3.3.3 Station Locations

JICA Study Team will propose the station locations based on the following basic conditions:

- Distance between stations will be around 1 km in terms of train operation and passenger convenience.
- The station location will be placed with consideration of good passenger access to and from the various public transport and potential commercial development sites adjacent to the station.

Table 3-3 shows JICA Study Team proposal in comparison with SDMP station locations.

Table 3-3 Comparison of Proposed Station Locations

El Malek El Saleh ～ El Giza ～ El Remayah Square								
SDMP				This F/S Study				
No.	Station	Mileage		No.	Station	Mileage		Article
		km	km			km	km	
1	El Malek El Saleh	0.000		1	El Malek El Saleh	0.000		To connect Metro Line1
			1.200				0.800	
				2	El Rauda	0.800		To attracte passenger in this Island
							1.000	
2	El Nile	1.200		3	El Nile	1.800		To connect other transports
			1.100				0.900	
3	Giza Square	2.300		4	El Giza	2.700		To connect Metro Line2
			1.500				1.100	
4	Pyramid Rd East	3.800		5	Station No.5	3.800		
			1.500				0.900	
				6	Station No.6	4.700		
							0.800	
5	Pyramid Rd Central	5.300		7	Station No.7	5.500		
			1.500				1.000	
				8	Station No.8	6.500		
							1.000	
6	Pyramid Rd West	6.800		9	Station No.9	7.500		
			1.500				0.900	
7	Ring Road	8.300		10	Station No.10	8.400		
			1.300				1.000	
8	Pyramid	9.600		11	Station No.11	9.400		
			1.000				1.200	
9	Al Remayah	10.600		12	El Remayah Square	10.600		To connect other transports

Source: JICA Study Team

(1) M4W-Sta.1 (El Malek El Saleh Station)

Due to the fact that this station will be a transfer station to Metro Line 1, it will be rather large in size. Depending on the required width of the station, the location of the station may affect the hospital building or retaining wall of the Salah Salem Road underpass.

On the other hand, this station must have a function as a terminal station until the operation for Phase 2 section. For an effective train operation, especially for shuttle operation, it is required to provide a scissors crossover at the end of the station as close as possible, with storage tracks.

(2) M4W-Sta.2 (El Rauda Station)

The alignment should be made to avoid the foundations of the existing bridge across the Nile Branch and the existing road flyover located along the right side of the Nile Branch. There are dense 7-8 storey buildings on the El Rauda Island, and therefore the station should be planned under the buildings, by utilizing the full space on the roundabout.

This station is proposed because most of the traffic in this island concentrates towards this road, even though the SDMP did not plan a station at this location.

(3) M4W-Sta.3 (El Nile Station)

This station will be allocated beside the Nile River and near Giza Square. Giza Square is a very congested place. Furthermore, this place is very narrow and has flyovers. Construction method should consider minimized disturbance to road traffic.

This station will be deep because Metro Line 4 passes underneath the Nile River. This depth will be approximately 40 m from the ground level.

(4) M4W-Sta.4 (El Giza Station)

The location of this station may need to be allocated near the Pyramids Road underpass where it crosses under ENR and Metro Line 2. Since a minibus terminal exists in front of El Giza Station of Metro Line 2, the improvement of said terminal together with the construction of pedestrian connecting paths will be proposed.

(5) M4W-Sta.5 to M4W- Sta.9

The locations of these stations are to be planned considering the basic distance between stations 1 km as typical station.

(6) M4W-Sta.10

The Ring Road which is now under construction is on Mariouteyah Canal. This station will be set on the eastern side of the Ring Road.

The crossing road at this point is a former canal which was changed to the road. It is assumed that this bridge was reinforced with an additional supporting structure and it might be unsuitable. Therefore, Metro Line 4 will pass through under the canal and this bridge. JICA Study Team assumed that this station will be slightly deep, approximately 25 m below the ground level.

(7) M4W-Sta.11

Mansoureyah Canal is under this crossing road. Therefore, Metro Line 4 will pass under the canal and road bridge. JICA Study Team assumed that this station will be slightly deep, approximately 25 m below the ground level.

(8) M4W-Sta.12 (El Remayah Square)

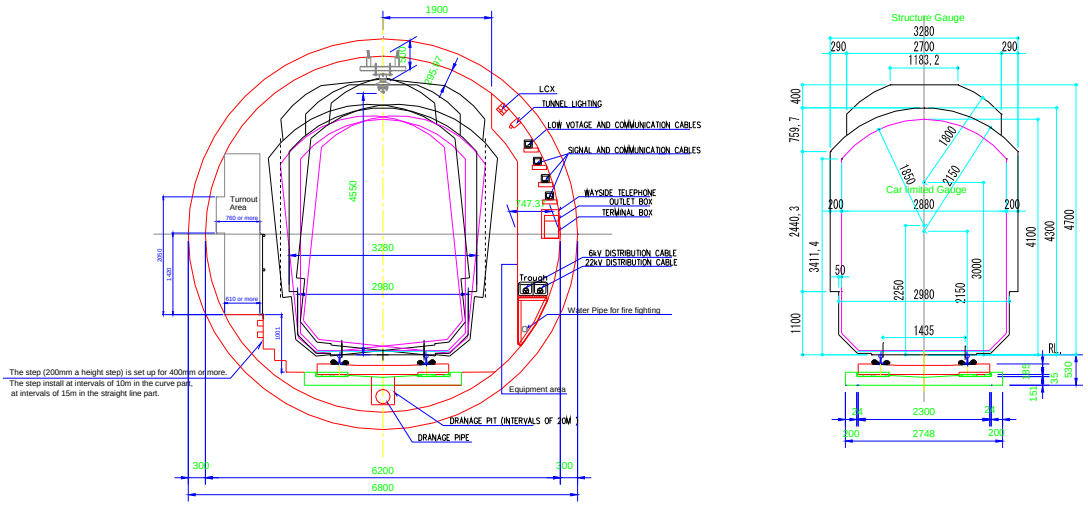
The alignment should pass under the road tunnel which is under the El Remayah Square. This road tunnel consists of connecting ramp to and from Alexandria Desert Road under the El Remayah Square.

GEM and GOPP have a plan to construct a pedestrian path to connect between GEM and Pyramids Area.

The location of GEM Station has not been concretized yet, because the location will depend on the location of workshop/depot and the route from GEM which have not been officially determined yet.

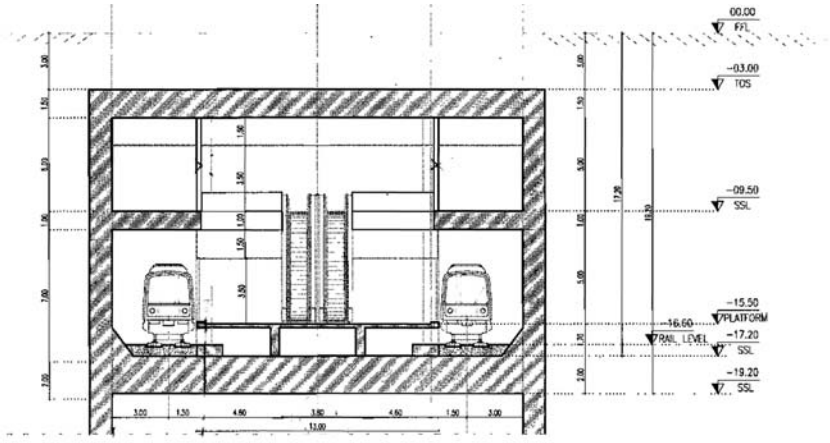
3.3.4 Type of Structures

JICA Study Team proposed that the section between El Malek El Saleh and El Remayah Square will be underground. JICA Study Team is planning to construct with “Single Track Double Tube” shield tunnel boring machine. Station structure will be constructed by cut and cover method. Typical cross sections of tunnel and station are shown in Figure 3-15 and Figure 3-16, respectively.



