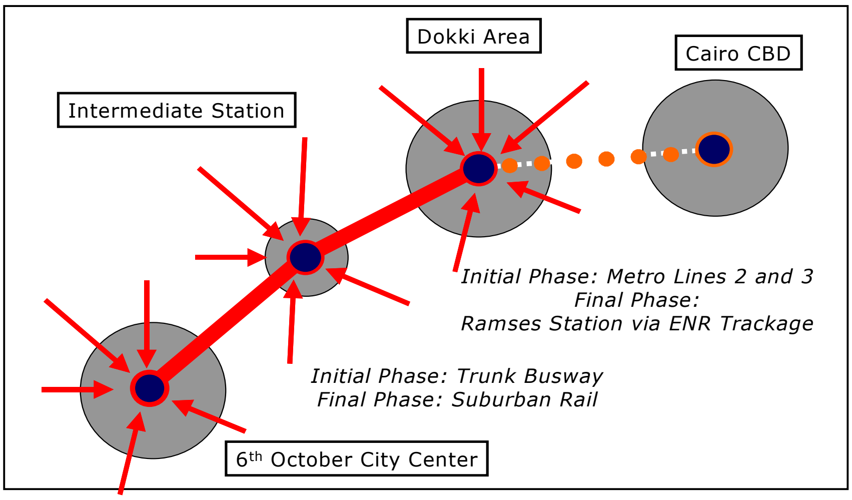


Figure 4.8.10 6th October Transit Corridor Service Concept

or 3 for Cairo CBD access. For the longer term option, the suburban rail service could, with proper selection of technology, transition to ENR trackage for a direct 6th October – Ramses Station service (Figure 4.8.10).

Costing for a trunk busway system must, with exception of core infrastructure, be drawn from overseas experience as little local precedence exists. It is expected that all of the specialized fleet, and components of mechanical devices (such as ticketing system) must be imported. Thus, costs will be considerable until such time as local expertise is established for, say, bus assembly and manufacturing. This is, based on the experience of other countries, eminently possible. The total cost of the busway, facilities and fleet is estimated at some 345 million constant year 2001 LE (Table 4.8.24). The indicated number of buses is based on a combination of year 2012 forecast demand, operating headway, operating speed, vehicle capacity and system operating length. It is noted estimated cost does not include land acquisition as preliminary discussions suggest the busway could be placed within existing rights-of-way. This issue should be reviewed in more detail during the recommended follow-on project feasibility study.

Table 4.8.24 Estimated Trunk Busway Capital Cost
6th of October Transit Corridor

Item	Amount (Million Constant Year 2001 LE)
Construction, 34 Kilometers	47.6
Stations and Depot	35.0
110 Buses	220.0
Mechanical Devices	20.0
Contingency (7 Percent)	22.6
Total	345.2

Source: JICA Study Team

- Urban Expressway Network: Busways along part of Expressway Number 4, as well as Expressways 3, 6, 8 and 9 (Refer Chapter 5 of this report for a discussion of the proposed urban expressway network). This system provides critical lateral dispersal options for public transport trips, with the Expressway 4 system functioning as an extension of LRT line 1 via an interchange point at Port Said Street. The facility also passes in close proximity of Zohoor and Abood intercity bus terminals, and takes advantage of the new proposed northern Nile River crossing. The southern segment utilizes the second proposed new Nile Bridge, follows, in essence, the Autostrad alignment, and extends as far as the eastern arc of the Ring Road. Various intermodal opportunities exist along this alignment with other bus priority systems, the LRT network, the metro and intercity bus terminals (Suez terminal, new Al Maaza terminal). The design of the expressway provides for two dedicated central bus lanes as depicted in Figure 4.8.6. This alignment is optimum for the intended bus operational scheme which, in essence, consists of a through loop service. That is, buses enter operation at one end of the system, pass along the entire extent of the busway, perform a turn-back loop at the opposite end of the system, and traverse the busway in the opposite direction back to the starting point where the loop is again initiated. Buses will thus never interact with the general traffic stream at any interchange except those located at system end points. The main focus of the system is a speedy and comfortable service; the location of stations must be carefully selected but would likely be limited to one station every five or so kilometers. At station approaches, the bus lanes would "drop down" to either ground level or to a mezzanine level (The expressway mainline will, in some locations, be located some 20 meters above ground level). The station itself, along with appropriate pedestrian facilities and linkages, would be located at these lower levels; thus, the expressway mainline level would only be used by vehicles.

The urban expressway bus priority network increases, in essence, the underlying expressway cross section by two lanes, to a total of six lanes (Refer Chapter 5 for discussion of expressway network concept). Thus, for costing purposes, bus priority treatments have been allocated the burden of providing two additional elevated lanes at a unit cost of 29.6 million LE per kilometer. The composite cost is estimated at some 1,639 million constant year 2001 LE (Table 4.8.25).

Table 4.8.25 Estimated Capital Cost
Urban Expressway Bus Priority Network

Item	Amount (Million Constant Year 2001 LE)
Construction, 48.5 Kilometers	1,435.6
12 Stations incl. Ramping	96.0
Contingency (7 Percent)	107.2
Total	1,638.8

Source: JICA Study Team

- Regional Primary Highway Network: The Ring Road serves as the core of this system, with bus service ultimately accommodated in bus lanes. No new mainline construction is foreseen once implementation is warranted from a demand point of view, but instead the conversion of existing traffic lanes from mixed to exclusive bus use. The Ring Road North System links a series of major radial systems including three metro lines, elements of the expressway priority system, satellite city corridors, El Marg intercity bus terminal, various park-and-ride facilities along the Ring Road and possibly Cairo international airport. The Ring Road South System likewise links elements of the expressway system, two Metro lines as well as Moneeb and Basateen intercity bus terminals.

Implementation cost is seen as being modest, as no new construction is anticipated, only lane conversion, traffic control and separation measures. Total cost is estimated at some 42 million constant year 2001 LE (Table 4.8.26).

Table 4.8.26 Estimated Capital Cost
Regional Primary Highway Bus Priority Network

Item	Amount (Million Constant Year 2001 LE)
Implementation, 50.0 Kilometers	12.5
11 Stations	22.0
Traffic Control Devices	5.0
Contingency (7 Percent)	2.4
Total	41.9

Source: JICA Study Team

- Urban Primary Street Network: As with the regional primary highway network, buslanes, either with-flow or contra-flow, can be considered. Segments passing through the Cairo and Giza CBD's, and paralleling the Nile River, with a spur to Ramses station, are intended to enhance through movements and improve flow at vital public transport nodes and stations in the area. An example of how bus lanes may be integrated with traffic management schemes is presented in Chapter 8 of this volume. The axis represented by the Seket El Wayly and Nasr City buslanes offer opportunity for transverse flow and dispersal opportunity for metro and LRT modes at moderate distance from the core area. The southern terminus of this system provides enhanced public transport options for Qatameya, southern New Cairo (In addition to LRT service to northern New Cairo) and Nasr City.

  As with regional highways, implementation cost is seen as being modest, as no new construction is anticipated, only lane conversion, traffic control and separation measures. Total cost is estimated at some 19 million constant year 2001 LE (Table 4.8.27).

Table 4.8.27 Estimated Capital Cost
Urban Primary Street Bus Priority Network

Item	Amount (Million Constant Year 2001 LE)
Implementation, 51.5 Kilometers	12.5
51 Stops	0.5
Traffic Control Devices	5.0
Contingency (7 Percent)	0.9
Total	18.9

Source: JICA Study Team

Bus lanes and bus streets included as part of the regional primary highway network and urban primary street network improvements should be seen as a traffic management measure (refer Chapter 8) whose implementation can be achieved, as shown previously, via modest expenditures. They can be very effective when road space is constrained and segregated rights-of-way for public transport are not available. As such, given that a gain of bus lanes is achieved at the expensive of standard traffic lanes, the treatment is a "move people, not vehicles" strategy.

A desirable complement to bus lanes is adjustments of traffic signal timing to facilitate bus flow at key intersections. This can substantially reduce average bus waiting times and can improve operating economy because bus delays at traffic signals usually represent 10 to 20 per cent of overall bus trip times and up to half of all delays. A short reserved bus lane upstream from a traffic signal in conjunction with bus priorities through a signal enables buses to bypass queues and move freely up to the intersection and then promptly through the signal, either on the normal green phase or on a special preempted phase.

Signal priority will have its greatest applicability along radial arterial streets leading to the city center, along arterials which intersect minor cross streets where network flow considerations are not important. At these locations, bus preemption can advance or extend the arterial green phase, particularly where signal cycle lengths are long and pedestrian requirements are minimal. In the city center, relatively little gains can be achieved from bus signal preemption. Any bus preemption should operate within prevailing traffic signal cycle lengths to be compatible with arterial and network flow considerations. Buses should be able to extend or advance the green in any given cycle.

(5) Cost Synopsis and Implementation Staging

Previous sections have presented the proposed public bus improvement program. In summation, total costs, in terms of constant year 2001 LE, are expected to aggregate to some 6.4 billion constant year 2001 LE over the 20-year planning horizon.

The implementation phasing considers that:

- The 6th of October trunk busway should be implemented during the initial five year period of the program (With right-of-way reservation proceeding immediately);
- The urban expressway bus priority treatment implementation is dependent upon the construction schedule adopted for the urban expressway network, and will thus gradually come into being over the course of the planning horizon;
- The regional primary highway bus priority treatment schedule will likely not have to be initiated until beginning the second five year period; and,
- The urban primary street priority treatments should proceed at the earliest opportunity, and have been included in the target areas transport management program (refer Chapter 8).

Highest outlay is anticipated during the first five year period, some 1.92 billion constant year 2001 LE, followed by the second five year period at 1.75 billion constant year 2001 LE (Table 4.8.28).

