4.3 SCHEMATIC FACILITY DESIGN

4.3.1 Alignment Design of UMRT

The route plans for all UMRT lines (Line 1, 2, 3a, and 4) coming together at Ben Thanh Central Station are designed individually. Although these route plans are optimized separately in each project, the review and adjustment among the route plans is necessary for the whole design as a central station to ensure the smooth transfer.

The current route plan, revised points of each line, and design criteria applied for the revision are described in this section.

1) Current Route Plan

(1) UMRT Line 1

(a) Route Plan

The route starting from Ben Thanh Station goes toward North-east along Le Loi Street. The distance of station center between Ben Thanh and Opera House stations is 715m.

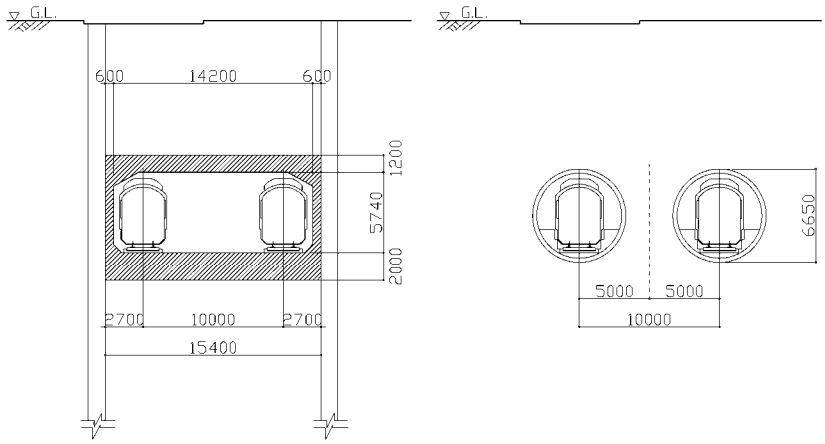
Ben Thanh Central Station area and Le Loi Street between Ben Thanh and Opera House Stations are established as the project area in this survey.

(b) Tunnel Plan

Ben Thanh Station, Opera House Station, and the tunnel section from Ben Thanh Station to KM+300 are planned to be constructed by cut and cover method. On the other hand the tunnel section from KM0+300 to Opera House Station is planned as TBM.

The 2 tunnels are arranged horizontally at Ben Thanh Station, and perpendicularly at Opera House Station. The tunnel layout is shifted in the TBM section. since the road width after Opera House Station is too narrow to arrange two shield tunnels in horizontally parallel.

Figure 4.18 shows the standard cross sections of the cut and cover tunnel and the shield tunnel of UMRT Line 1.



Source: Management Authority for Urban Railway (MAUR)

Figure 4.18 Standard Cross Section of C&C Tunnel and Shield Tunnel of Line1

(c) Station Plan

Ben Thanh Station for UMRT Line1 is designed as two (2) stories, namely the concourse is on the B1 floor and the platform is on the B2 floor. The platform layout is designed as one (1) island with two (2) tracks.

Since Ben Thanh Station is the terminal station of Line1, the scissors crossing is placed in front of Ben Thanh Station for the return operation. In addition, receiving sub-station is planned at Ben Thanh Station.

The rail level of Ben Thanh Station is designed as -13.65m.

(2) UMRT Line 2

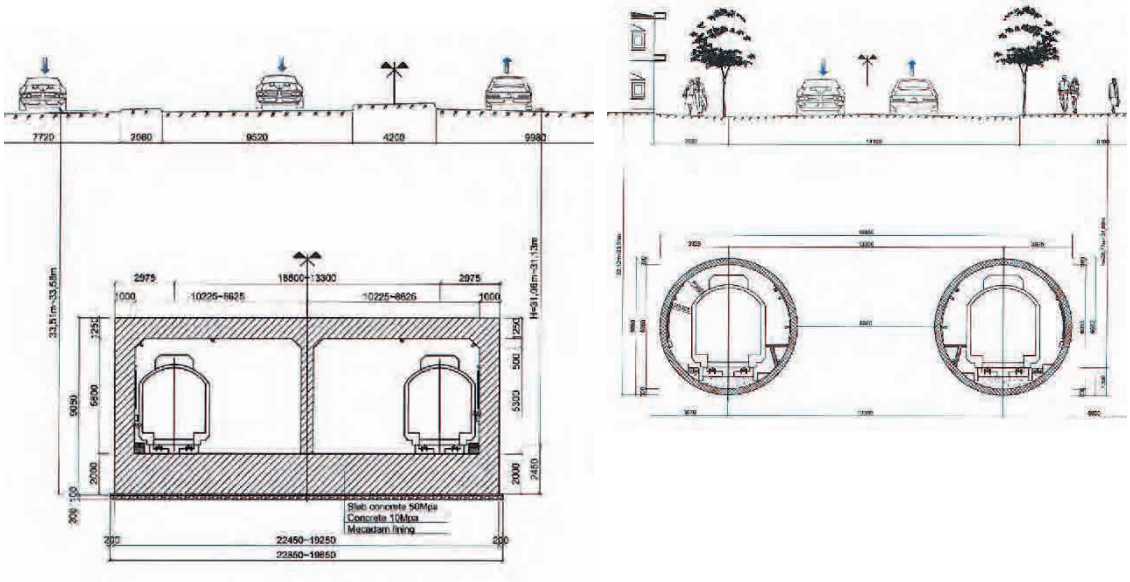
(a) Route Plan

The route of UMRT Line2 starting from Ben Thanh Station goes toward north-east along Pham Hong Thai street via Cach Mang Thang 8 street.

(b) Tunnel Plan

Ben Thanh Station and the connecting section of 224m are planned as cut and cover tunnel. The other section up to Tao Dan Station is planned as shield tunnel.

Figure 4.19 shows the standard cross section of the cut and cover tunnel and the shield tunnel of UMRT Line2.



Source: Management Authority for Urban Railway (MAUR)

Figure 4.19 Standard Cross Section of C&C Tunnel and Shield Tunnel of Line2

(c) Station Plan

Ben Thanh Station of Line2 is located at the deepest area in the Ben Thanh Central Station.

No detailed design of Ben Thanh Station is shown in the F/S, however, the platform layout is designed as one (1) island type with two(2) tracks. Since Ben Thanh Station is the terminal station of Line2 in Phase 1, the scissors crossing is placed in front of Ben Thanh Station for return operation.

In the F/S, the rail level at the center of Ben Thanh Station is designed as -29.10m.

Special attention is paid to the rail level of UMRT Line 2 at Ben Thanh Station in developing the layout of Ben Thanh Central Station to keep the adequate vertical alignment of Line 2.