Source: JICA Study Team

Figure 3-15 Typical Cross Section of Tunnel



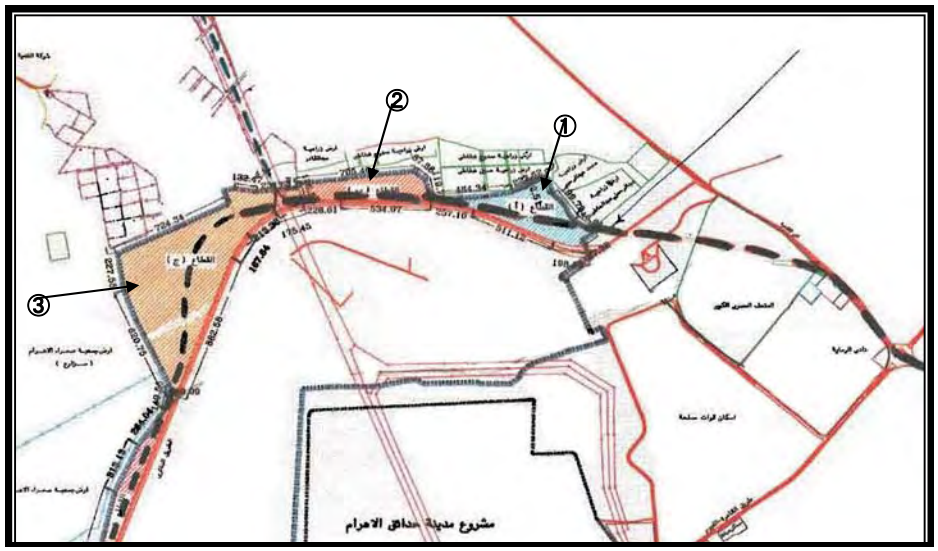
Source: JICA Study Team

Figure 3-16 Typical Cross Section of Station Structure

3.4 El Remayah Square to Depot/Workshop

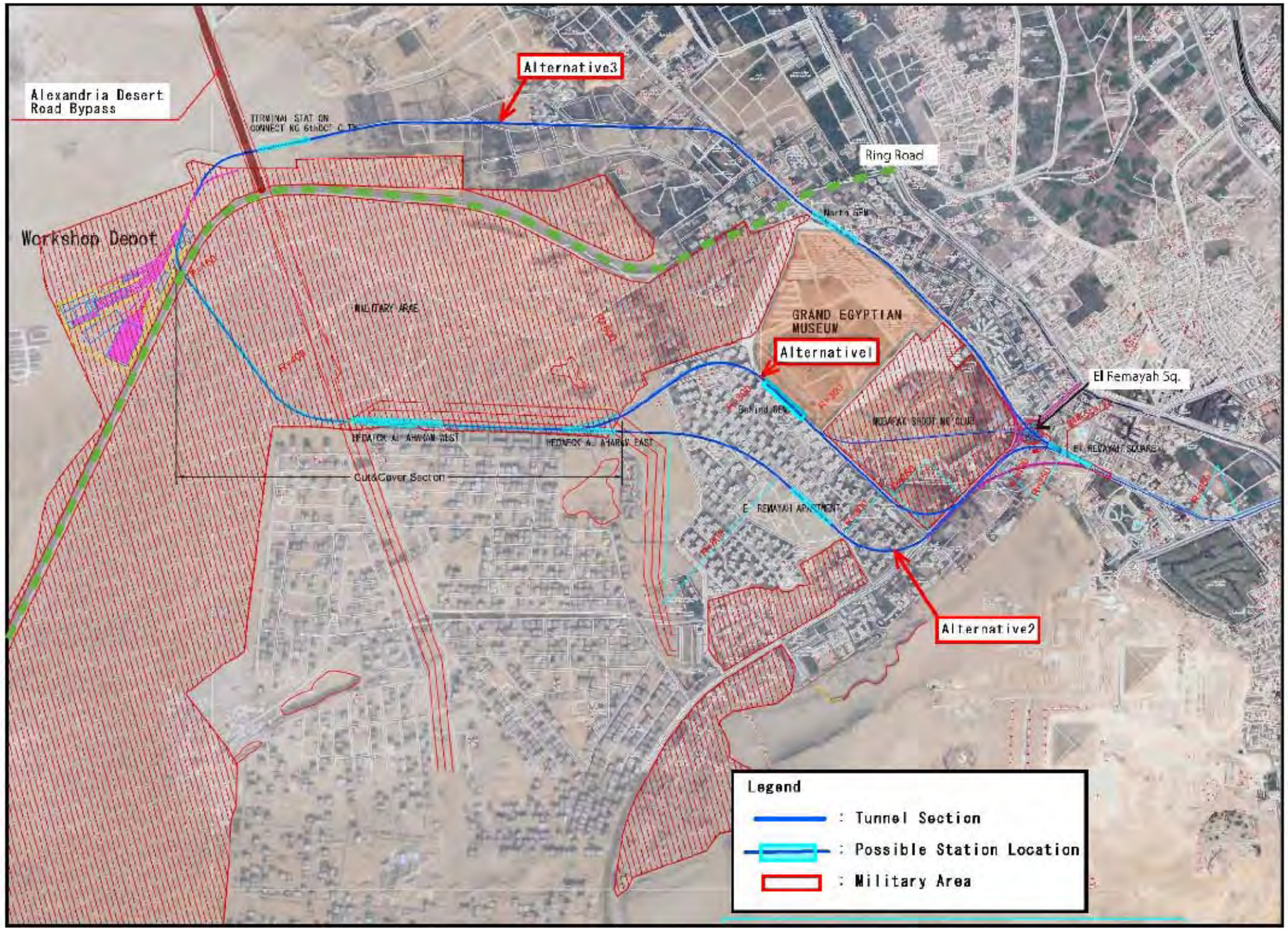
3.4.1 Location of Depot/Workshop

Possible workshop/depot area which was provided by NAT is shown in Figure 3-17. JICA Study Team has studied and tentatively recommended location 3 in Figure 3-17 as the optimum location. Based on this, three alternative access routes from El Remayah Square to the workshop/depot have been studied. Alternative access routes are shown in Figure 3-18 and comparison of routes are shown in Table 3-4.