Table 4.8.28 Estimated Twenty Year Cost
Public Bus Services

Program	Amount (Mill Constant 2001 LE) by Five Years Ending				
Element	2007	2012	2017	2022	Total
Fleet Expansion and Modernization	1,153.7	1,009.0	1,153.7	1,009.0	4,325.5
6th October Trunk Busway	345.2	0.0	0.0	0.0	345.2
Urban Expressway Priority Network	398.7	709.6	253.4	277.1	1,638.8
Regional Primary Highway Priority Network	0.0	28.5	13.4	0.0	41.9
Urban Primary Street Priority Network	19.3	0.0	0.0	0.0	19.3
Total	1,916.9	1,747.1	1,420.6	1,286.1	6,370.7

Data source: JICA Study Team

4.8.6 The Nile Ferries

(1) Description and implementation staging

CTA operates 10 ferry lines for passenger transport which can be separated in two categories :

- Transversal lines that cross the Nile providing direct connections between the two banks of the Nile or between the banks and the islands of Waraq, Zamalek and Gazirat Al Roda; there are five such lines in total;
- Radial lines that follow the Nile and have several stops on the banks of the Nile or the previous mentioned islands; there are five such lines in total.

The ferry network was put into service in 1966 with six lines. At the beginning, these lines crossed the Nile in order to link the two banks and were short lines (on average 2 km/line). Now, the service has been extended and some lines have been created not only to cross the Nile but also to follow the Nile (from North to South).

The CREATS team proposes to implement a new express ferry line following the Nile between Maadi, the central area, Imbaba, Shobra and Warrak. The average speed of this service should be 30 km/h instead of 9-14 km/h of the current service. Headways should be low around 10 minutes in order to provide an attractive commuter service.

(2) Service performances

a) Trips demand

The new line is expected to carry 25,000 passengers per day in 2022 with a maximum of 1,000 passengers per direction on the busiest section during the peak hour periods .

b) Supply indicators and fleet requirement

The new express ferry capacity is supposed to reach 110 persons. The length of the line is 25 km and includes 11 stations, although this total is flexible and can readily be adjusted based on operational requirements. The calculated required fleet is 17 new boats, with a minimal 6 minutes and 30 seconds headway. The ferry annual kilometers is estimated to reach 2 million boat-kilometers.

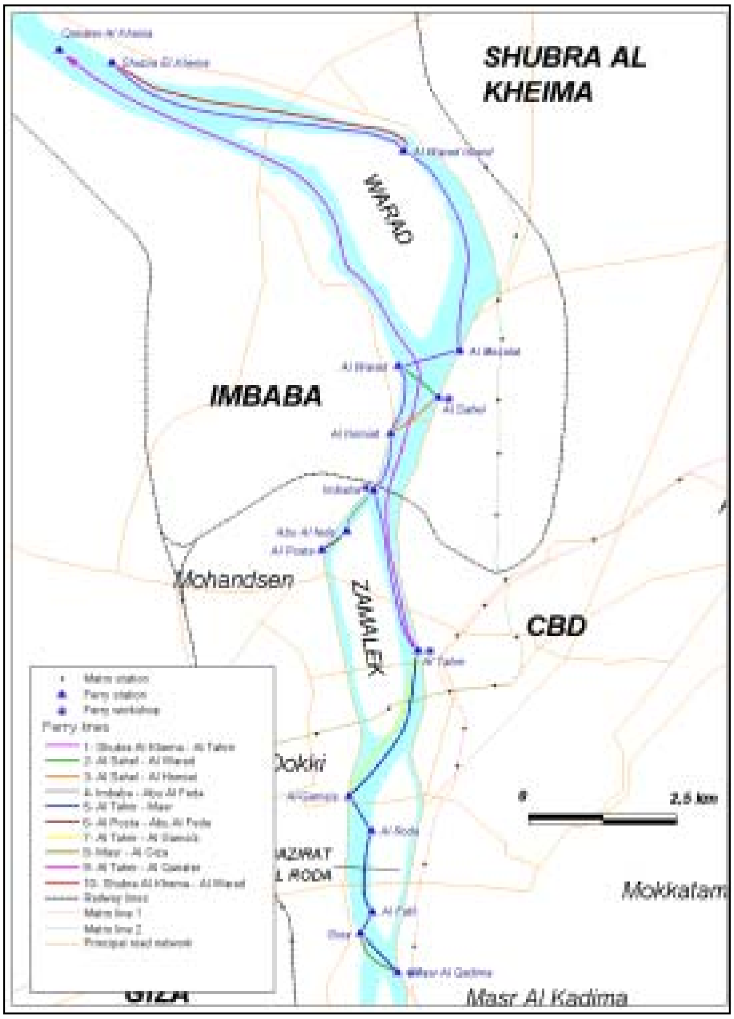


Figure 4.8.11 CTA Nile Ferry Lines

(3) Capital cost

The capital cost of the new recommended line includes construction of boat stations and purchase of 17 new ferry boats. The required capital cost is 50 million LE (Table 4.8.29).

Table 4.8.29 Estimated Twenty Year Cost Ferry Line Service

CREATS Proposal		Length (km)	Unit Cost (LE mil)	Cost (LE mil)	Implementation Period 02-07	08-12	13-17	18-22	Agency
				50.0	25.0	25.0			
PTF1	Fleet Expansion, Modernization; Stations	25.0	2.0	50.0	O	O			CTA

CHAPTER 5: URBAN ROAD SYSTEM

5.1 EXISTING ISSUES, OPPORTUNITIES AND CONSTRAINTS

The urban road network system in the Study Area can be discussed in two major categories. One is the regional corridor network which has a higher capacity or higher order of design to serve for regional traffic movement in the Study Area, which are mostly the Ring Road and its radial routes for connection with suburban communities. The other is the urban corridor network which is to serve for the traffic movement among the urban centers, mostly inside of the Ring Road. The major regional corridors have generally a high design standard with multi-lane divided structure, which can accommodate high level of service. Many of major urban corridors also generally have wide and divided multi-lane structures. The rapid increase of the number of vehicles and the dynamic growth of urban economic activities, however, have been escalating the traffic volume all over the region, which keeps creating a lot of problems in the area. Those problems necessitate many of the streets to have complex direction control at many of intersections, which creates additional movements and detours.

According to CREATS Road Condition Survey, the current pavement conditions of major roads in Cairo are generally good. However, an example of Cairo Governorate shows that the annual road maintenance budget is about 30 % of the estimated annual requirements. This suggests that the maintenance effort has been concentrated on major arterial streets, and there is a substantial backlog of maintenance on the lower classes of roads.

As a recent major achievement in the GCR road sector, the Ring Road has been constructed, which has total length of 95 km with 22 interchanges. The 6th of October Elevated Expressway has been a long-term urban expressway project in the center of Cairo. The 11.3 km viaduct project commenced in 1969, and completed in 1999. The Azhar Tunnel project was planned to connect Opera Square and Salah Salem Street by two one-way tunnels to improve one of the major chronic bottleneck of Azhar Street around Khan Khaleely area, which opened in October 2001.

The discussion of road capacity is coordinated among the various sectors and provides quantitative and relational guidelines for the road sector (principal focus: road and intersection analysis), public transport sector (principal focus: bus capacities in mixed flow and within priority treatments); and, modeling sector (principal focus: simulated network development and associated speed, capacity and volume interactions). In defining the capacity, while the *US Highway Capacity Manual* is considered an excellent choice as a basis for the Egyptian capacity framework, Cairo driving behavior, enforcement practices, right-of-way rules, traffic mix and other issues, under urban conditions, do differ from those observed in more developed cities. Such considerations will impact approaches, and results from, more detailed capacity analysis. Yet, unfortunately efforts to rigorously quantify speed, volume and capacity of urban roads in emerging cities have, to date, been limited. A milestone exception to this pattern are recent investigations supported by the World Bank and Asian Development Bank in a Southeast Asian context, which has been advanced through the release of an *Indonesian Highway Capacity Manual* (IHCM) and development of the *Integrated Road Management System* (IRMS). The approach adopted by CREATS is to utilize the strength of these various techniques as well as findings in a unified and mutually complementary manner to keep the Egyptian framework as practical as possible.

A comparison of the survey results in observed travel speed and traffic counts have yielded several prominent implications particularly in defining a speed-flow relationship for CREATS road capacity. The observed speed-flow relationship on the 6th of October Expressway have shown a reasonable results when the directional nominal number of lanes (NNL) is redefined as actually being 2.5 effective number of lanes (ENL). However, the survey data and previous reviews in Egypt, pertaining to operations along urban arterial streets confirm that speed-flow relationship under interrupted and semi-interrupted conditions depend on many variables, and identification of a clear speed-flow curve is considered problematic. Investigations therefore focused on an analysis of observed speed ranges and observed volume ranges. Lane usage patterns along arterial streets mirror those noted on the expressway, that is, as flow conditions approach saturation, the ENL exceeds the NNL. Thus, an adjustment is again in order to reflect this fact, which typically increases the NNL by 0.5 lanes for multi-lane arterials.

The Cordon Line traffic count results show that the daily total volume of 322,411 vehicle/day, or 480,134 pcu/day goes out and comes into the Study Area. Among the 18 Outer Cordon locations, the volume on Alexandria Agriculture Road is by far the dominant. The Inner Cordon locations, which are the boundary of GCR and the new suburban communities in the east and west, show pretty high volumes, too. The hourly fluctuation pattern on these Inner Cordon have a clear *outbound peak in the morning, and inbound peak in the afternoon*, which is totally opposite pattern from other locations.

The Screen Line traffic count results show that the daily total volume of 896,085 vehicle/day or 1,003,753 pcu/day crosses the Nile River in the Study Area. Among the bridges over the Nile, the volume on the 6th of October Bridge is by far the dominant.

Traffic conditions at major districts show that the traffic flow from Central Giza, Central Cairo through Heliopolis/Nasr City is the major flow direction in the urban area. Particularly, the 6th of October Expressway, Salah Salem Street and Nasr Road (Autostrad) are the heavy volume corridors. In the west of Giza, the parallel corridors of Haram Street (the Pyramid Road) and Malek Faysal Street are very high-volume corridors. Many other major arterial streets connecting suburban districts and urban centers also show very high volumes.