(3) UMRT Line 3a

UMRT Line 3a connects Ben Thanh Station to Tan Kien Station in the South-west of HCMC with length of 9.7km. The Line 3a route starting from Ben Thanh Station goes toward South-west along Pham Ngu Lao Street.

Detail description of Line3a shall be referred to Line1 since Line3a is an extension of Line1.

(4) UMRT Line 4

(a) Route Plan

The route of Line 4 around Ben Thanh Station runs along Pasteur Street toward South-east and turn to Le Loi Street toward South-west. Line 4 underpasses Line1 at the corner of Pasteur and Le Loi Streets, then runs parallel with Line1 up to Ben Thanh Station.

After Ben Thanh Station, Line 4 runs along Nguyen Thai Hoc Street via Tran Hung Dao Street.

(b) Tunnel Plan

Ben Thanh Station is planned as cut and cover tunnel. The other section around Ben Thanh station is planned as shield tunnel. The cross section of shield tunnel is the same with that of Line1.

At the crossing point of Line 1 and Line 4, Line 4 underpass Line1 with distance of 6.7m (the same size with the diameter of the shield tunnel).

(c) Station Plan

Ben Thanh Station of Line 4 is arranged almost parallel with Line1 station. The rail level of Line 4 at Ben Thanh Station is designed as -22.98m and there is a 9.33m height difference from the rail level of Line1. The platform layout is designed as one(1) island type with two (2) tracks.

No crossover is arranged fore and after Ben Thanh Station since Ben Thanh station is not a terminal station of Line 4.

2) Revised Points of the alignment

(1) UMRT Line1

(a) Horizontal Alignment

- The track center distance could be revised from 10m to 5m.
- With the revision of the track center distance, the horizontal alignment from Ben Thanh station to Opera House station shall be revised.
- IP is shown in appendix drawings.
- The end point of scissors crossing of Opera House side shall be moved 39.5m to Ben Thanh Station due to the above review.

(b) Vertical Alignment

- The vertical alignment from Ben Thanh station to Opera House station shall be revised, due to the review of horizontal alignment.
- The rail level at the station shall be unchanged.
  Ben Thanh Station = -13.65m
  Opera House Station = -12.95(EBT), -25.15(WBT)
- The rail level (WBT) at the crossing point with Line 4 shall be revised as shown below.
  Original = -19.40m @KM+435
  Revised = -19.85m @KM+435

(2) UMRT Line1

(a) Horizontal Alignment

- The alignment from Pasteur street toward Le Loi shown in the F/S shall be unchanged.
- Assuming that two tracks are concentric circles, the radius of two tracks is as follows.
  Inside Track: R350
  Outside Track: R360
- Outside S curve shall be revised with the consideration to avoid the conflict between the vertical curve to be inserted in front of Ben Thanh station and the transition curve.

(b) Vertical Alignment

- The rail level of Ben Thanh station (-21.01m) shown in the F/S shall be unchanged.
- In order to maximize the separation distance between Line 1 and Line 4 at the crossing point, the vertical alignment (see drawings) shall be revised with the consideration to design criteria. Besides it makes interference range of diaphragm wall of underground shopping mall reduce.

(3) UMRT Line2

(a) Horizontal Alignment

- In the F/S,the scissors crossing is placed in front of Ben Thanh Station, so the review of the alignment is not necessary in principle.
- However, the location of scissors crossing is relatively far from Ben Thanh Station, and this condition may be critical to setup the train headway.
- Considering the above mentioned information, it is proposed to relocate the scissors crossing at nearest to the station as shown in the drawings, and consequently, horizontal curve with R1,000 is allocated in platform.
- The adoption of this proposal shall be decided by MAUR.

(b) Vertical Alignment

- Rail level of Line2 at the Ben Thanh Station shall be planned as the lower of the following conditions.
  ① (Rail level of Line1 at the Ben Thanh station) -12.0m
  ② (Rail level of Line4 at the Ben Thanh station) – 6.5m
- According to the above results, rail revel of Line2 is determined to ①

  Rail revel of Line2 at Ben Thanh Station: -13.65 -12.0 = -25.65m

3) Design Criteria

The design criteria for the review of alignment are shown below.

(1) Horizontal Alignment

- Minimum Radius of Curve: R=300(m)
- Equilibrium Cant: $Cm = GV^2/127R$ (mm)

  Where, G: Track Gauge (1,435mm)
  V: Train Speed (kph)
  R: Curve Radius (m)
- Transition Curve: Half sin wave shape transition curve (according to Line 1 Project)
- Length of Transition Curve: Maximum Length among L1 to L3 (Round up with 5m interval)

  $L_1 = 450C_a$ (m)
  $L_2 = 7.4C_aV$ (m)
  $L_3 = 6.7\ C_dV$ (m)

  Where, C_a: Actually Applied Cant (mm)
  C_d: Cant Deficiency (mm)
  V: Train Speed (kph)

(2) Vertical Alignment

- Gradient:

Maximum gradient for main line	35 ‰
At point and crossing works	equal or less than 10 ‰
Within the horizontal curve section	equal or less than (35-600/R)
At stations (throughout the platform)	0 ‰
Minimum Gradient:	2‰

- Vertical curves: Minimum radius VCR=3,000m (exceptional case: 2,000m)

(3) Turnout

- For main line: No.10 turnout

(4) Track Center Distance

- The minimum distance between track centers in underground section shall be 4.2 meters. (Construction Gauge: 3.4m + Refuge space 0.8m)

(5) Others

i) Vertical curves shall, wherever possible, be positioned such that coincidence with horizontal transitions is avoided.

ii) Points and crossing shall not coincide with vertically curved track and horizontal transitions.

iii) Vertical curve is to be omitted for the gradient change with 10‰ or less, but for the study of i) and ii) above, VCR2,000 shall be assumed.

4.3.2 Subway Station Facility Planning

1) Intorduction

Station is the first contact point for railway passengers and railway industry association and also the starting point of providing services to passengers. In order to provide a good service to passengers efficiently, it is necessary for a service provider to examine the whole concept of the station.

Here, we will explain the facility plan of the station including not only Line 1 but Line 2, Line 3a and Line 4 which are planning to be expanded in the future and office facilities and its incidental equipments at Ben Thanh Central Station, and also introduce our challenges and countermeasures for development of Ben Thanh Central Station.

2) Station Facilities

About the facilities which should certainly be built a subway station, the designation and purpose are shown in Table 4.14. Moreover, we show the fundamental view of the station facilities planning in the Ben Thanh Central Station.