Source: NAT

Figure 3-17 Possible Planning Area for the Workshop/Depot



Source: JICA Study Team

Figure 3-18 Alternative Access Routes to the Workshop/Depot

Table 3-4 Comparison Table for Alternative Access Routes to the Workshop/Depot

	Alternative 1	Alternative 2	Alternative 3
Basic Concept to set Alternatives	According to the discussions with the concerned authorities, it is not allowed to pass through Military area (red shaded area) and GEM area, therefore the alternative routes basically avoid passing the areas except "Hedaeck Al Aharam East to Workshop/Depot via Hedaeck Al Aharam West" alignment which is approved by Military's personnel verbally in the Joint Site Inspection among Military, NAT, and JST held on 6th July. (note: Alt. 1 passes slightly under Military area (Mubarak Shooting Club)).		
Background	This route is already confirmed by the Joint Site Inspection among NAT, Military and JST on 6th July. However, this route must pass under "Mubarak Shooting Club" even if the radius of curve becomes minimized, although we were informed that it is not allowed to pass the area.	This route is prepared to modify Alternative 1. The route avoids passing under "Mubarak Shooting Club" based on the request from NAT.	This route is prepared i) to keep the location of Remayah Sq. Station convenient, and ii) to avoid Military areas except Workshop/Depot, etc.
Advantage	• Possible to connect Hedaeck Al Aharam East Station with Workshop/Depot. The access route is verbally agreed with Military personnel at the Joint Site Inspection among NAT, Military and JST.	• Possible to connect Hedaeck Al Aharam East Station with Workshop/Depot. The access route is verbally agreed with Military personnel at the Joint Site Inspection among NAT, Military and JST.	• No military area is passed, according to our information received from NAT. • The location of Remayah Sq. Station can keep close to Remayah Sq. It means the station is more convenient than Alt.1 and Alt.2. • "Terminal Station connecting 6th Oct. City" is located at the end point of Alex. Dessert Road Bypass. It means the connection is more convenient than Hedaeck Al Aharam West Station which is the connecting terminal for Alt.1 and Alt.2.
Disadvantage	• Passing under Mubarak Shooting Club. (JST understand it is forbidden by Military.) This is fatal disadvantage. • The location of Remayah Sq. Station should be moved to app. 100m far from Remayah Sq. in order to avoid the horizontal curve at the section. It means the station becomes inconvenient. • Passing under El Remayah Apartment area. • It is not sure when Military's approval for "Hedaeck Al Aharam East to Workshop/Depot via Hedaeck Al Aharam West" section will be obtained. • Hedaeck Al Aharam East Station cannot avoid being located in the curve section (R1000m).	• The location of Remayah Sq. Station should be moved to app. 100m far from Remayah Sq. in order to avoid the horizontal curve at the section. It means the station becomes inconvenient. • Passing under El Remayah Apartment area. • It is not sure when Military's approval for "Hedaeck Al Aharam East to Workshop/Depot via Hedaeck Al Aharam West" section will be obtained.	• .No station will be put between "North GEM Station" and "Terminal Station connecting 6th Oct. City". • Passing under the residential area along the northern side of Ring Road.
Result	Not recommended	***Recommended Secondarily***	***Recommended Firstly***

Source: JICA Study Team

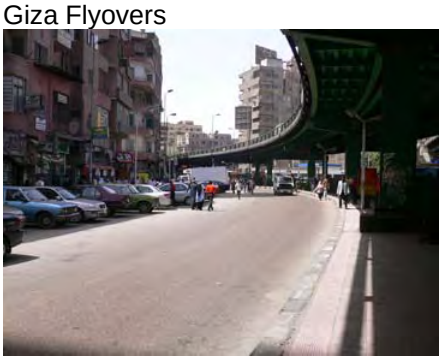
3.4.2 Alignment from El Remayah Square to Depot/Workshop

As mentioned in section 3.4.1, JICA Study Team has recommended two alternatives as possible routes. Once JICA Study Team is officially informed of the location of the workshop/depot, further detailed study will be carried out.

3.5 List of Hard Points

List of Hard points between El Malek El Saleh and El Remayah Square is shown below:

Location	Reason
El Malek El Saleh 	Due to the fact that this station will be a transfer station with Metro Line 1, it will be rather large in size. Depending on the required width of the station, the location of the station may affect the hospital building or retaining wall of the Salah Salem Road underpass. On the other hand, this station must function as a terminal station until the operation of Phase 2 section starts. For an effective train operation, especially for shuttle operation, it is required to provide a scissors crossover at the end of the station, as close as possible, with stabling tracks. However, this alignment is to be connected with Phase 2 section and pass under Salah Salem Road which is curved close to the end of the station where a scissors crossover needs to be provided. In order to provide the scissors crossover at the end of the station without changing the station location, the subsequent alignment towards the east bound should pass under a residential area, especially in case Phase 2 section is on the north bound towards El Sawaha Square.
Nile Branch to El Rauda Island 	The alignment should avoid the foundations of the existing bridge across the Nile Branch and the existing road flyover located along the right side of the Nile Branch. There are dense 7-8 storey buildings on the El Rauda Island, and therefore, the station should be planned under the buildings, using wide spaces on both sides of the road. This station is proposed because most traffic in this island concentrates towards this road, even though the SDMP did not plan a station at this location.

Crossing point of Nile River 	The space between the tunnel and the existing bridge foundations should be planned considering its effects and the planned toll road. A ventilation duct should be provided at one side of the River Nile.
Giza Flyovers 	There are several flyovers going in five directions. Metro Line 4 has to pass and avoid the foundations of the flyover. There is also a bus terminal at said location. Thus, Giza Square under the flyover is always very congested at all times of the day. It will be necessary to implement a traffic diversion plan during construction.
El Giza ENR Underpass 	The station for connecting with Metro Line 2 needs to be located nearby Pyramids Road underpass where this crosses under the ENR line, and a viaduct of Metro Line 2. A minibus terminal exists in front of Giza Station of Metro Line 2, therefore, the improvement of said terminal should be taken into consideration in construction planning.

Source: JICA Study Team

Figure 3-19 List of Hard Points

CHAPTER 4
ROUTE SELECTION FOR PHASE 2 SECTION

CHAPTER 4 ROUTE SELECTION FOR PHASE 2 SECTION

4.1 Transportation Demand

4.1.1 Population by the Distance From/To the Stations

The potential demand for metro line is closely related to the population size around the station. In order to study the potential demand for Metro Line 4 alternatives, station covering population is calculated using GIS function prepared in Arc GIS software and future population plan by shiaha. Table 4-1 presents the measurement results. The 2,000 m population covered by Metro Line 4 phase 1 section is 1.5 million in year 2008 and 2.1 million in year 2050. That of Metro Line 4 alternative 1 is 2.9 million in 2008 and 3.7 million in 2050, while that for alternative 2 is 1.4 million in 2008 and 2.2 million in 2050. Comparing the population between Phase 2 alternatives, alternative 1 is larger than alternative 2, which concludes that Metro Line 4 Phase 2 alternative 1 has much greater potential demand for passengers than alternative 2. Moving to the 1,000 m coverage population, the same findings are determined.

Table 4-1 Station covering Population by distance

Distance from Station	2008	2012	2017	2022	2027	2050
	(,000)	(,000)	(,000)	(,000)	(,000)	(,000)
Metro Line 4 Phase 1						
0m - 500m	313.4	320.4	325.5	330.0	336.3	391.8
501m - 1000m	480.7	498.7	514.8	530.4	548.8	650.0
Sub Total	794.1	819.1	840.3	860.4	885.1	1,041.8
1001m - 1500m	367.7	387.4	407.2	427.5	450.7	551.2
1500m - 2000m	337.5	359.3	382.1	405.5	431.4	535.2
Total	1,499.3	1,565.7	1,629.5	1,693.4	1,767.2	2,128.2
Growth Rate	1.00	1.04	1.09	1.13	1.18	1.42
Metro Line 4 Phase 2 Alternative 1 North Extension						
0m - 500m	469.1	475.7	483.9	482.9	485.8	560.3
501m - 1000m	934.2	951.4	972.0	976.1	986.4	1,139.0
Sub Total	1,403.2	1,427.1	1,455.8	1,459.0	1,472.2	1,699.3
1001m - 1500m	813.2	835.1	859.8	870.7	884.3	1,026.2
1500m - 2000m	714.7	736.6	762.0	776.1	792.4	925.4
Total	2,931.1	2,998.8	3,077.6	3,105.8	3,148.9	3,650.9
Growth Rate	1.00	1.02	1.05	1.06	1.07	1.25
Metro Line 4 Phase 2 Alternative2 East Extension						
0m - 500m	218.2	230.1	249.6	276.9	302.1	348.5
501m - 1000m	397.7	422.1	458.5	505.1	546.7	630.5
Sub Total	615.8	652.2	708.1	782.0	848.8	979.0
1001m - 1500m	413.5	436.5	468.0	504.1	534.8	616.8
1500m - 2000m	407.3	423.8	446.3	471.0	493.7	569.4
Total	1,436.6	1,512.5	1,622.5	1,757.1	1,877.3	2,165.3
Growth Rate	1.00	1.05	1.13	1.22	1.31	1.51