In contrast with the administrative classification of road network, which focuses on responsibility of maintenance of the roads, the road classification by function is the indicator of importance for planning/design purposes. The objective of the functional classification of urban road network in CREATS is to provide more efficient usage of the road system by giving different priorities and policies to different classes of the road network. As a proposal, the definitions of functional classes in Cairo context are proposed, and the recommended policies on the major fields of road management, which are, road structure, traffic management, and environmental policy, for each classes of roads are discussed, together with a proposal of classification for National Primary Arterial, Regional Primary Arterial and Urban Expressway.

The key issues in the urban road system are summarized as in three topics. The first is *the completion and extension of the Ring Road network*. Although the Ring Road network is basically complete with the opening of the final link between Cornish Street and Autostrad, unclosed Ring Road in southwest Giza will still remain a problem in the network since north-south traffic demand on the Ring Road at the western part of Cairo stays in an inconvenient condition without a direct linkage.

The second key issue is *the elevated expressway extension in the urban area*. The completion of the 6th of October Expressway gave a large impact on traffic movement in Cairo. In the long-term road sector planning in GCR, the extension of urban expressway network will be an important alternative.

The third key issue is *the future urban development scenarios and regional road network system*. The pioneer Egyptian policy of urban expansion in the desert has created more than 10 new communities in the desert. Today many private industries are in function, and housing units and infrastructure have been built or under construction. Although the current population in these new cities still stays in moderate number, it is important to quantify the ultimate traffic demand and secure the right of way for the future transport needs, even though the construction may start much later.

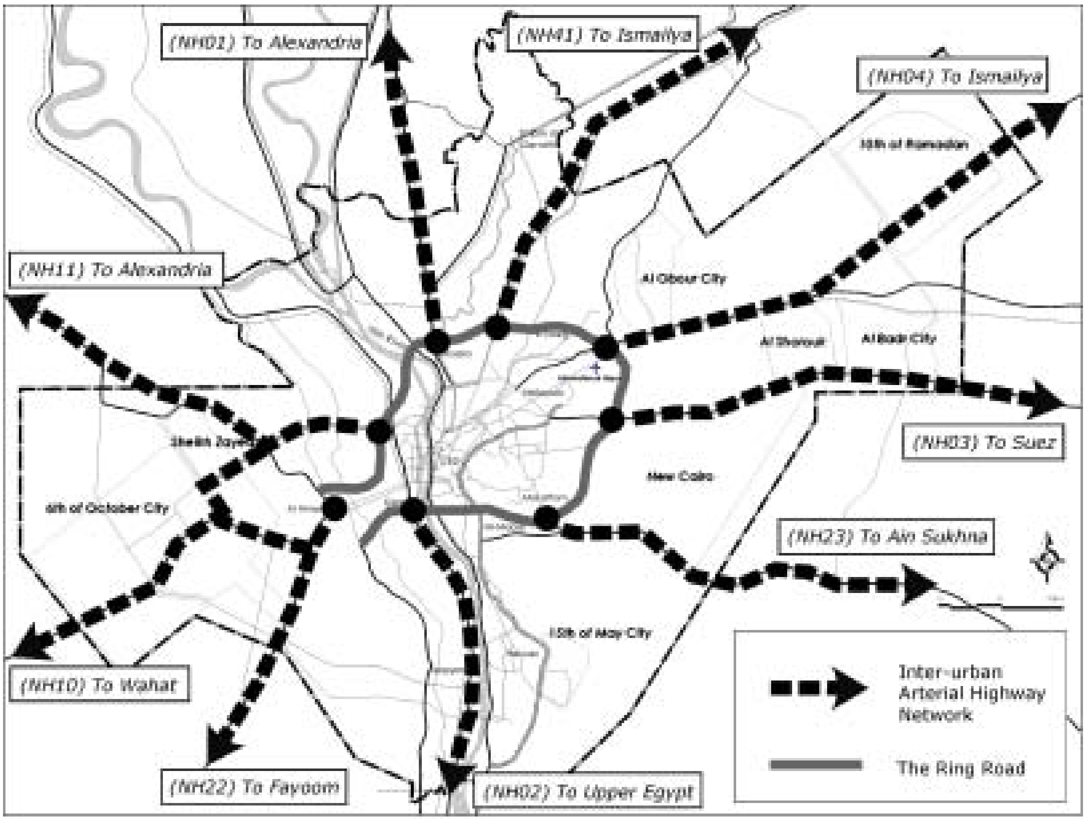
5.2 URBAN ROAD HIERARCHY STRUCTURING

5.2.1 ISSUES: Current Road Network Hierarchy

(1) National Highway Network System

Greater Cairo is the center of nationwide road network of Egypt. It is located at the mouth to the Delta, and the road network to the north will widely spread from Cairo. Road network to the south along the Nile is the traditional and the most important network to the Upper Egypt. The long-term national plan of new community development, however, has been aiming to proceed towards the desert in the east and west to protect the arable land along the Nile, and the national road network has also given higher priority to develop eastward and westward linkages.

Such historical background has formed a radial-circumferential pattern of national road network around Greater Cairo. Figure 5.2.1 shows the present major national arterial highway network from the Ring Road.



Source: JICA Study Team

Figure 5.2.1 National Arterial Highway Network

The national traffic count data shows a steady growth of traffic volume on these national highways (Table 5.2.1). Among these national corridors the Alexandria Agriculture Road is by far the busiest corridor, followed by the Ismailya Desert Road, which shows a prominent traffic growth.

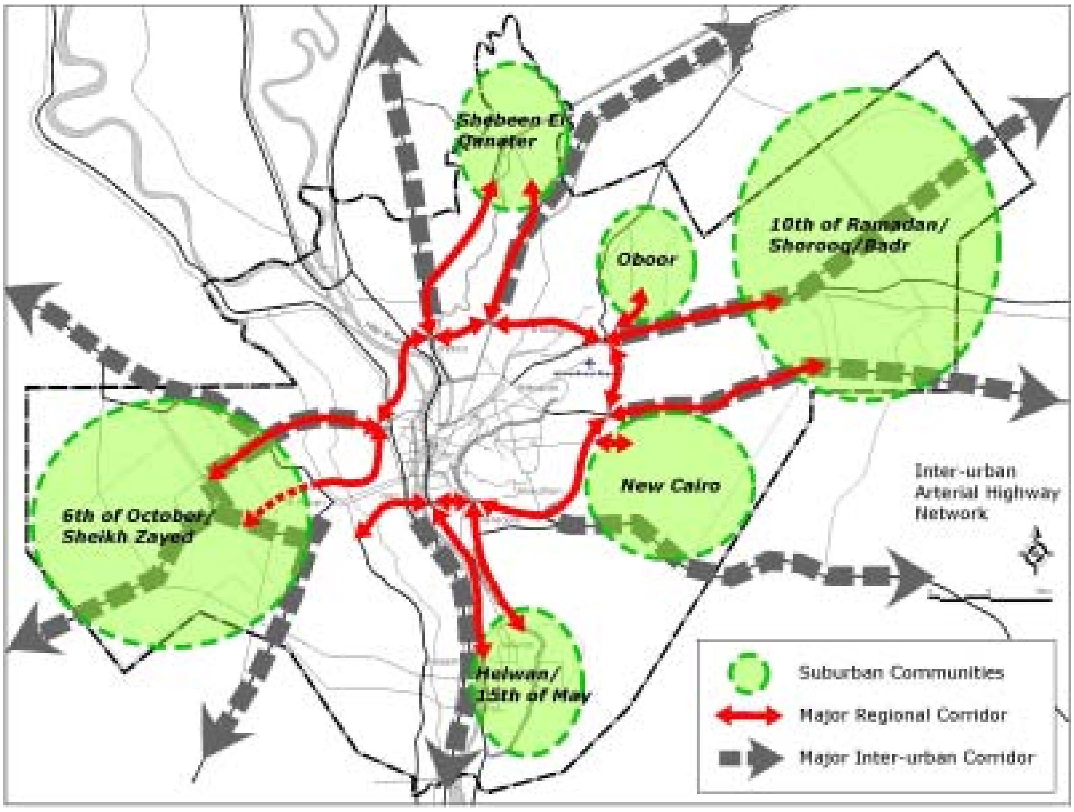
Table 5.2.1 National Traffic Count Data (outside of the Study Area)

No.	Corridor Name	1991 Volume (vpd)	2000 Volume (vpd)	2000/1991	Annual Growth
NH11	Alex. Desert Road	8,821	17,886	2.03	7.32%
NH01	Alex. Agriculture Road	38,919	55,163	1.42	3.55%
NH04	Ismailya Desert Road	8,961	*32,772	3.66	13.83%
NH41	Ismailya Agriculture Road	5,724	10,109	1.68	5.35%
NH03	Suez Desert Road	4,907	10,962	2.23	8.37%
NH21	Upper Egypt Desert Road	8,604	10,349	1.20	1.86%
NH22	Fayoom Desert Road	4,846	10,792	2.08	8.34%

Source: General Authority for Roads, Bridges and Land Transport
*Note: NH41 Year 2000 Volume is an estimated value from 1999 volume due to the change of counting location.