(1) Designation and purpose for use of Facilities

Table 4.14 Designation and Purpose of Station Facilities

Designation		Purpose
B1 (Concourse) or B2 (Facilities space)		
1	Station Office	Room which performs office work. The room serves as the station disaster prevention management office.
2	Station member’s Room	A station member's rest station. The room serves as cooking and a dining-room.
3	Station cleaning member’s Room	The room serves as cooking and a dining-room. It is utilized as a cleaning official's in charge rest station and locker room.
4	Women station member’s Room	The locker room of woman members.
5	Men station member’s Rest Room	A station member's bedroom. The room is classified into those for early shift and for late shift.
6	Crew’s Rest Room	The crew's bedroom. Since office hours differ, a single room is preferable.
7	Conference Room	The room is used as a station member's conference room, education, roll call, and a workplace.
8	Ticket Counter	Room which place ticket machines and adjustment machines.
9	Season Ticket Counter	The place which sells a season ticket.
10	Passenger's Toilet	The room makes man and woman separate.
11	Handicapped people's Toilet	The type toilet corresponding to a wheelchair user.
12	Station member's Toilet	The room makes man and woman separate.

13	Station member's Lavatory and Bathroom	The room is used for a shower or wash.
14	Warehouse	The storage place of documents, signboards, cleaning tools, and garbage, etc.
15	Crew's Toilet	The room makes man and woman separate.
16	Signal Treatment Room	Room which operates a signal and point and crossing.
B2,B3 and B4 (Platform of each Line)		
17	Waiting Room	For a passenger's waiting room. It is good to constitute a bench and air conditioning equipment.
18	Platform arrangement member's Room	The room is also a place of emergency supplies.
19	Crew Waiting Room	Waiting room for the crews to the next crewing.

(2) The basic concept of the facility plan for Ben Thanh Central Station

(a) Passengers can transfer to Line 1, Line 2, Line 3a and Line 4 through inside gate.
(b) For passengers' convenience, three gates will be installed at 1st Phase and four gates will be installed at 2nd Phase. Those gates will have an access to all lines.
(c) The structure of the station allows passengers to transfer between Line 1 and Line 2 directly from platform to platform.
Transfer between Line 1 and Line 4 can be done through B1 concourse.
Transfer between Line 2 and Line 4 can be done through an access way.
Line 3a will share a platform with Line 1 for Line 3a is considered as a continuous line of the Line 1.
As mentioned above, passengers can transfer among all lines without passing though the gate.
(d) With an aim of creating a subway that can be easily used by everyone including vulnerable road
users, escalators and elevators will be installed on all lines and also construct a walkway that enables passengers to move from ground to the platform by one route.
(e) Ticket Counter will be located near each gate.
(f) Station Office will be located in a concourse.
(g) Station Office and Staff Office should be located nearby each other in case of any passenger service will be needed.
(h) Office facilities and crew facilities should be intensively located on the B1 and B2 floor.
(i) Importing the concept of Universal Design, ticket vending machine, elevators, restrooms, information display, etc. should be designed user-friendly and easy to obtain necessary information.
(j) Subway concourse and Underground Shopping Mall should be connected on the same level of floor heights.
(k) Machinery equipments of each line should be installed at the space of each line.
(l) Due to security reasons, entry to the station outside hours will be restricted to station staff only.

Therefore, it is recommended to set up a station controlled area taking into consideration in relation to Underground Shopping Mall and install a roll-up door.

(m) Considering road configuration and passengers' convenience, ground level entrances should be preferably located where multi-way access is available.

(n) It is necessary to take measures to prevent water seepage not only in these areas controlled by station but also a whole basement area including Underground Shopping Mall.

(3) Station Office

Station Office is a central to railway operation and a place that provides management of general administration and disaster prevention as well as services to passengers. A full-range of disaster prevention equipment, centralized monitoring equipment and counting machine of operating data etc. should be installed here.

Also, extra space for emergency situation and providing assistance to passengers will be needed. Location of the station office is recommended to be near the center of the station considering the surroundings – entrance stairways, stairways to platforms, public roads and spaces.

(4) Toilets

Since toilets at the station are available to the general public, universal design is being actively introduced and it is important to combine these toilet facilities to work better for various people – hand washing basin, toilet basin, urinal, multifunctional toilet for wheelchair users.

Toilets for passengers should have;

・There needs to be large and bright open and functional space.
・There needs to be sanitary and feeling of purity.
・Consideration of crime prevention should be made.
・Consideration of the weak should be made.

Regarding multifunctional toilets, it is recommended to install male/female toilets separately as general use toilets for wheel chair users and elderly people, expecting mothers and person accompanying small children. It is necessary to take into account of gender differences between caregiver and person in need of care when deciding a location of the toilets.
Due to the staff toilets should be located separately from the one for passengers.

As for the position of installation, it is preferable to have annexed to the station office or the station member's room. About the number of installation, it is required to decide in consideration of the number of station members.

(5) Lighting Equipment

Appropriate lighting facilities shall be installed for station personnel offices, passenger platforms, and concourse areas. The illuminance and type of lighting equipment shall secure sufficient brightness by location, technique, and source of the lighting. Considering passenger convenience, safety and comfort, and the workability of station

personnel, appropriate lighting levels shall be provided as follows.

Table 4.15 Standard Lighting Level

Area	Standard Lighting Level (lx)
Ticketing and Fare Adjustment	500
Concourse	300
Platforms	100
Station Offices	200
Passageway and Stairs	100
Toilets	100

(6) Proposal of the Installation Area of Station Facilities

We propose about the installation area of the station facilities in the Ben Thanh Central Station at 1st Phase on the basis of an installation base area required for each facility in a concourse floor and a platform. (Refer to Tables 4.16 - 4.17)
In addition, we propose the necessary area to control three lines at 2nd Phase. (Refer to Tables 4.18 - 4.19)

Table 4.16 The occupation area of the station facilities in Ben Thanh Central Station (1st Phase)

【Facilities related to station members】

Designation		Ben Thanh Central Station	(Reference: Tokyo Metro)	
		Occupation area (m^2)	Required range (m^2)	
B 1 (Concourse: Community of Line 1 and Line 2)				
1	Station Office	**660＋190 = 850**	180 × 2 Lines ＝ 360	732
2	Station member Room		1.3×25×2 Lines ＋ 35 (Dining-room etc.) ×2 Lines ＝ 135	
3	Woman member Room		1.3 × 5 人 × 2 Lines ＝ 13	
4	Assistant stationmaster' bedroom		6 × 2 人 × 2 Lines ＝ 24	
5	Station cleaning member Room		50 × 2 Lines ＝ 100	
6	Passenger's Toilet (Including of Handicapped people's Toilet)		100 × 1 place ＝ 100	
7	Signal Treatment Room	**285**	50 × 2 Lines ＝ 100	300
8	Conference Room		100 × 2 Lines ＝ 200	
9	Ticket Counter	**160 (Sum totals of three ticket gates)**	40 × 3 place ＝ 120	
10	Season Ticket Counter	**180**	150 × 1 place ＝ 150	
Total		**1,475**	1,302	