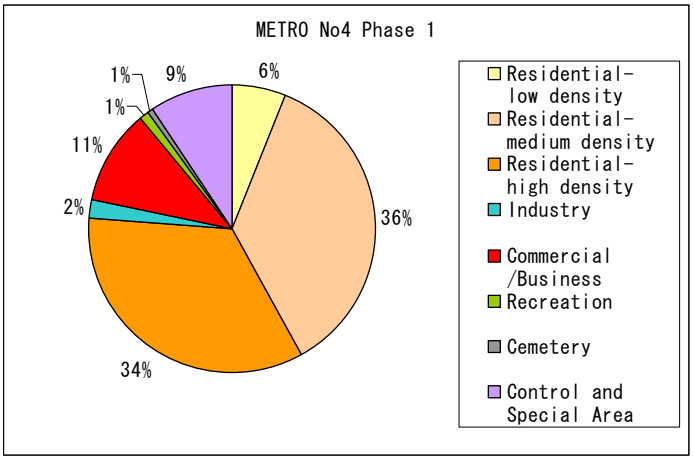
Source: JICA Study Team

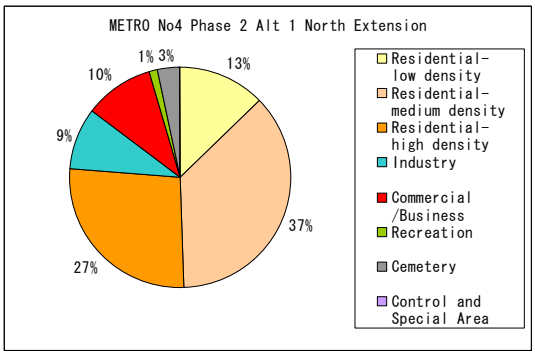
4.1.2 Future Land Use by the Distance From/To the Stations

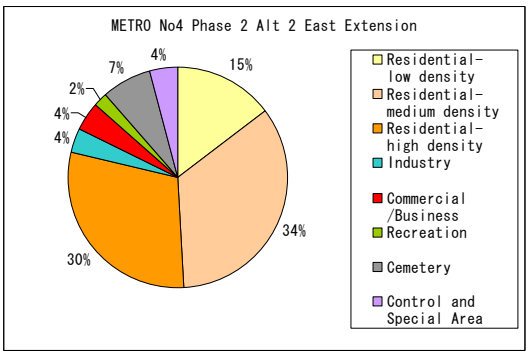
Applying the same type of analysis for the station covering population, the land use type in future 2027 is measured. The characteristics of each are as follows:

- Metro Line 4 Phase 1: commercial/business, 11%; control and special area, 9%
- Metro Line 4 Phase 2 alternative 1 (north extension): commercial/business, 10%; industry, 9%
- Metro Line 4 Phase 2 alternative 2 (east extension): cemetery, 7%

More than three quarters of land use for each section is covered by residential areas, and thus, high potential demand is expected. However, comparing the Phase 2 alternatives, alternative 1 is more efficient for the entire route and the stations. Alternative 2 has some sections passing along the cemetery area.







Source: JICA Study Team

Figure 4-1 Future Land Use Composition within 2,000 m Distance From/To the Stations

4.1.3 Potential Metro Passenger Demand in the Future

The number of passengers of Metro Line 4 and Heliopolis Super Tram line divided into Phases 1 and 2 of Metro Line 4, are calculated based on the traffic assignment results mentioned in Section 2.4.5.

In terms of the potential demand for Phase 2, alternative 1 has bigger passenger volumes than alternative 2. However, the gap between these alternatives has decreased each year, because the growth rate of population along alternative 2 is higher than alternative 1.

The demand of Heliopolis Super Tram in alternative 2 is expected to be more than 0.6 million, which is already over the capacity of a super tram mode. This means that if there is no rail mode service within Nasr City, the traffic condition there will be serious. Alternative 2 has two service lines within Nasr City, so the public transport demand in said city will be well balanced between Metro Line 4 and the super tram line.

Table 4-2 Metro Station and Section Passenger by Alternatives

Year	No. of Passenger (per day)				Maximum passenger at section (per hour per direction)			
	Phase 1	Phase 2	Line 4 Total	Heliopolis Super Tram	Phase 1	Phase 2	Line 4 Total	Heliopolis Super Tram
Metro Line 4 phase 2 alternative 1 north extension								
2022	799,000	1,124,000	1,718,000	624,000	30,900	50,700	50,700	31,900
2027	1,025,000	1,181,000	1,968,000	647,000	40,600	53,100	53,100	33,100
2050	1,346,000	1,278,000	2,347,000	688,000	53,300	55,800	55,800	43,700
Metro Line 4 phase 2 alternative 2 east extension								
2022	873,000	714,000	1,401,000	298,000	30,900	28,100	30,900	15,700
2027	1,104,000	946,000	1,814,000	333,000	40,300	34,100	40,300	18,000
2050	1,471,000	1,208,000	2,360,000	436,000	53,000	43,500	53,000	22,600

Source: JICA Study Team

Note: The passenger who rides on both Phase 1 and 2 sections of Metro Line 4 are passengers counted for Phase 1 and 2 respectively. Therefore, the total number of passenger of Metro Line 4 is smaller than the simple summation of Phase 1 and 2 sections.

4.1.4 Findings from the Viewpoint of Demand Forecasting

Based on the comparative analysis of metro demand forecasts, the findings are summarized as follows:

- Metro Line 4 Phase 2 alternative 1 has a suitable route from the viewpoint of potential demand and population distribution and land use
- Metro Line 4 Phase 2 alternative 2 is also required within Nasr City area from the viewpoint of potential demand
- The Heliopolis Super Tram line is saturated in the near future, even if the Metro Line 3 starts its full line service. The Heliopolis Super Tram line should be planned to accommodate a larger capacity in the near future.

4.2 Routes Setting of Alternative Routes

4.2.1 Alternative Route 1: Northern Route Proposed by CREATS Report (El Malek El Saleh – El Sawaha Square - Ring Road Exit No. 18)

JICA Study Team has reviewed and selected the northern route proposed by CREATS Report for Phase 2 section. In order to achieve a smooth implementation of construction for Phase 2, starting/approaching shaft for TBM will be located at the new station, which will be around 1 km from the El Malek El Saleh Station. From the result of the site survey, the suitable location for a new station was determined to be in front of the Children Cancer Hospital. This site is the only place where the station can be constructed without any resettlement. Towards the Port Said Street, the route will pass underneath low rise residential and commercial areas because no road exists with enough width. After approaching Port Said Street, said street is the only route that can be chosen until El Sawaha Square is reached. From El Sawaha Square to the Ring Road Exit No. 18, the route can run with a viaduct structure at either side of Ismaileya Canal. This route is shown in Figure 4-4.

This route has some hard points, especially the section running parallel to the main sewer tunnel, approximately 4 km from Sayyida Zainab Plaza to Ghamra Station.

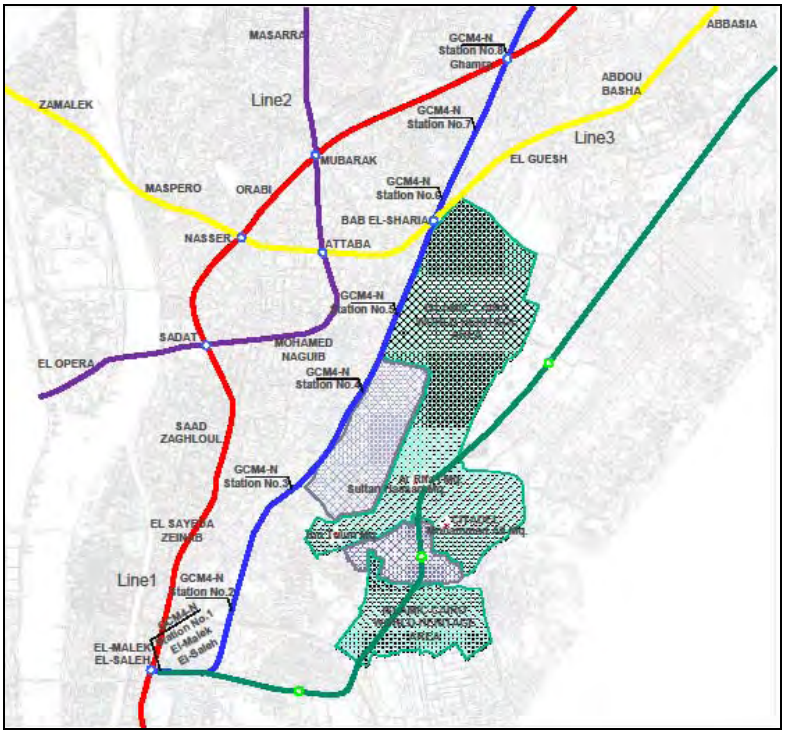
Figure 4-2 Site in front of Children Cancer Hospital