(2) Urban Road Network System

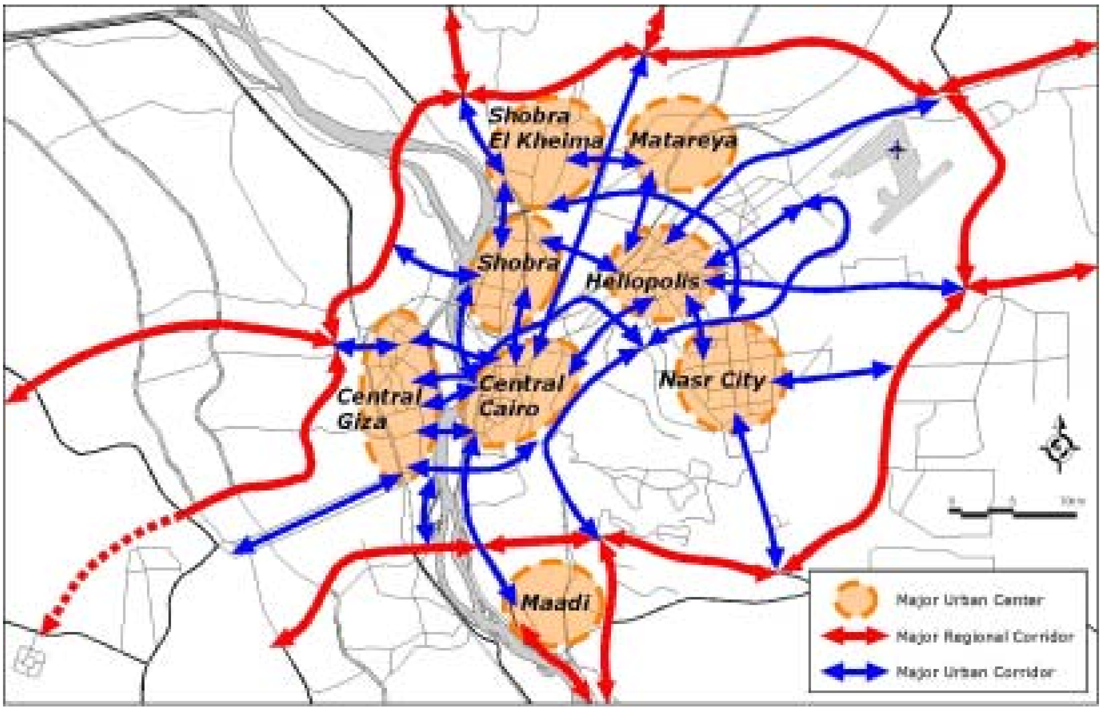
The urban road network system in the context of CREATS Study Area can be discussed in two major categories. One is the regional corridor network which has a higher capacity or higher order of design to serve for regional traffic movement in Greater Cairo Region and the entire Study Area. The other is the urban corridor network to serve for the traffic movement among the urban centers, mostly inside the Ring Road. Figure 5.2.2 shows the relationship of the major suburban communities



Source: JICA Study Team

Figure 5.2.2 Suburban Communities and Regional Road Network

versus the regional corridors in the Study Area, whereas Figure 5.2.3 shows the relationship of the major urban centers versus the regional and urban corridors in the area inside the Ring Road.



Source: JICA Study Team

Figure 5.2.3 Urban Centers and Regional/Urban Arterial Road Network

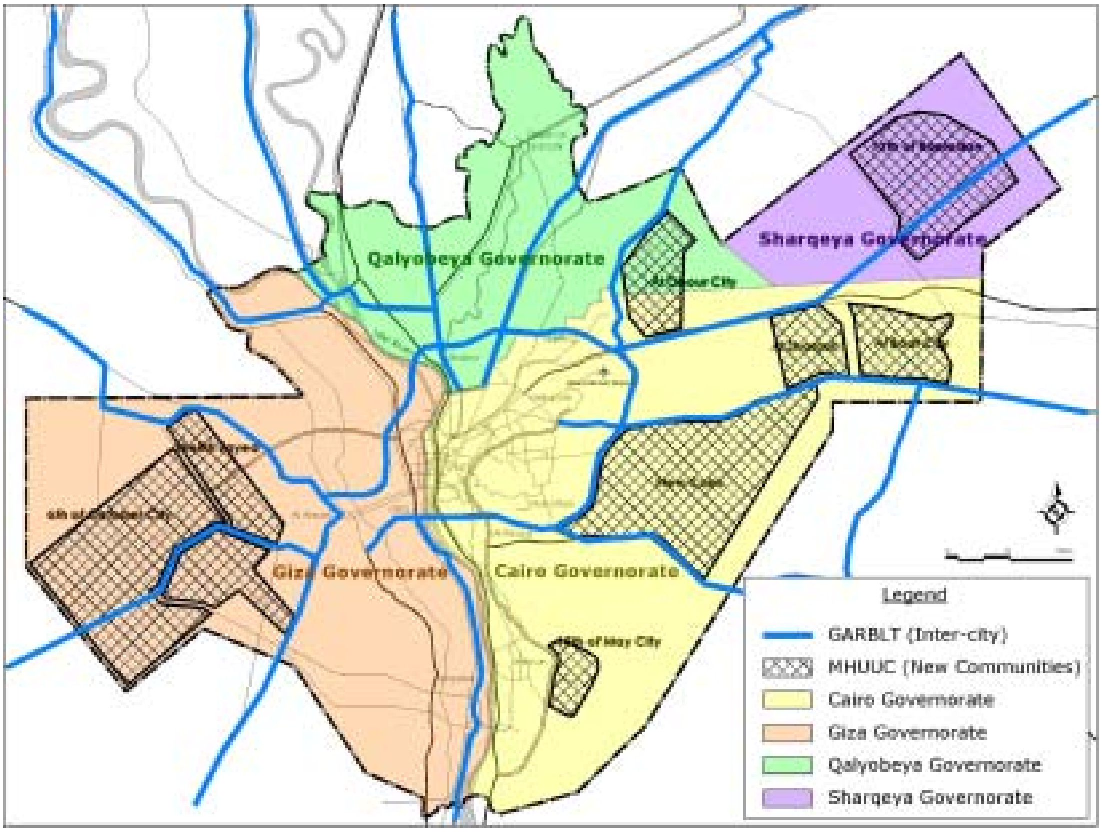
The major regional corridors have generally a high design standard with multi-lane divided structure, which can accommodate a pretty high level of service. The Ring Road was planned for the physical boundary of urban area, as well as serving as bypasses for regional traffic to avoid coming into the urban centers. The Autostrad (Nasr Road) was planned to carry a major portion of traffic between Helwan/15th of May City and the urban centers. The 6th of October Elevated Expressway, which is locally called "6th of October Flyover", functions as de facto urban expressway in the city center. The length of this Expressway is still short (11.3 km), but it certainly functions to serve for higher-grade services.

(3) Administrative vs. Functional Classification of Road Network

The traffic congestion on the road network in GCR is often caused by an imbalance between too little road capacity and too much traffic demand. However, generally the road space in Cairo is wider than many of other mega cities in the world, and the road network in GCR has high capability of flowing the existing demand. In many cases, the traffic problems in the city are caused by inefficient traffic flow in the road network, and ineffective traffic management. One of the missions of the road sector master plan should be to propose an optimum network structure within the existing framework and constraints.

To make the traffic flow efficient, it is critically important to classify the road network in accordance with the function of the links so that the policy for development and improvement of the links will be rationally implemented for the traffic flow optimization.

Currently the road network in the Study Area is classified into several administrative or jurisdictional responsibilities in terms of road maintenance. Figure 5.2.4 shows the administrative classification of the existing road network in the Study Area.



Source: JICA Study Team based on the information from governmental sources

Figure 5.2.4 Administrative Classification of Roads in the Study Area

Most of the inter-city roads are under the responsibility of General Authority for Roads, Bridges and Land Transport (GARBLT). The boundary of responsibility under GARBLT on these roads terminates at certain location at or inside of the Ring Road. All the other road network is under the responsibility of each Governorate, namely Cairo, Giza, Qalyobeya and Sharqeya. The exceptions are in the new communities, where all the roads are under the responsibility of the Ministry of Housing, Utilities and Urban Communities (MHUUC). In GCR there have been many cases that MHUUC constructed the roads and transferred to the MOT or the Governorates. The examples are the Ring Road, of which the transfer to the MOT is still going on, and the 26th of July St., which was transferred to Giza Governorate, and Autostrad, which was transferred to Cairo Governorate.

In contrast with these administrative classifications, the road classification by function is the indicator of importance for planning/design purposes. The purpose of the following sections is to discuss and propose functional classification of the road network in the Study Area. The fundamental concept in urban road system planning is to separate the spatial structure for vehicles from that for pedestrians and residents.

5.2.2 APPROACH: Functional Classification for GCR Urban Road System

In the modern urban transport system, the expected function of roads is to achieve sufficient or acceptable mobility for vehicular traffic on one hand, and yet provide comfortable urban living environment to pedestrians and residents on the other. It can be attained by a careful urban road design in case of new community developments. In the existing urban area, however, it is quite difficult to apply such a systematic separation of vehicles from pedestrians and residents. In many cities over the world efforts have been made to increase the capacity of traffic on the existing urban road system on one hand, and yet to maintain comfort of pedestrians and living environment on the other by providing additional physical or institutional improvement to the existing road network and structure.

As a result of these efforts, it is widely accepted that the separation of the vehicle and people in the network can be maximized by functionally classifying the existing road systems, and by applying different policies and regulations depending on the function of the road.

The function of a road can fundamentally be measured by **mobility** of the vehicle, and **accessibility** to the adjacent land space and activities. Although all of the road links are expected to have both functions, the unplanned mixture of these two functions will cause higher side frictions on main highway or increase of accidents by through traffic in the residential area. It is therefore critically important to classify the road links depending on which of these two functions should have more priority.

The objective of the functional classification of urban road network in CREATS is to provide more efficient usage of the road system by giving different priorities to different classes of the road network. The ultimate goal would be the traffic enforcement policies and regulations will conform to the criteria of the functional classification so that the maximum mobility can be attained at the higher level of road network, and maximum safety and comfort can be attained with better accessibility at the lower level of the road network.

It is therefore necessary to identify three basic terms of spatial connection for the purpose of defining the function of roads. **National connection** is defined as the spatial connection of the Study Area (GCR and the defined additional new communities) with other urban areas outside of the Study Area. **Regional connection** is defined as the spatial connection within the Study Area and its vicinity between the urban area inside of the Ring Road and the suburban communities outside of the Ring Road. **Urban connection** is defined as the spatial connection between the core urban centers inside and around the Ring Road.