B 2				
11	The bedroom for men（early shift）	**480**	8 × 4 人 × 2 Lines ＝ 64	424
12	The bedroom for men（late shift）		8 × 4 人 × 2 Lines ＝ 64	
13	The bedroom for women		8 × 1 人 × 2 Lines ＝ 16	
14	Men station member's toilet		15 × 2 Lines ＝ 30	
15	Women station member's toilet		15 × 2 Lines ＝ 30	
16	Men station member's Lavatory and Bathroom		20 × 2 Lines ＝ 40	
17	Women station member's Lavatory and Bathroom		20 × 2 Lines ＝ 40	
18	Warehouse		70 × 2 Lines ＝ 140	
Total		**480**	424	
B 2，B 4（The platform of Line 1 and Line 2）				
19	Waiting Room	**5**	5	
20	Platform arrangement member’s Room	**10**	10	
Total		**15**	15	

Table 4.17 The occupation area of the crew facilities in Ben Thanh Central Station (1st Phase)

【Facilities related to crew members】

Designation		Ben Thanh Central Station	（Reference: Tokyo Metro）
		Occupation area (m^2)	Required range (m^2)
B 1（Concourse: Community of Line 1 and Line 2）			
1	Crew Office	**1,370**	180 × 2 Lines ＝ 360
2	Conference Room		30 × 2 Lines ＝ 60
3	Rest Room		20 × 2 Lines ＝ 40
4	Crew’s Room		50 × 2 Lines ＝ 100
5	Dining Room		60 × 2 Lines ＝ 120
6	Locker Room		60 × 2 Lines ＝ 120
7	Crew’s Bedroom		170 × 2 Lines ＝ 340
8	Crew's toilet		20 × 2 Lines ＝ 40
9	Crew's Lavatory and Bathroom		40 × 2 Lines ＝ 80
10	Warehouse		40 × 2 Lines ＝ 80
Total		**1,370**	1,340
B 2，B 3，B 4（The platform of each line）			
11	Crew's standby Room	**5**	5
Total		**5**	5

Table 4.18 The necessary area to control three line (2nd Phase)

【Facilities related to station members】

Designation		Ben Thanh Central Station	(Reference: Tokyo Metro)	
		Occupation area (m^2)	Required range (m^2)	
B 1 (Concourse: Community of Line 1, 2 and 4)				
1	Station Office	**490 + 350 = 840**	180 × 3 Lines = 540	782
2	Station member Room		1.3×25×3 Lines + 35 (Dining-room etc.) ×3 Lines = 222	
3	Woman member Room		1.3 × 5 人 × 3 Lines = 20	
4	Assistant stationmaster' bedroom	**190**	6 × 2 人 × 3 Lines = 36	186
5	Signal Treatment Room		50 × 3 Lines = 150	
6	Station cleaning member Room	**150**	50 × 3 Lines = 150	
7	Conference Room	**300**	100 × 3 Lines = 300	
8	Ticket Counter	**250**	40 × 4 place = 160	
9	Season Ticket Counter	**150**	150 × 1 place = 150	
10	Passenger's Toilet (Including of Handicapped people's Toilet)	**205**	100 × 1 place = 100	
Total		**2,085**	1,828	
B 2 (Between Line 1 and Line 4)				
11	The bedroom for men (early shift)	**720**	8 × 4 人 × 3 Lines = 96	636
12	The bedroom for men (late shift)		8 × 4 人 × 3 Lines = 96	
13	The bedroom for women		8 × 1 人 × 3 Lines = 24	
14	Men station member's toilet		15 × 3 Lines = 45	
15	Women station member's toilet		15 × 3 Lines = 45	
16	Men station member's Lavatory and Bathroom		20 × 3 Lines = 60	
17	Women station member's Lavatory and Bathroom		20 × 3 Lines = 60	
18	Warehouse		70 × 3 Lines = 210	
Total		**720**	636	
B 2, B 3, B 4 (The platform of each line)				
19	Waiting Room	**5**	5	
20	Platform arrangement member's Room	**10**	10	
Total		**15**	15	

Table 4.19 The necessary area to control three line (2nd Phase)

【Facilities related to crew members】

Designation		Ben Thanh Central Station	(Reference: Tokyo Metro)
		Occupation area (m^2)	Required range (m^2)
B 1 (Concourse: Community of Line 1, 2 and 4)			
1	Crew Office	**2,160**	180 × 3 Lines = 540
2	Conference Room		30 × 3 Lines = 90
3	Rest Room		20 × 3 Lines = 60
4	Crew's Room		50 × 3 Lines = 150
5	Dining Room		60 × 3 Lines = 180
6	Locker Room		60 × 3 Lines = 180
7	Crew's Bedroom		170 × 3 Lines = 510
8	Crew's toilet		20 × 3 Lines = 60
9	Crew's Lavatory and Bathroom		40 × 3 Lines = 120
10	Warehouse		40 × 3 Lines = 120
Total		**2,160**	2,010
B 2, B 3, B 4 (The platform of each line)			
11	Crew's standby Room	**5**	5
Total		**5**	5

3) Station Equipment

When the viewpoint of service to a user is also taken into consideration, the machinery of a station is equipment with many opportunities which I actually use or see for a user. For example, station equipment means equipment of ticket gate, a lift (escalator elevator), a platform screen door, etc. Here, we introduce the fundamental view and the main equipment about installation of station equipment.

Also at the Ben Thanh Central Station, we recommend installing these station equipments.

(1) Ticket Gate

Formerly, in the ticket gate of the station in Japan, the station member clipped the ticket with scissors, and collected the passenger's tickets. Recently, at the station of urban areas, the automatic ticket gate is installed for the simplification and economization of business. Many equipments of station office, station member's room and ticket counter, etc. are unified and economized.

There are several types of tickets according to the materials and functions.

a) Paper Tickets

Necessary information is printed on the paper.

b) Magnetic Tickets (Magnetic Stripe Cards)

Necessary information is recorded on a magnetic stripe on the paper or plastic card. Magnetic tickets made of plastic are recyclable.

c) IC Tickets

The necessary information is recorded on IC chips embedded in plastic cards, etc. IC cards function as SF (stored fare) cards and commuter passes. However, each passenger has to keep their own IC card.