4.2.2 Alternative Route 2: Eastern Route Proposed by SYSTRA Study (El Malek El Saleh - Nasr City - Ring Road)

JICA Study Team has reviewed and selected the eastern route proposed by SYSTRA Report[9] for Phase 2 section. The route starts from El Malek El Saleh Station towards the Citadel, running under the Salah Salem Street. From Salah Ad-Din Plaza to El Azhar Park, the route is running under the World Heritage Area (Figure 4-3) which is the west side of Mohammed-Ali-Mosque. After passing the World Heritage area, the route will have enough width upon reaching the Ring Roads, such as Salah Salem, Ismail El Fangary, El Nasr Road, Abas El Akad and Ahmaed El Zomor. This route is shown in Figure 4-4.

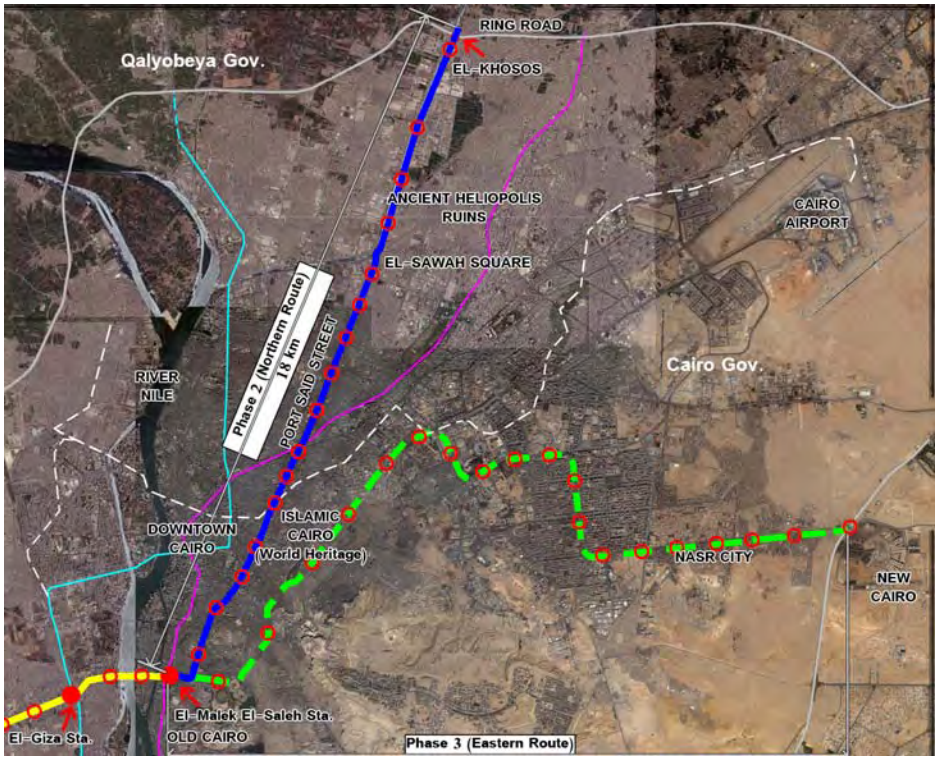
[9] GREATER CAIRO PUBLIC TRANSPORT STUDY STAGE 1 PHASE 3 Report 4 in May 2000

This route was selected considering its connection with Metro Line 3 and the Upgrading Tram Line project in Nasr City. There are less hard points for construction than the northern route. However, construction of the World Heritage area is very sensitive and needs careful consideration.



Source: JICA Study Team by using UNESCO's data

Figure 4-3 World Heritage Area



Source: JICA Study Team, Map: Quickbird

Figure 4-4 Alternative Route Corridor for Phase2 Section (Northern Route and Eastern Route)

4.3 Construction Hard Points

4.3.1 Identified the Hard Points in Each Alternative

(1) Alternative Route 1: Northern Route

The northern route of Metro Line 4 is planned to run on/under Port Said Street where the Spine Wastewater Tunnel (SWWT) exist. SWWT is the trunk sewer water tunnel of the Greater Cairo and is located under 11-12 metres from the ground level of Port Said Street. The horizontal and vertical alignments of the northern route of Metro Line 4 would be closely situated near the SWWT. Therefore, the construction methods of the station and tunnel for said northern route are studied as follows taking the location of the SWWT into consideration.