The Study Team recommends that the functional classification of the CREATS Study Area be based on the definitions as follows:

National Primary Arterial Highway

- The highest level of national corridor which carries major portion of long distance trips with highest level of travel speed and minimum mileage attained by higher design standard and higher control of access.

- It will have an access to urban area through urban expressway, regional primary highway, urban primary arterial streets, and will not have a direct connection to the lower classes of urban streets.

Regional Primary Arterial Highway

- The highest level of regional corridor which carries major portion of trips between central metropolitan area and suburban new settlement areas in and around the Greater Cairo Region.

- It will have an access to urban area through urban primary and secondary arterial streets, and will not have a direct connection to the lower classes of urban streets.

Urban Expressway

- The special type of urban primary arterial streets which carries major portion of urban trips in the metropolitan area with highest level of travel speed and minimum mileage attained by higher design standard and full control of access.

- It will have a grade separation to all other structures attained by, most of the cases, a viaduct or tunnel structure above or below existing urban primary arterial streets, and will have an access to urban primary arterial streets through interchange only.

Urban Primary Arterial Street

- The highest level of at-grade urban corridor which carries major portion of trips inside urban area.

Urban Secondary Arterial Street

- Interconnects and augments the urban primary arterial system to provide services to trips of moderate length in urban area.

Collector/Distributor Street

- The main street in a residential or commercial unit surrounded by the primary and secondary arterial network which collects and distributes the local traffic to/from the primary and secondary arterial street network.

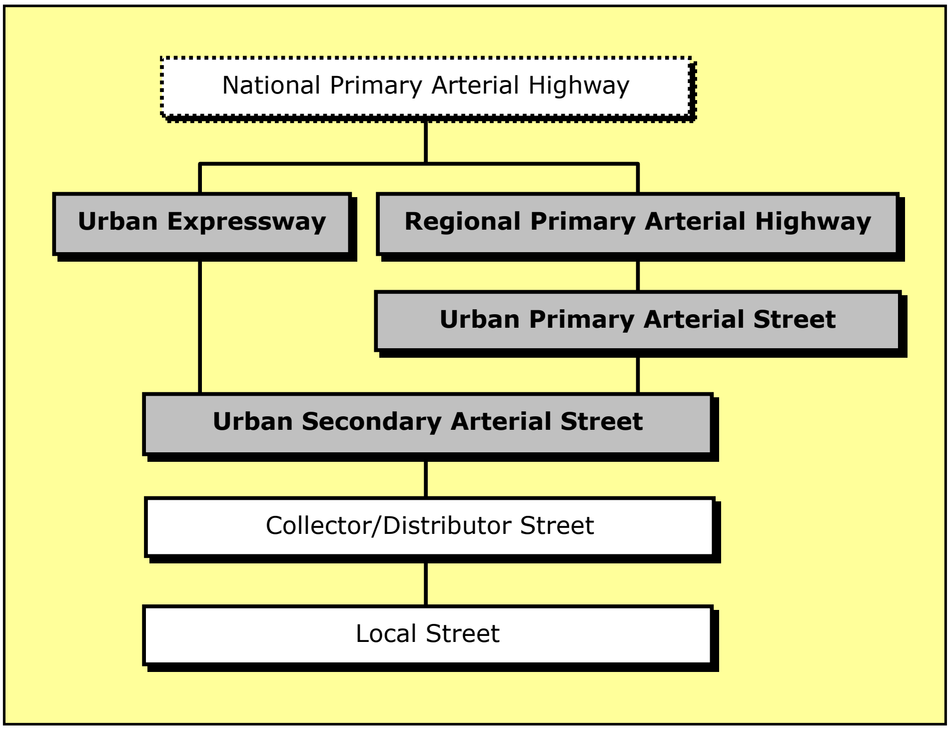
- The passing trips across the residential and commercial area will be excluded.

Local Street

- The lowest level of urban street in the residential or commercial unit surrounded by arterial street network. The main function will be full accessibility to the adjacent land space, and traffic volume and speed will be controlled for local residential/commercial activities.

- Direct connection to higher classes of urban streets will be provided through collector/distributor streets so that the residential/commercial environment will be highly protected against passing traffic.

The proposed hierarchical relationship among these classes of roads is shown in Figure 5.2.5.



Source: JICA Study Team

Figure 5.2.5 Proposed Hierarchy of Functional Classes of Roads

5.2.3 ACTION: Road Network Hierarchy and Development Policies

As a regional master plan study, the focus of CREATS will be to propose the road management policy for four major classes of the hierarchy, Regional Primary Arterial Highway, Urban Expressway, Urban Primary Arterial Streets and Urban Secondary Arterial Streets among the others.

In the conventional functional classification category, Urban Expressway was included in Urban Primary Arterial Street, since the difference in these two was mainly in road structure, rather than function. In the modern urban road system, however, Urban Expressway has unique functions compared with other Urban Primary Arterials. It has much higher capacity with full control of access, and it can attain much higher operational speed on the roadway due to the grade separation against all other crossing streets. Particularly when Urban Expressway is developed as a network system in urban area, it obviously provides a higher level of service to the vehicular traffic, which necessitates a different transport policy for its function from other classes of roads. It is therefore recommended that Urban Expressway be given an independent functional class.

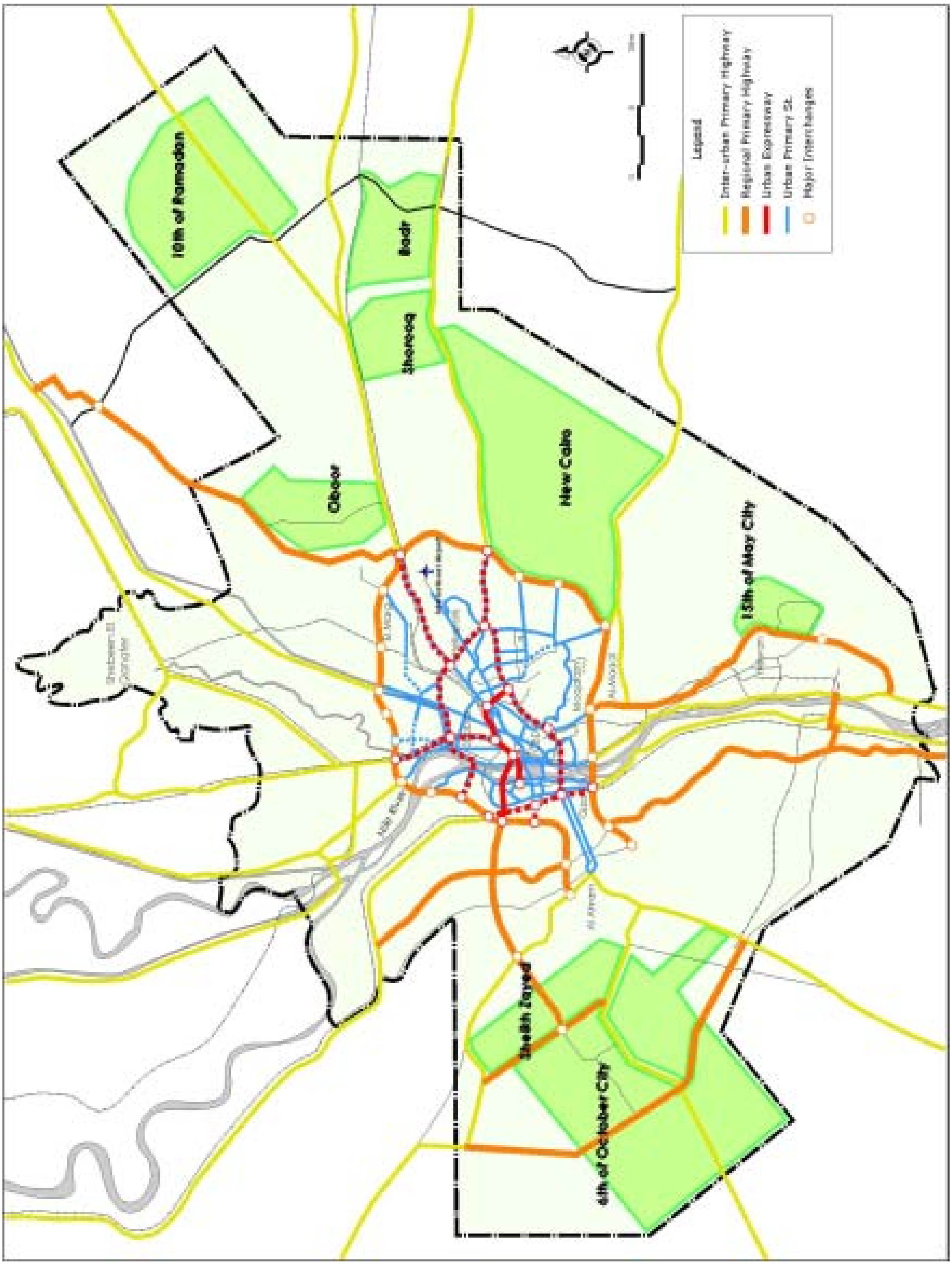
In the context of Greater Cairo Region, or the Study Area, it is recommended that the road network be classified as in Figure 5.2.6 for the entire Study Area, and in Figure 5.2.7 for within the Ring Road area. Table 5.2.2 shows recommended policies on three major fields of road management, road structure, traffic management and environmental measures for each class of roads including National Primary Arterial. The fundamental criteria for this policy definition are higher control of access to achieve higher mobility in the higher classes of roads, and more pedestrian and resident friendly provisions for lower classes of roads. Also, Figure 5.2.8 through 5.2.12 shows recommended typical cross sections for Regional Primary Arterial Highway, Urban Expressway, Urban Primary Arterial Street and Urban Secondary Arterial Street, respectively. These recommendations for the typical cross sections do not mean that all of the streets should follow such cross sections. However, when new streets are planned and constructed or existing streets are improved, it will be a guide specification for the design so that such new links would satisfy their functional responsibility. The number of lanes should be determined by the expected traffic demand for the design year.