Recently, the spread of the tickets of type corresponding to an IC card is progressing quickly, and advanced features of the ticket gate equipment corresponding to this are needed. Simultaneously, it is necessary to take into consideration the structure which is easier to use for the mobility impaired people.

Also in this project, the ticket shall be mainly a contactless IC ticket made of plastic in consideration of the future prospects of use on buses, in shops, and other places. However, it is necessary to install a ticket machine for a user without an IC card.

At least two ticket vending machines should be installed in order to ensure that they will operate properly. Those two machines should be located 1m apart from each other. Also, fare adjustment machines should be placed inside the ticket gate.

Ensure to keep extra space in case of additional machines will be required. Create a space for calculating and hand washing machine and air conditioner should be installed.

At least two ticket vending machines should be installed at one place. If an IC card system was to be implemented, it is expected that frequency of use will be lower, so that number of tickets to be sold per machine should be 150/hr, 1,400/day.

The number of installation of the station equipment in this project is shown.

・In 1st Phase

We recommend the number of "Passenger gate" in "Preliminary Design of Line 1 project" for operation of only Line 1.

Accordingly, 15 set / the number of ticket gates x 2 ticket gates = 30 sets.

As for the number of each ticket gate, it is preferable to install according to the width in front of a ticket gate.

・In 2nd Phase

The required number of automatic gates for this project are obtained from the following.

$$N = P \times C / T$$

Where;

N: Required numbers (unit)

P: Number of passengers per peak hour (people/hour)

C: Intensive volatility of passengers depending on events or transfer from/to other transportation modes

T: Maximum number of processes per unit per hour (people/unit/hour)

In calculating the required number of the automatic ticket gate of 2nd Phase, we describe again the number estimation value of passengers of Ben Tyne Station ("4.1.2 Number of users at Ben Thanh Central Station").

Table 4.2 Result of Estimated Number of Users at Ben Thanh Central Station (Pax/day)

		2025	2050
Transfer	Line 1 <> Line 2	59,400	126,500
	Line 1 <> Line 4	38,300	50,100
	Line 2 <> Line 4	21,300	28,800
Station <> Outside		50,500	73,600
Total		169,500	279,000

From Table 4-2, since the number of passengers “Station <> Outside” is “73,600 Pax/day”, the passengers per peak hour is

73,600 pax/day x 0.2 (rate of peak per hour) = 14,720 (pax/hour).

On the other hand, the number of ticket gates will be four places.

P ＝ 14,720 pax / 4 parts ＝ 3,680 pax / 1 part

C ＝ 1.5 （Install in consideration of opening of an event）

T ＝ 50 pax / unit / minute ＝ 3,000 pax / unit / hour

N ＝ P×C／T ＝ 3,680 x 1.5 ／ 3,000 ＝ 1.84 ≈ 2 unit/ 1 part

In this project, we recommend installing eight automatic ticket gates [two sets x four places] in the ticket gate which we establish newly.

Next, although it is mentioned in the "Preliminary Design of Line 1 project" that “the number of Automatic ticket vending machines to be installed should be 9 unit/ 1 part in 2040”,iti is sufficient to install 9 unit x 2 parts = 18 machines considering the fact IC card is planned to be introduced.

(2) Automatic Fare Adjustment Machine

The fare adjustment machine is installed inside the ticket gates and used for fare adjustments, such as excess fare. This fare machine reads the ticket information when the ticket is inserted into the machine. At this time, the fare is deducted from the remaining balance on the ticket and any balance due is displayed. After inserting the necessary amount of money, an adjusted-fare ticket will be dispensed, with which the passenger can pass through the automatic gate.

About the Automatic adjustment machine in this project, two units should be installed at each gate in case the one stops its service for maintenance.

The required number in the following fiscal year of this project is shown in Table 4.20.
However, about the time of installation, in consideration of the number of passengers, and an investment effect, it is necessary to discern suitable time so that it may not be overinvested.

Table 4.20 The number of installation of station equipment (Total)

Year	Automatic ticket gate	Automatic ticket vending machine	Automatic adjustment machine
2025	30	18	2
2050	38	18	2

(3) Lift (escalator, elevator)

In Japan of the aging society, a duty of installation of a lift (escalator elevator) is imposed aiming at barrier-free. Various escalators -- for example, a speed change type, a spiral type, or a horizontal level exists on the way -- are installed.

The guidelines for installation of escalators are as follows:

a) The escalator step width shall accommodate two people side-by-side.

b) In the part in which it can be constituted only one set, the escalator shall usually operate in the up direction, and the operation in the down direction shall be possible depending on passenger flow.

c) The escalator speed shall be approximately from 30 m/min to 40 m/min.

d) The step surface and comb plate shall have a slip-resistant design.

e) The demarcation lines such as yellow lines shall be added to clearly indicate the step and comb plate section for safety.

f) It needs attention to prevent women's national costumes from becoming caught in the escalator.

Then, the type corresponding to a wheelchair is installed in the elevator.
Furthermore, when using glazing (see-through type) structure, a prospect becomes good, the structure of a station is grasped visually, and there is an effect of criminal deterrence.

The guidelines for installation of elevators are as follows:

a) The entrance width shall be wider than 90 cm so that wheelchair users can get on and off smoothly.

b) The control panel inside and outside the elevator shall be installed in consideration of the position and display for wheelchair users and the visually impaired.

c) The voice guidance system shall be installed in the elevator car.

d) The elevator doors shall be equipped with glass windows that allow passengers to be seen from the inside or outside of the elevator.

e) Considering that passengers in wheelchairs can use elevators smoothly, the type of elevator shall be the walkthrough type, if available.

f) Flood measures shall be considered for the ground level.

Also at Ben Thanh Central Station, it is preferable to install an escalator or elevator in consideration of station structure, arrangement of a ticket gate and a station office, etc.

Here, we calculate the number of installation of the escalator in this project.

In Table 4.2, we calculate the number of installation of escalator from the numerical value of a "Line 1 < > Line 2" with most transfer number. In this case, we adopt the standard of Tokyo Metro.

Precondition: The numerical value per peak hour (Tokyo Metro standard)

Transport capacity of escalator (Form 1200type): 1.66 (pax/second) = 5,976 (pax/hour)

Amount of passenger flow: 0.85 (pax/m/second) = 3,060 (pax/m/hour)

・In the case of 2025 (Up-and-down passenger)

59,400 (pax) x 0.2 (the rate of a peak per hour) ＝ 11,880 (pax/hour)

11,880 (pax/hour) /5,976 (pax/hour) ＝ 1.99 ≈ 2 unit/ 1 part

Moreover, in order to build stairs, the transport capacity of escalator increases.
It would improve the quality of service for passengers if two escalators are installed in other areas.