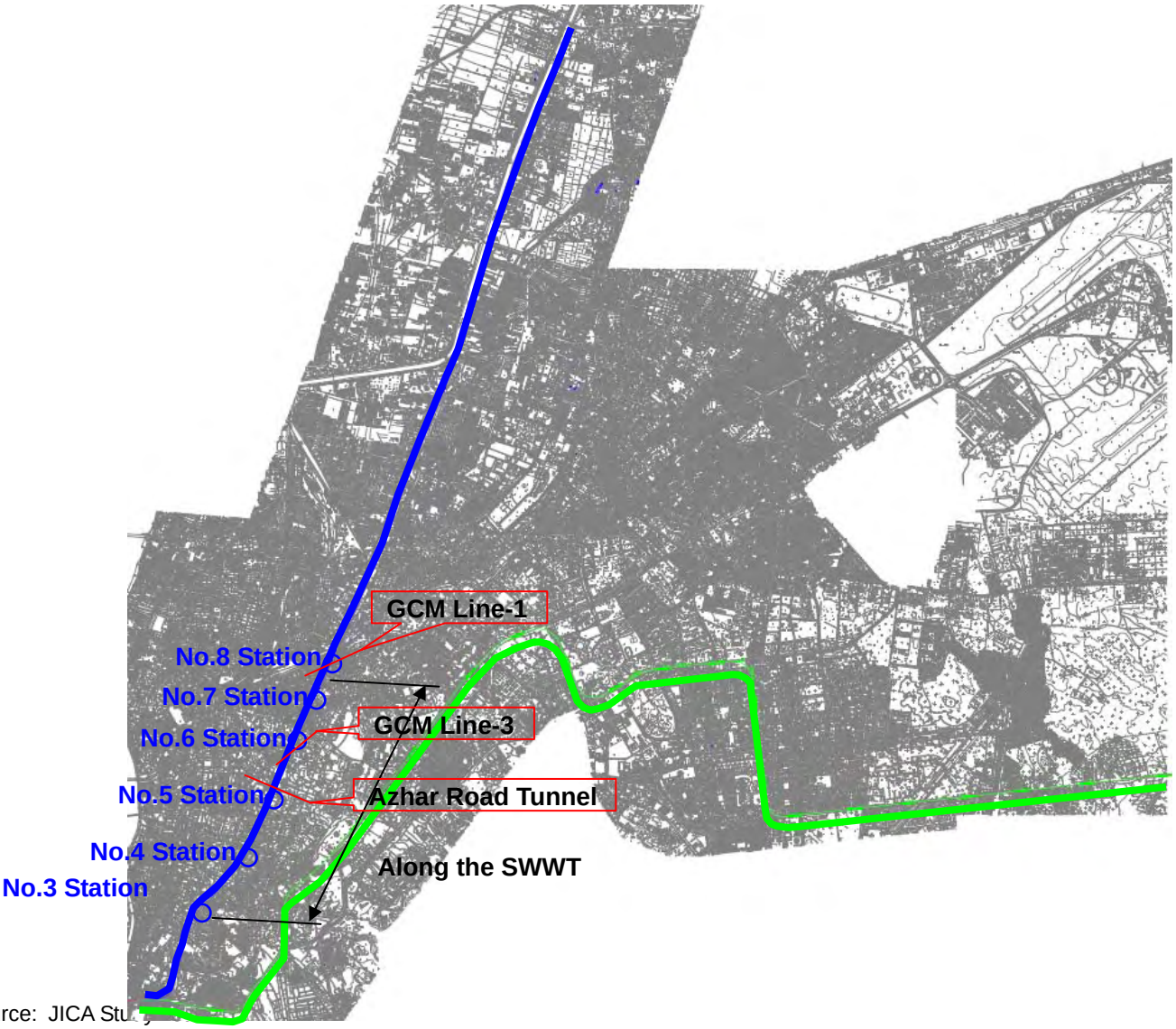
a) Station Construction

16 stations are allocated on the northern route and the following construction hard points are identified and shown in Table 4-3 and in Figure 4-5, respectively.

Table 4-3 Hard Points of the Northern Route

No.	Hard Points	Description
1	No. 3 Station construction	- SWWT would be located in the station.
2	No. 4 Station construction	- SWWT and its manhole would be located in the station.
3	No. 5 Station construction	- SWWT and piles of the flyover would be located in the station. - Excavation would be deeper than 40 m.
4	No. 6 Station construction	- SWWT would be located in station. - Excavation would be deeper than 40 m.
5	No. 7 Station construction	- SWWT would be located in the station.
6	No. 8 Station Construction	- Station would be constructed under the Greater Cairo Metro Line 1 and ENR.

Source: JICA Study Team



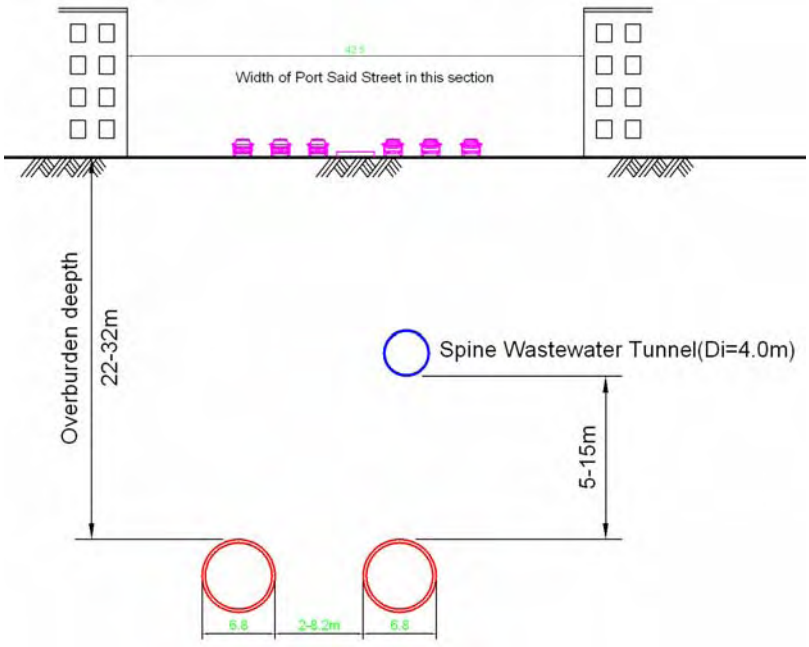
Source: JICA Study

Figure 4-5 Hard Points Location of Northern Route

b) Tunnel Construction

The SWWT has approximately 5 metre outer diameter tunnel and located 11 to 12 metre below the ground level of Port Said Street. The Metro Line 4, which consists of a tunnel with 6.8 m outer diameter, is preliminarily planned to be located 22 to 32 m below the ground level. The distance between the outside walls of these tunnels would be 5 to 15 metre. Typical tunnel cross section is shown in Figure 4-6. The scale of these tunnels is relatively small and their distance is sufficient enough for stability according to past practices and experiences in Japan. Therefore, the tunnel construction of Metro Line 4 which is situated under the SWWT would not be difficult if proper methodology is applied. The construction methodology is indicated in Section 4.4. The practices adopted and experiences

on tunnel neighbouring construction in Japan are introduced in Section 4.3.1 (1)-c).



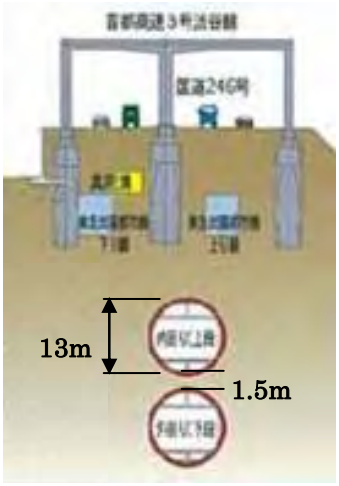
Source: JICA Study Team

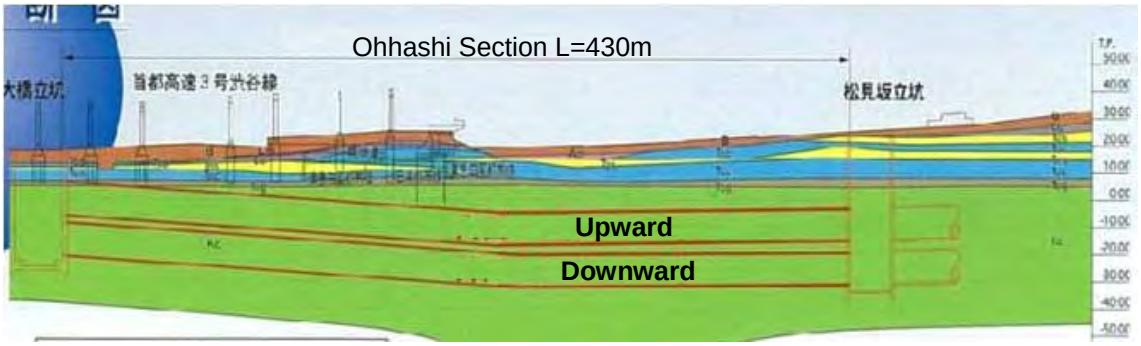
Figure 4-6 Typical Cross Section Under Port Said Street

c) Practices Adopted and Experiences on Tunnel Neighbouring Construction in Japan

i) Yamate Tunnel

The Yamate Tunnel has dual two lanes with large 13 m outer diameter and was constructed to connect the sub-centres as part of the ring road in Tokyo, in order to mitigate the congestion of the expressways in the metropolitan area. The daily transportation networks in Tokyo, which have been constructed underground, are increasing and complex and hence, 13 metro lines were provided as of 2009. Moreover, there are many high-rise buildings and structures supported on deep piles in Tokyo. The Yamate Tunnel was constructed by avoiding these tunnels and piles. In order not to affect these structures, the distances among the foundations and other tunnels are minimized as much as possible. As shown in Figure 4-7, the tunnels run parallel and are located vertically in some parts. The distance between the outside walls of the two tunnels is only 1.5 to 3.0 m for a longitudinal length of 430 m. The construction of this section was carried out without requiring any countermeasure and extra cost.