The Regional Primary Arterial Highway and Urban Primary Arterial Street should have a wide lane designation of 3.5 m to attain the highest level of service. This is the widest lane designation from any international standard. Any wider lane than 3.5 m would not be recommended under any planning purposes because it would result improper lane usage (i.e. parallel drive). The Regional Primary Highway should have a open median of at least 6 m for division of opposite traffic (Figure 5.2.8). It is recommended that Urban Primary Arterial Street be designated to have frontage road wherever the right-of-way is available, so that the highest mobility can be attained by eliminating roadside activities from the through traffic lanes (Figure 5.2.9). The Urban Primary Arterial Street should have at least 6 m median, wherever possible. This can be used for landscaping for the initial purpose, and also it could be utilized for pier of any elevated structure for expressways or rails in the future (Figure 5.2.10).

The Urban Expressway section should be able to accommodate high-speed (60 – 100 km/hr) traffic on the viaduct, yet the lane width of 3.25 m is recommended so that it should minimize the road width for the viaduct on existing streets. The CREATS public transport plan suggests exclusive busways and bus priority lanes on many streets and expressways. When a busway is planned, the typical cress section can be as in Figure 5.2.11.

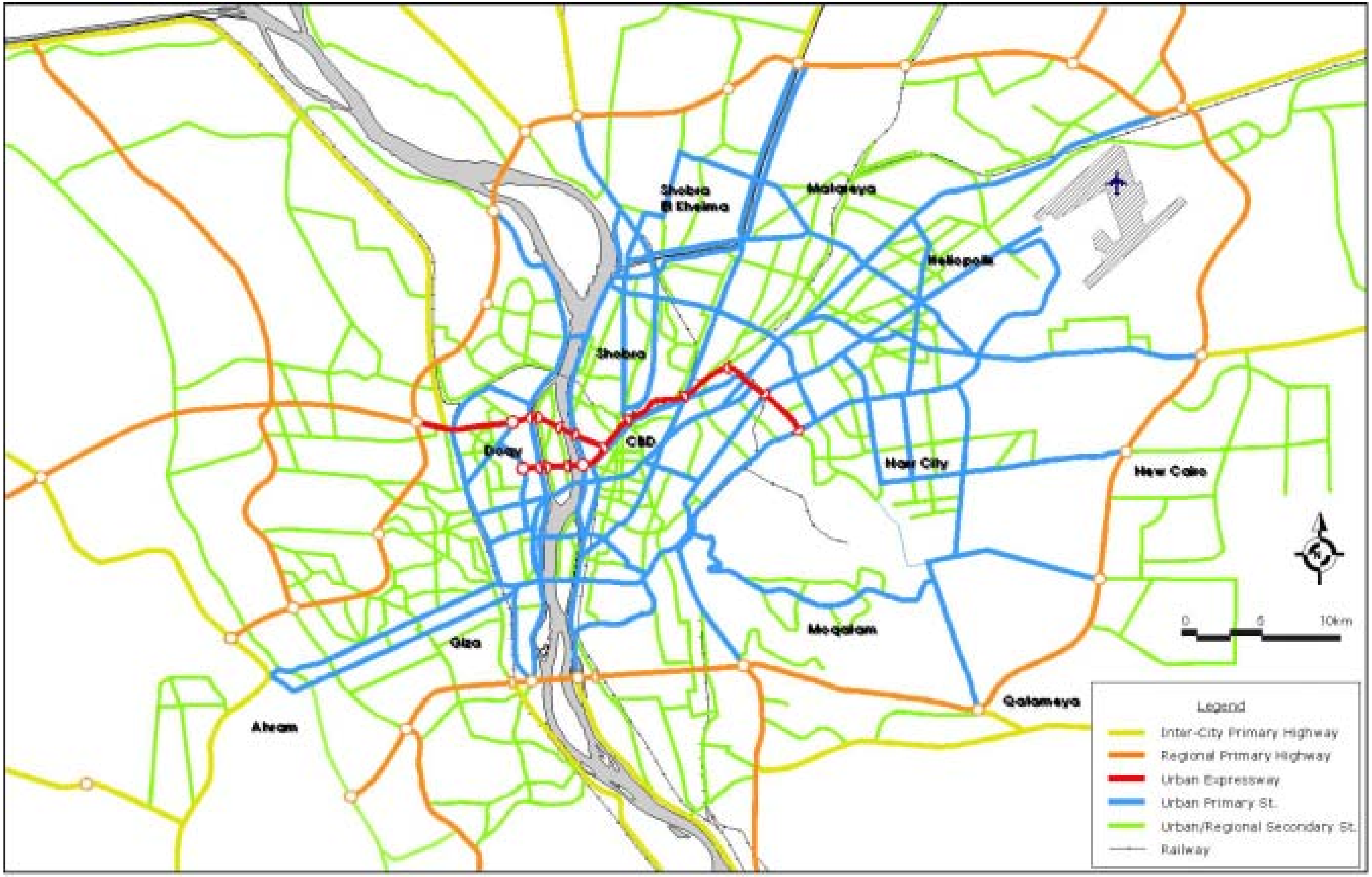
The cross section for the Urban Secondary Arterial Street can be slightly narrower than that of Urban Primary Arterial Street to save the space for the right-of-way. The recommended lane width of 3.25 m is still wide enough to satisfy any major traffic stream (Figure 5.2.12). A cross section of “without shoulder” case is also provided for the Urban Secondary if there is a limitation for the right-of-way, which can be more often the case for Urban Secondary Arterial Street (Figure 5.2.12), where the possibility of compromise on road structure might be higher than the Urban Primary Arterial Street due to the hierarchical importance in the network.

In the higher classes of roads (Regional Primary and Urban Expressway), the road structure will enable the vehicular traffic to attain maximum operational speed in safer conditions. In the medium classes of roads (Urban Primary and Urban Secondary), which most of major streets in the city belong to, should have a reasonable balance of mobility and accessibility. For Urban Primary the mobility should still prevail than Urban Secondary. In the lower classes of roads (Collector/Distributor and Local), higher level of control against through traffic should be applied so that the residential environment, pedestrian comfort and convenience will be attained. For the comprehensive zonal traffic control, many options can be applied. One extreme policy is to physically ban entire vehicular traffic in a zone to provide a mall in the area. This can be applied to a busy commercial zone, for example. A moderate policy can be to discourage the vehicles having no purpose in the zone to come into the zone by furnishing artificial obstacles so that the vehicles in the zone are obliged to reduce the speed.



Source: JICA Study Team

Figure 5.2.6 Recommended Functional Classification of Existing Road Network (for Study Area)



Source: JICA Study Team

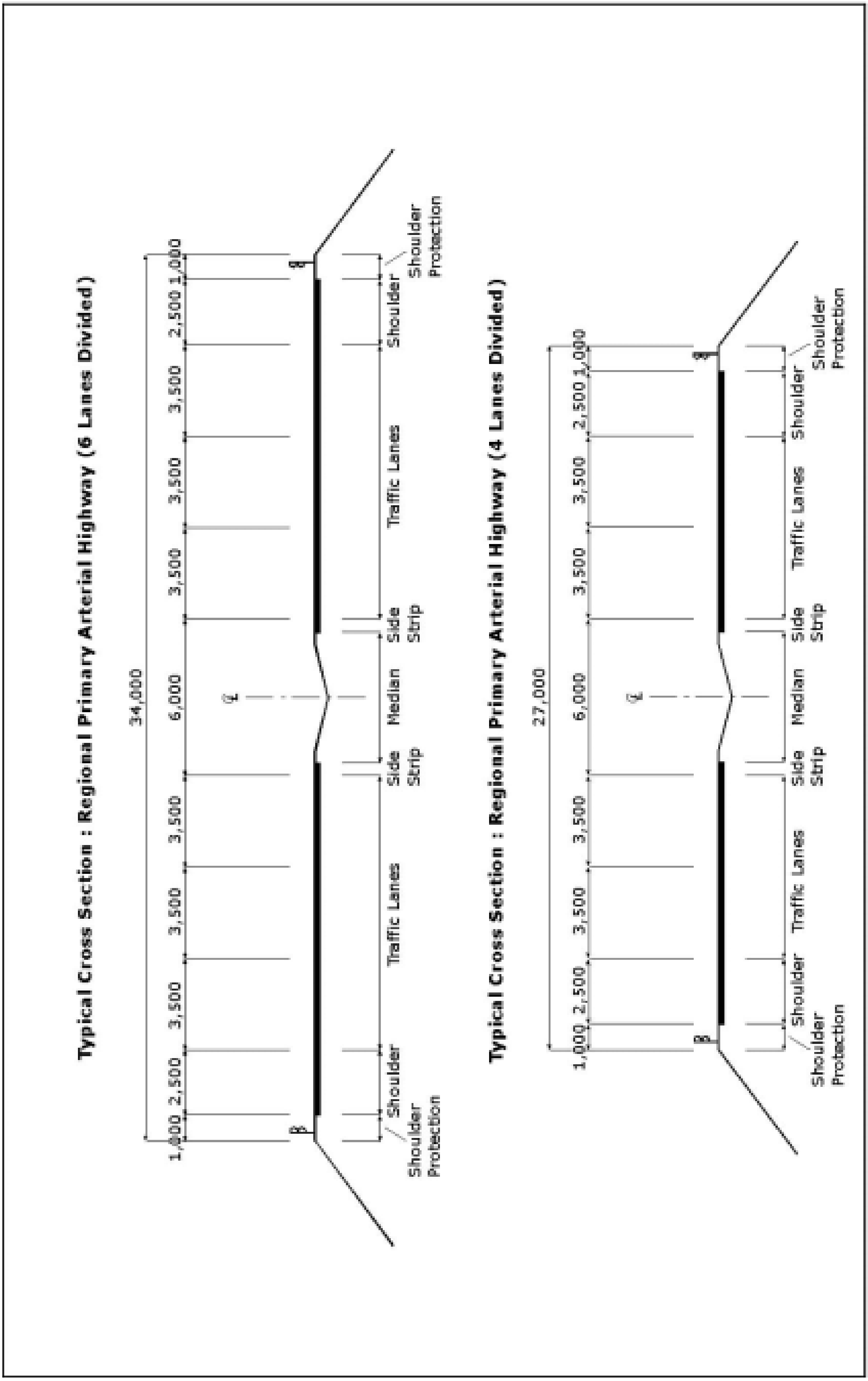
Figure 5.2.7 Recommended Functional Classification of Existing Road Network (for within Ring Road area)