・In the case of 2050 (Up-and-down passenger)

126,500 (pax) x 0.2 (the rate of a peak per hour) ＝ 25,300 (pax/hour)

25,300 (pax/hour) /5,976 (pax/hour) ＝ 4.23 ≈ 5 unit/ 1 part

Although our calculation shows that there will be 5 escalators are necessary, we propose installing 2 escalators.
However, it is expected to cause congestion situations on the platform.
Therefore, we calculate the width of stairs which must be wide enough for peak passenger flows.

25,300 (pax/hour) – 5,976 (pax/ hour) x 2 (unit) ＝ 13,348 (pax/hour)

13,348 (pax/hour) / 3,060 (pax/m/hour) = 4.36 (m) ≈ 4.4 (m)

For this project, we recommend to set the width of stairs between platform of Line 1 and Line 2 as 4.4 meters assuming not only the construction of Line 1 but also the construction of all three lines have been completed.
1.5~2.2 meters width should be enough for other stairs.

(4) Platform Screen Door、a platform fence of a movable type

Recently, the example which prepares a screen door between a platform and a track is increasing. The reason is for the purposes, such as preventing a passenger from falling from a platform, reducing a platform watchman's burden, and aiming at effective use of platform width.

There are two types. One is the "full-screen type" of the height covered to a ceiling, and another is the "fence type" of the height of the waist. A train door and a platform door are interlocked with both of the types, and open and close together. Therefore, the advanced driving skill for stopping within decided limits is required so that the position of both of doors may not deviate.

4) Passenger Information Display System in the Subway Station

There is much voice referred to as the passenger of a subway station “I do not know where the entrance is.” “I do not know where the exit is.” “I do not understand how to transfer.” There is needed the offer of the information in connection with suitable and effective guidance so that passenger can smoothly act within a station yard and a train.

It is preferable to devise a design, a sign, a color, etc. also at Ben Thanh Central Station, and it is preferable to guide a passenger to the destination not waver.

(1) Guidance signboard

We explain the main guidance signboard for every setting position.

(a) Station entrance

Subway logo mark……Illuminate from inside. In order to show the entrance of a station, we hang up the signboard in which the subway logo mark is shown over a conspicuous position.

Station name signpost……Illuminate from inside. We put up a station name post.

Wall type station name signpost……Illuminate from inside. We display a station name and a subway line name on the wall of a gateway section.

First train and last train timetable ……Illuminate from inside. We publish the timetable which first rain time and last train time.

When installing a shutter in an entrance, it is good to install in the outside.

(b) Concourse

Display of a stop station……Illuminate from inside. We install in the wall of the front of platform stairs. When it cannot install, or when hard to see, we install in an intelligible position.

Ground exit guidance display……Panel system. We install the surface of a wall of guidance zoon and near an entrance turning point. As for the number of information of a surrounding landmark, less than ten places are intelligible.

Station vicinity map……Same as "Ground exit guidance display"

(c) Near a ticket gate

All the subway line figure ……Panel system. We install in the surface of a wall outside a ticket gate.

Fare table……Panel system. We install in the ticket machine upper part.

Entrance sign of a ticket gate ……Panel system. We install on an automatic ticket gate and display the direction of an exit and platform guidance.

(d) Platform

Timetable……We put up the timetable of "Weekday", "Saturday and Holiday."

The map of a transfer, the map of facilities……We put up a pillar etc.

Station Yard Map……It is stuck on a signboard. When a transfer in other lines is complicated, we express a station yard in three dimensions, and guide an intelligible transfer route.

Ticket gate guidance sign……It is stuck on a pillar or a wall. When there are two or more ticket gates, the direction of a ticket gate and surrounding landmark information are shown. The written contents of landmark information presuppose that it is the same as a ground exit guidance sign.

The station map which stops……The map which displays the name of the station in a line.It is intelligible when it indicates according to a direction.

Automatic onboard indicator for train information……Train time, a destination, etc. are shown.

(e) Inside the train

The station map which stops ……It is an electrical scoreboard form. It is notified on the upper part of a door.

Line network diagram……It is notified on the upper part of a door.

(2) Automatic onboard indicator for train information

It is equipment for providing information in advance to a passenger. Moreover, since it can also perform broadcast of passenger guidance, dangerous prevention, etc., it is considered about safety.

(3) Guidance for a visually impaired person

The guidance board by the voice type and the touch type……It is installed near a ticket gate or a ticket machine.

Braille-type plate …… It is installed in all the stairs and handrails of all the stations.

Guidance chime……It is installed near an entrance, a ticket gate, and a ticket machine.

Tactile ground surface indicator, Braille block …… It is installed in a passage, a platform, a concourse, etc. from the ground to a platform.

5) Machine and Equipment facilities

(1) Air Conditioning, Ventilation equipment

In a subway station, normally the air-conditioning system is used for keeping a high quality of air since it is difficult to let fresh air in from outside. Also, the ventilation system and smoke ventilation system should be installed to ensure passenger safety in the event of a fire breaking out.

(2) Water Supply and Drainage

Water is needed for toilets for station personnel and passengers, hot water supply, cleaning, and fire equipment. The facilities for water supply and drainage in each station shall be installed assuming that water supply and sewerage systems are already prepared. The daily water requirements of a station are as follows:

1) For station personnel and cooling water for air conditioning facilities, approximately 35 m^3 per day shall be assumed.
2) For toilet use, approximately 1.5 m^3 per 10,000 passengers per day shall be assumed.
3) For water for fire fighting, the water requirement shall be considered in the future in compliance with standards such as local fire laws.

As drainage facilities, septic tanks shall be installed to treat toilet and domestic wastewater. After the treatment complying with local wastewater standards, wastewater is drained to the outside of railway facilities.

For septic tank capacity, the targeted number of persons shall be assumed approximately 0.8% of the number of boarding and alighting.

(3) Necessary dimension of Machinery room

Based on an installation base area required for each machinery facilities in a concourse and a platform, we propose the installation area of the machinery facilities in Ben Thanh Central Station.
The area of the machinery facilities of Line 1and Line 2 is shown in Table 4.21 - 4.22.
However, finally it is necessary to perform a detail design about a required area.
In addition, we propose the area of machine facilities required for Line 4 to Table 4.23.