Source: Metropolitan Expressway Co., Ltd

Figure 4-7 Neighbouring Construction of the Yamate Tunnel in Tokyo

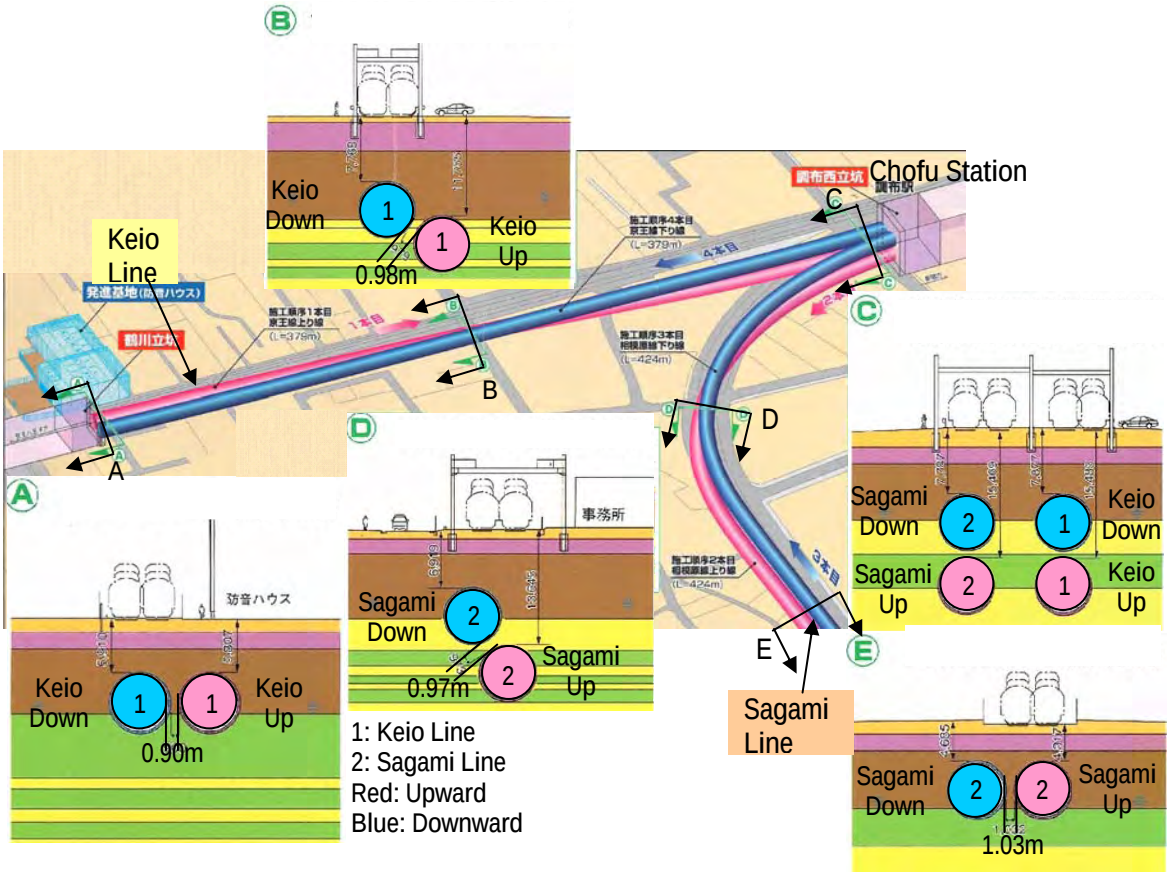
ii) Keio Line and Sagami Line

There are many adopted practices and experiences of neighbouring construction which are carried out without any required countermeasure and extra cost. These include tunnels, underground stations, other foundations, etc. Keio Line and Sagami Line were connected at Chofu Station and both were originally operated as railways at grade. Due to the expansion of population in the western part of Tokyo, the two tracks of each line were extended with tunnel structures in order to increase the capacity. The method is shown in Figure 4-8.

The two single track tunnels of Keio Line are situated horizontally before merging with Sagami Line at Chofu Station. Sagami Line is also constructed with same configuration (see section A and E). In order to connect with Chofu Station, it is required to locate both lines vertically due to the limited right of way (see section C). To change the location of tunnels from horizontal to vertical position, the alignments of both lines were twisted and the tunnels' location were shifted to a very close position (see section B and D). The distance between the tunnels is about 1 metre or less. Even with such complicated alignment and the

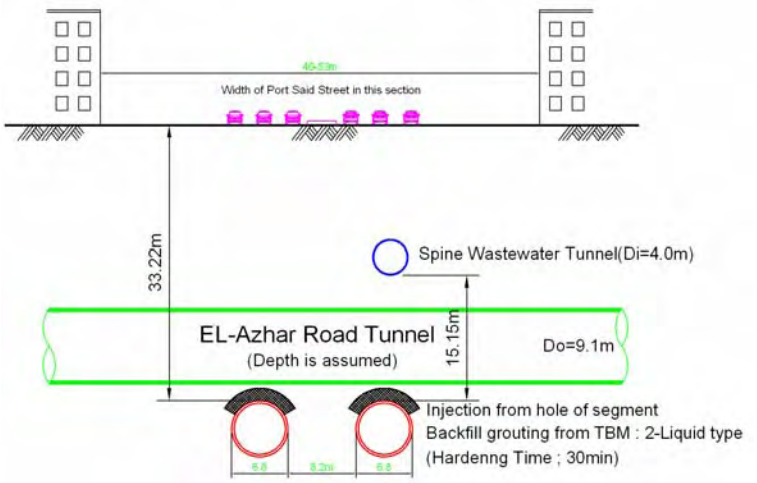
neighbouring construction method, these tunnels were constructed without required countermeasure.

The crossing of Metro Line 4 with the Metro Line 3 Tunnel and Azhar Road Tunnel is not difficult compared with these complex neighbouring constructions.



Source: Keio Corporation

Figure 4-8 Complicated Neighbouring Tunnel Construction of Keio Line and Sagami Line in Tokyo



Source: JICA Study Team

Figure 4-9 Cross Section at Crossing Point of El Azhar Road Tunnel

(2) Alternative 2: Eastern Route

a) Station Construction

There is no major utility to be obstacle for the station construction, and crossing structures would not affect the eastern route. Therefore, there are no construction Hard points for the station construction.

b) Tunnel Construction

There are some points where tunnel passes under the foundations of the flyover and buildings. However, no countermeasure will be required for the works because of the following reasons:

- The foundation is not expected to be so deep since the ground condition of the area consists of rock layer.
- The tunnel would pass through the rock layer below the foundations/piles.

4.4 Construction Methodology

4.4.1 Structure Selection

The basic principles of the structure selection are as follows:

1. Tunnel is applied in the residential and commercial areas taking into consideration the scenery and environmental influence.

2. Viaduct is applied in suburban area.

(1) Northern Route

The alignment from El Malek El Saleh Station (Station No. 1) to El Sawaha Square Station (Station No. 13) would pass through the residential area. Thus, tunnel structure will be provided along this section. After the El Sawaha Square Station (Station No. 13) is an industrial area. The structure will then be shifted from tunnel to viaduct between Station No. 13 and Station No. 14. The viaduct structure runs along the Ismailia Canal and continues up to the end (Station No. 17).

(2) Eastern Route

The alignment of eastern route would pass through a residential area only. Therefore, tunnel structure is applied to the whole eastern route.