Table 5.2.2 Recommended Policies on Road Structure/Traffic Management/Environmental Measures with Functional Classification

Policy Category & Item		Inter-urban Primary	Regional Primary	Urban Expressway	Urban Primary	Urban Secondary	Collector/Distributor	Local
Road Structure	Structure	Embankment/Viaduct /Cut/Underground	Embankment/Viaduct /Cut/Underground	Embankment/Viaduct /Cut/Underground	At-grade	At-grade	At-grade	At-grade
	Crossing System	Interchange	Interchange	Interchange	Flyover/Signalized	Flyover/Signalized	Signalized	---
	Number of Lanes	Multi-lane Divided	Multi-lane Divided	Multi-lane Divided	Multi-lane Divided	Multi-lane Divided/Undivided	4-2 Lane Undivided	---
	Pedestrian Facility	N.A.	N.A.	N.A.	Dual Sidewalk	Dual Sidewalk	Dual Sidewalk	---
	Bus/HOV* Lanes	N.A.	(Possible)	(Possible)	(Possible)	N.A.	N.A.	N.A.
	Typical Number of Lanes	4 - 8	4 - 8	4 - 6	4 - 8	2 - 6	2 - 6	2 - 4
Traffic Management	Speed Limit	120 km/hr or less	120 km/hr or less	100 km/hr or less	80 km/hr or less	70 km/hr or less	50 km/hr or less	30 km/hr or less
	Parking Regulation	Parking/Stopping Prohibited	Parking/Stopping Prohibited	Parking/Stopping Prohibited	Parking Prohibited (Stopping Allowed)	Parking Prohibited (Stopping Allowed)	Designated	Designated
	One-way Operation	N.A.	N.A.	N.A.	Applicable	Applicable	Applicable	Applicable
	Vehicle Type Restriction	N.A.	N.A.	N.A.	Vehicle Type/Hour	Vehicle Type/Hour	No Cargo Vehicle	Specified Vehicle Type Only
	Signal Control	N.A.	N.A.	N.A.	Synchronized Signalization	Signalized/Enforcer	Signalized/Enforcer	Comprehensive Zonal Traffic Control
	Pedestrian Accommodation	Full Grade Separation	Full Grade Separation	Full Grade Separation	Grade Separation/ Crosswalk	Crosswalk	Crosswalk	Comprehensive Zonal Traffic Control
Environmental Measures	Roadside Facility	Buffer Area	Buffer Area	Noise Barrier/Wall	Roadside Flora	Roadside Flora	Roadside Flora	Roadside Flora
	Traffic Regulation	Speed Limit	Speed Limit	Speed Limit	Cargo Traffic Control	Cargo Traffic Control	Comprehensive Traffic Control	Comprehensive Zonal Traffic Control
	Land Use Restriction	Non-residential Area	Non-residential Area	Non-residential Area	Residential Area will be guided to Non - residential	Residential Area will be guided to Non - residential	---	---

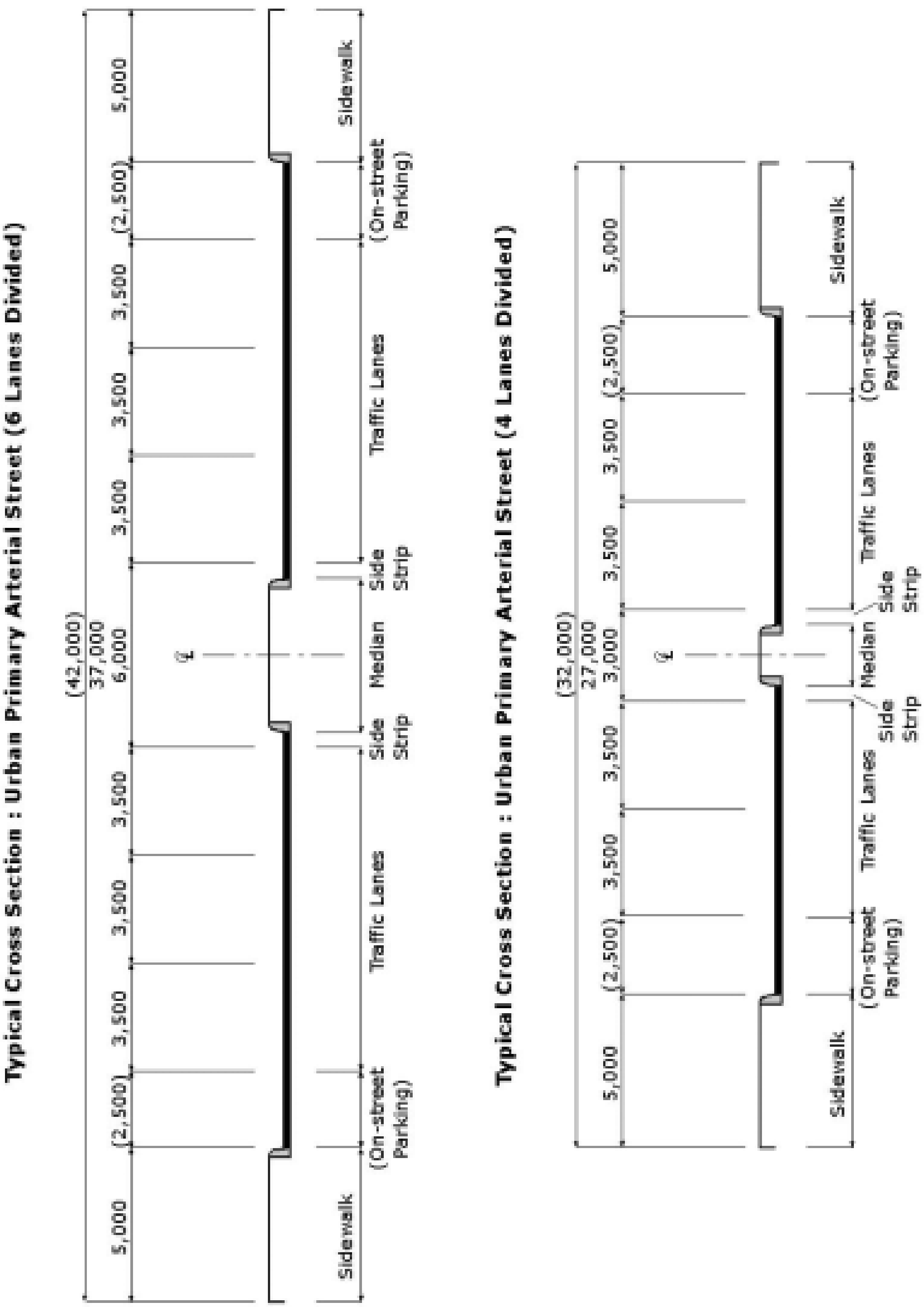
**Note: HOV (High Occupancy Vehicle) Lane is an exclusive lane for vehicles with more than certain number of passengers.*