Table 4.21 The occupation area of the machinery facilities in Ben Thanh Central Station ofLine 1

【Facilities related to machinery of Line 1】

Designation		Ben Thanh Central Station		(Reference: Tokyo Metro)	
		Occupation area (m^2)	Space height (m)	Required range (m^2)	Space height (m)
B 1 (Concourse)					
1	Air Handling Unit Room	**1,280**	**5.4**	1,000～2,050	4.5～5.0
2	Electric Supply Room	**1,290**	**5.4**	200	4.5～5.0
3	Signalling/Telecomunication		**5.4**	250	4.0
4	Emergency Electric Room		**5.4**	200	4.5～5.0
5	Drain Pump Room		**5.4**	50	4.0
6	Hygiene Pump Room		**5.4**	25	4.0
7	Hygiene Ventilation Room		**5.4**	6	
8	Fire Service & Water Tank & Pump Room		**5.4**	50	4.0
9	Water Supply Pump Room		**5.4**	50	4.0
Total		**2,570**		1,831～2,881	
B 2					
10	Substation Room	**900+500**	**6.5**	1,100	more than 5.0
11	Tunnel Ventilation Fan Room	**Beginning side 740+510 End side 600+430**	**6.5**	Beginning side and End side 700 ～ 800	4.5～5.0
Total		**3,680**		1,800～1,900	

Table 4.22 The occupation area of the machinery facilities in Ben Thanh Central Station of Line 2

【Facilities related to machinery of Line 2】

Designation		Ben Thanh Central Station		(Reference: Tokyo Metro)	
		Occupation area (m^2)	Space height (m)	Required range (m^2)	Space height (m)
B 3 (The floor of a transfer)					
1	Air Handling Unit Room	**1,000**	**6.4**	1,000～2,050	4.5～5.0
2	Electric Supply Room	**490**	**6.4**	200	4.5～5.0

3	Emergency Electric Room		**6.4**	200	4.5～5.0
4	Signalling/Telecomunication	**560**	**6.4**	250	4.0
5	Drain Pump Room		**6.4**	50	4.0
6	Hygiene Pump Room		**6.4**	25	4.0
7	Hygiene Ventilation Room		**6.4**	6	
8	Fire Service & Water Tank & Pump Room		**6.4**	50	4.0
9	Water Supply Pump Room		**6.4**	50	4.0
10	Substation Room	**1,100**	**6.4**	1,100	more than 5.0
Total		**3,150**		2,931～3,981	
B４（platform）					
11	Tunnel Ventilation Fan Room	**Beginning side 680 End side 680**	**6.5**	Beginning side and End side 700 ～ 800	4.5～5.0
Total		**1,360**		1,400～1,500	

Table 4.23 The occupation area of the machinery facilities in Ben Thanh Central Station of Line 4

【Facilities related to machinery of Line 4】

Designation		Ben Thanh Central Station		（Reference: Tokyo Metro）	
		Occupation area (m^2)	Space height (m)	Required range (m^2)	Space height (m)
B２（The floor of a transfer）					
1	Air Handling Unit Room	**1,240**	**6.5**	1,000～2,050	4.5～5.0
2	Electric Supply Room	**900**	**4.6**	200	4.5～5.0
3	Signalling/Telecomunication		**4.6**	250	4.0
4	Emergency Electric Room		**4.6**	200	4.5～5.0
5	Drain Pump Room		**4.6**	50	4.0
6	Hygiene Pump Room		**4.6**	25	4.0
7	Hygiene Ventilation Room		**4.6**	6	
8	Fire Service & Water Tank & Pump Room		**4.6**	50	4.0
9	Water Supply Pump Room		**4.6**	50	4.0
10	Substation Room	**790(+540)**	**6.5**	(1,100)	more than 5.0
Total		**2,930**		2,400～3,650	

B 3 （The both ends of Line 4 platform）					
11	Substation Room	**540(+740)**	**5.4**	1,100	more than 5.0
12	Tunnel Ventilation Fan Room	**Beginning side 1,290 End side 560+380**	**7.9 7.9,6.5**	Beginning side and End side 700 ～ 800	4.5～5.0
Total		**2,770**		1,800～1,900	

6) Communication Facilities

Communication facilities have very important role in a station – they provide information to passengers and ways of contact with each other to station staff. “Public address facilities”, “passenger information display system” and “clock system” shall be recommended as telecommunication facilities for passenger services. CCTV Monitoring System is also recommended to maintain passenger safety and to monitor the station.

(1) Public Address Facilities

Public address facilities are used to broadcast information on train operations and emergencies to passengers in the station. Usually, an automatic broadcast is made to all stations or to specified stations via centralized control. Furthermore, an independent broadcast is enabled for each station.

(2) Passenger Information Display System

For the passenger information display system, a display panel is installed on the platform of each station to indicate the departure time of trains, operational status, and other information.

(3) Closed Circuit Television (CCTV) Monitor System

The CCTV monitor system is installed to monitor the status (flow of passengers at the station concourse) in the station yard for each station. The monitor cameras are installed at the station entrance, stairs, escalators, and platforms. On the platform, in particular, the system is used by train crews and station service staffs to confirm the safety of passengers from arrival to departure of a train.

7) The structural measurements of each floor (height, width) and a proposal

Regarding the height and width of the structure, each line is based on F/S, and we are considering the compatibility of station facilities for Ben Thanh Central Station.
The result was that there is no difficulty in the F/S proposal for each line’s 2D figure.

As for the longitudinal line figure, it is the advantage that the lines are shallow, but when passing Ben Thanh Central Station of line four, plenty of space is necessary in order to start the shield machine, and due the offset needed at the intersection where Line 1 crosses Le Loi Street, we determined the current F/S rail level is valid.
In accordance with that, the measurement of each floor was decided the height necessary for

the machinery facilities and necessity of earth covering, and the rail level for line was calculated.
Therefore, keeping in mind, the R.L. of Line 4 at Ben Thanh Central Station and the construction of Le Loi Street, the current R.L. of the F/S investigation is valid.

From that, the height of the structure was considered, the R.L. of Line 1, and the height of the concourse are deliberated, it was discovered that by securing the necessary amount of earth covering the necessary height for the facilities in the underground space and concourse can be secured. Therefore, the height of Line 1 R.L. and the measurements of the structure were determined.

8) Air Conditioning, Ventilation equipment on the platform or concourse

In a subway station air –conditioning and ventilation systems are equipped with platform, concourse, station offices and communication facilities room in order to improve the internal air circulation for the human and operating devices.
At the same time, a smoke control system is also equipped to ensure passengers' safety in the event of a fire.

9) Tunnel ventilation system

High density of train operation causes a temperature rise in the subway tunnels.
Especially it is greatly affected by the exhaust when using air-conditioning system.
Therefore, ventilation system and smoke exhaustion systems are installed to control a temperature rise and provide fresh air and safe evacuation routes for passengers in case of fire and the train stops inside the tunnel.