Source: JICA Study Team

Figure 4-10 Structural Type of Northern Route and Southern Route

4.4.2 Methodology of Station Construction

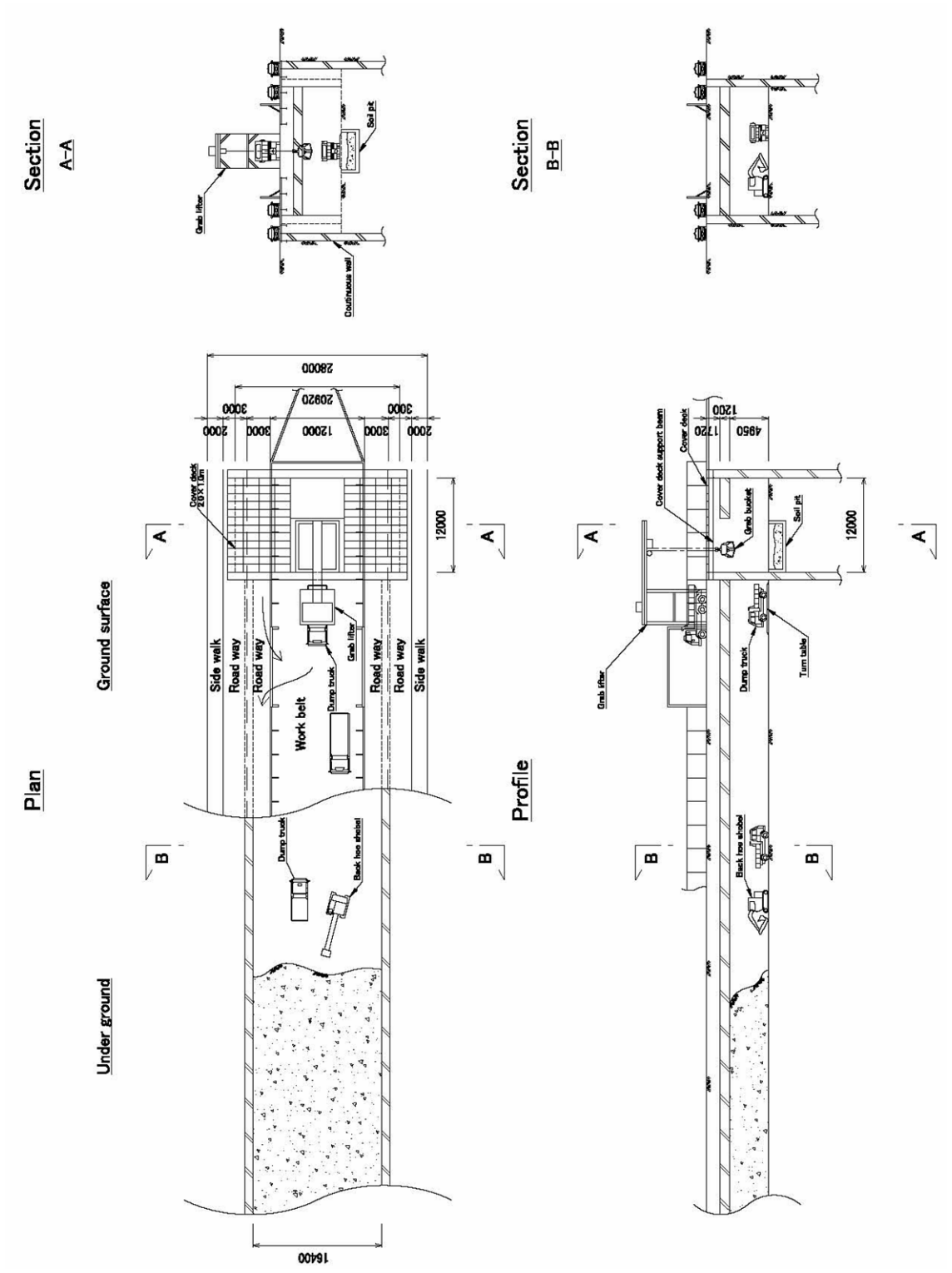
In principle, the stations are allocated under public spaces such as roadways. In order to minimize the impact on road traffic, the cut and cover method of construction with road decks is applied in principle. Moreover, the station would be constructed by the top down method where concrete slab is cast from top to bottom to minimize the required construction area and mitigate the deformation of surrounding ground.

(1) Standard Station

Typical cut and cover methods with road decks are indicated in Figure 4-11, Figure 4-12 and Figure 4-13. The top of the construction site is covered with road decks which minimize effects to road traffic during construction. The social and economical loss due to the traffic congestion should be mitigated and minimized. This method is most common in Japan.

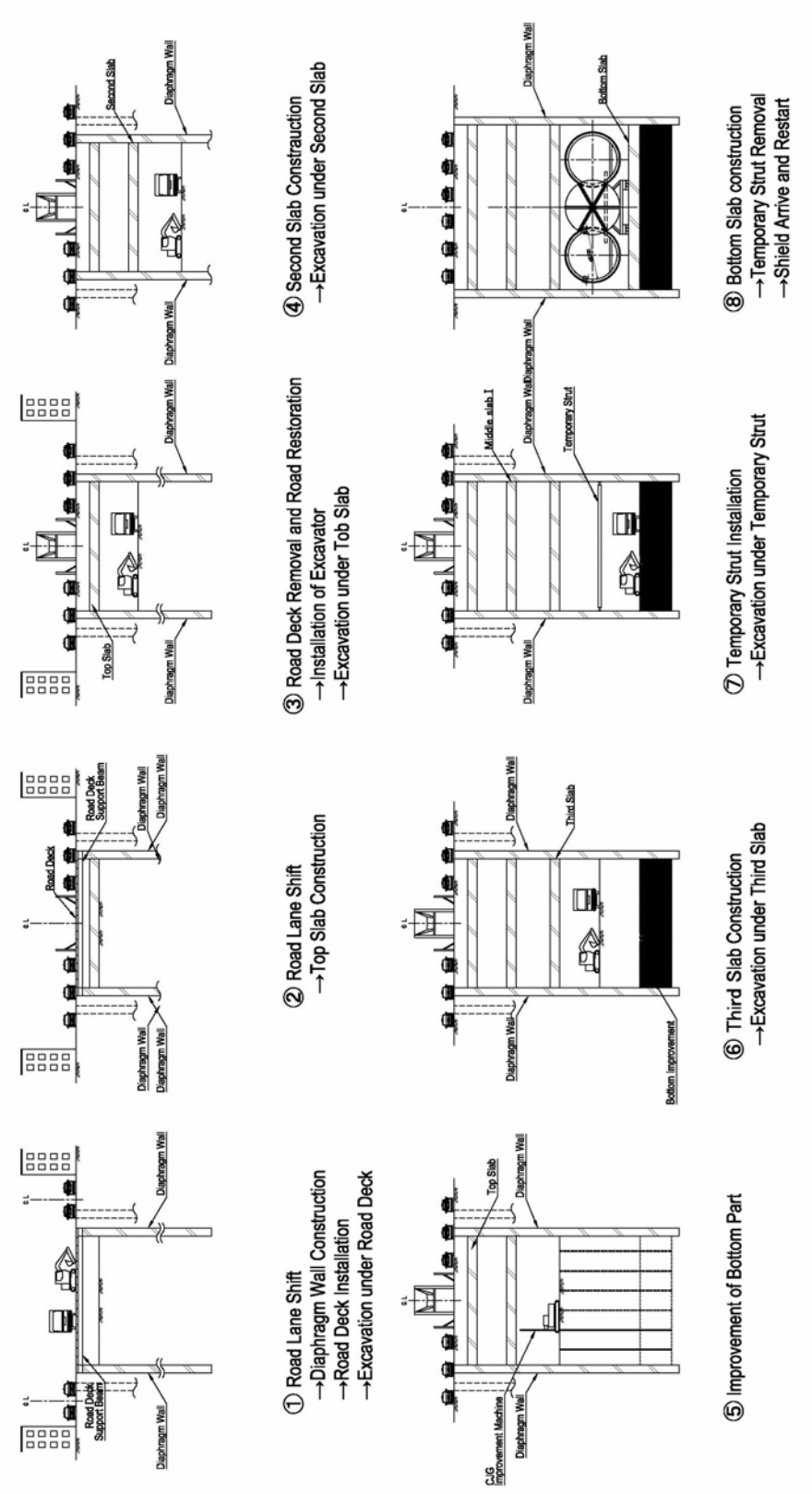
Source: Obayashi Co., Ltd.

Figure 4-11 Intersection at Grade Covered with Road Decks



Source: JICA Study Team

Figure 4-12 Plan and Profile of Cut and Cover with Road Deck Method during Station Construction



Source: JICA Study Team

Figure 4-13 Procedure of Installing the Road Deck during Station Construction