Source: JICA Study Team



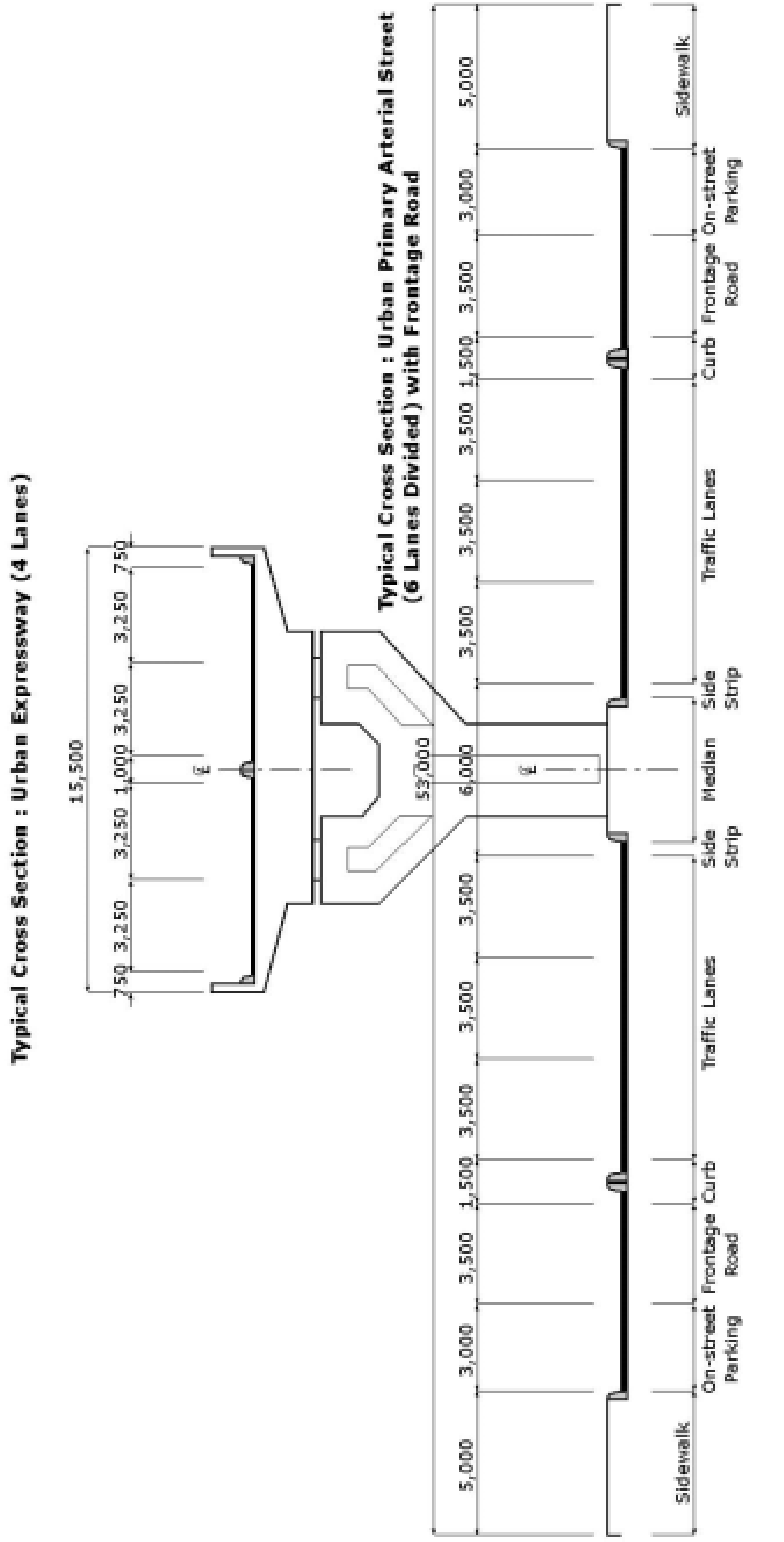
Source: JICA Study Team

Figure 5.2.8 Typical Cross Sections for Regional Primary Arterial Highway



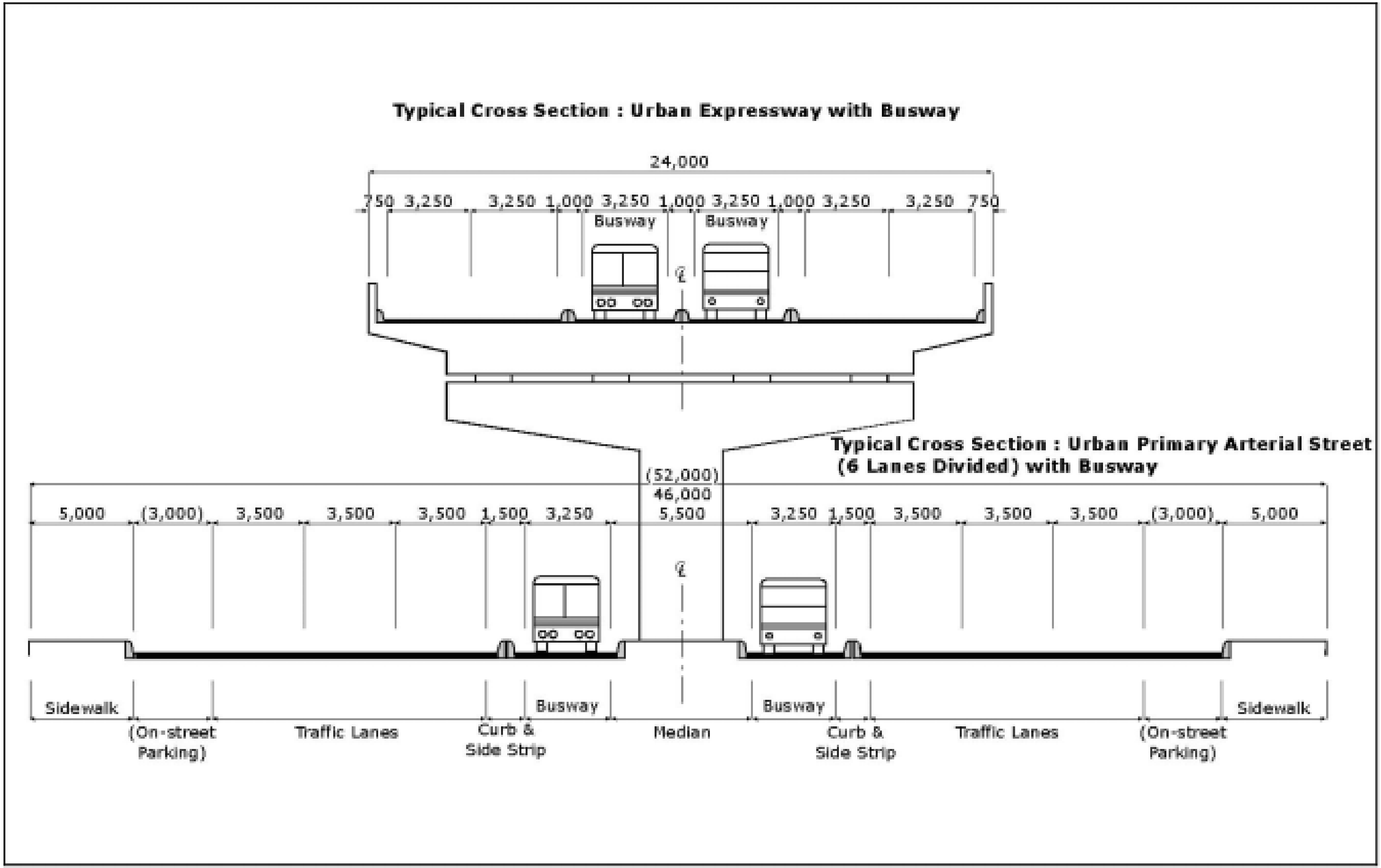
Source: JICA Study Team

Figure 5.2.9 Typical Cross Sections for Urban Primary Arterial Street



Source: JICA Study Team

Figure 5.2.10 Typical Cross Sections for Urban Expressway over Urban Primary Arterial Street



Source: JICA Study Team

Figure 5.2.11 Typical Cross Sections for Busway Designations

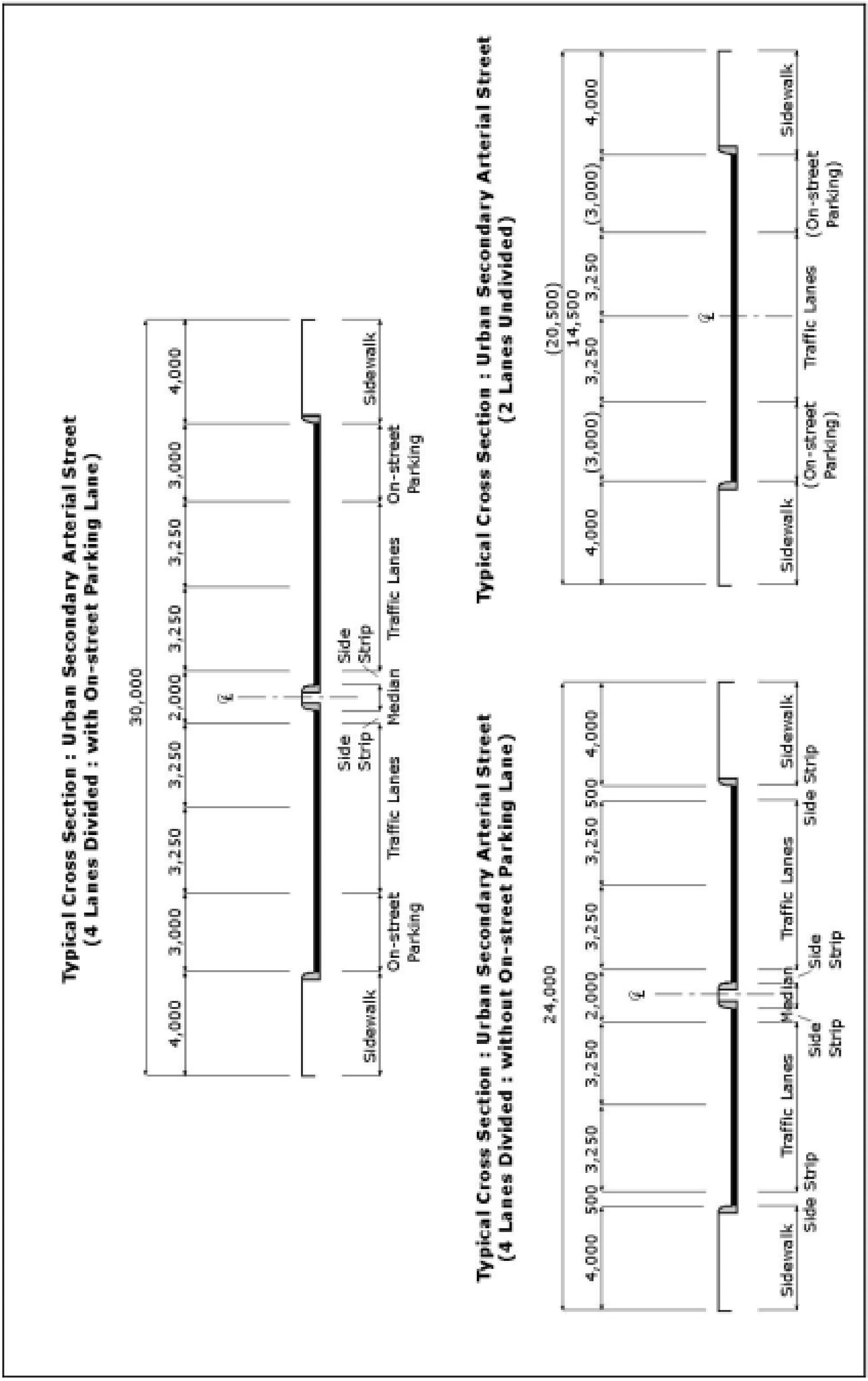


Figure 5.2.12 Typical Cross Sections for Urban Secondary Arterial Street

Source: JICA Study Team