There are two types of ventilation, that is "Longitudinal ventilation system" and "Ventilation tower system between stations".
The former is the system that blows the air and the airflow moves in the same direction the train runs along the track.
The latter is the system that exhausts air from the ventilation tower between stations.
For this project, we recommend to a longitudinal ventilation system which is used mainly in a parallel single track shield tunnel.
In this case, station should have its own air supply and exhaust system.
Figure 4.16 shows the standard descriptions of the ventilation system facilities.

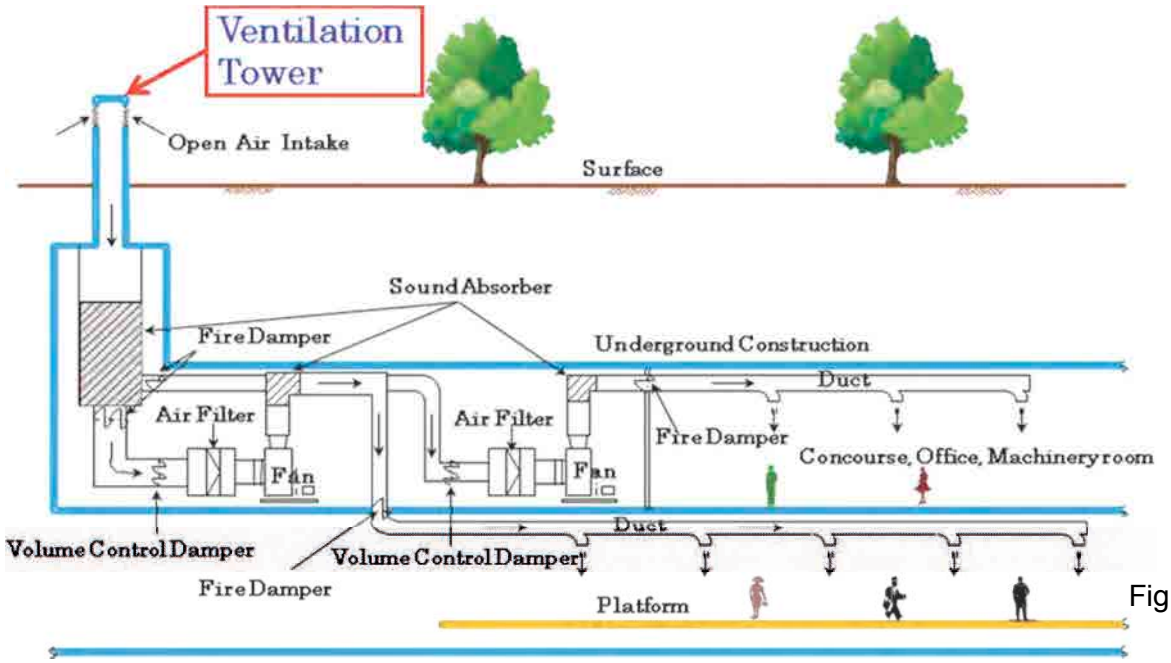


Fig 4.20 Ventilation Tower Equipment Outline (open air intake case)

10) Regarding fire prevention measures and the related equipment

Japan has standards for fire prevention measures that must be followed when building an underground railway.

We will introduce Japan's standards for fire prevention measures here, and we recommend that the same measures be implemented into this project.

(1) Standards for Fire Prevention Measures in Japan

(a) Fireproof building structures

All building structures underground should be made non-burnable.

(b) Install of a disaster prevention monitoring room

A disaster monitoring room should be set up in the station where information is collected, communication and commands is carried out, and staff is always present to give passengers guidance as well as monitor the fire prevention shutters.

(c) Install alarm and warning devices

i) Alarm devices

All stations should be equipped with automatic fire detection devices which transmit the information to a receiver in the disaster prevention monitoring room.

ii) Warning devices

The following equipment should be installed in the stations;

- Communication equipment for communication between the disaster prevention monitoring room and the fire department, the police department, traffic control at the Integrated Control Center as well as within the station and the other buildings in the area.
- A unified public announcement equipment should be installed in the disaster prevention monitoring room.

・A wire-less back-up antenna should be provided in the disaster prevention monitoring room to ensure that communication is possible with those above ground.

(2) Regarding security

(a) Fireproof building structures

As a rule, they are built using non-flammable materials, and non-flammable materials should be used for furniture as well such as desks and lockers.

(b) Cables should be heat resistant and non-burnable

Equipment for disaster prevention should be as fire resistant as the building standard laws and fire prevention laws state and electric power supply cables must be heat and fire resistant for all intended purposes.

(c) Sectionalize for fire control

For instead the station, other than the platform, the station is sectionalized by fire prevention shutters and non-flammable floors, walls and fire doors are located within every 1,500m2, in order to ensure and escape route and to prevent the fire from spreading.

(3) Types of disaster prevention equipment

Disaster prevention equipment can be broadly divided into five categories

(a) Fire-fighting equipment

Equipment that detects and displays the outbreak of a fire, equipment to put out a fire, such as fire extinguisher, and equipment to prevent a fire from spreading, such as fire door, fire shutters are installed

(b) Ventilation equipment

Smoke exhaust equipment to discharge smoke, and smoke barriers are installed to prevent smoke from spreading.

(c) Evacuation guidance equipment

Public announcement equipment can be heard throughout the station premises, and emergency lighting with illumination intensity in case of a black out, and guidance lights to indication the evacuation route are installed.

(d) Communication and liaison equipment

Communication equipment for emergency contact with police and fire departments as well as buildings which have direct access, and intercoms between rooms on the station premises, an in-house telephone, a regular telephone and a telephone used exclusively for contact with the Integrated Control Center are installed.

(e) Other

Also, a private power generator and storage batteries are installed in case of a blackout, in order to provide the power needed for disaster prevention equipment.

(4) Smoke Exhaust Equipment

By using smoke exhaust equipment to discharge smoke outside and preventing it from permeating the station premises, it is possible to ensure that an escape route is available and people can evacuate with confusion, and also fire-fighting activities can be carried out effectively.

As for the concourse and rooms to be occupied, the distance between the ventilation shafts, and the location of the manual closing devices is decided, and it is necessary to make the ventilation shaft and ducts non-flammable, airtight and install fire spreading prevention equipment.

(5) Evacuation guidance equipment

(a) Guide lights

Types of guide lights can be divided according to where they are located, such as the evacuation door guide light, passageway guide light, stairway guide light.

(b) Emergency lighting

Fluorescent lights with self-contained batteries or incandescent lamps are used for emergency lighting, taking into consideration reliability and economic efficiency. They should be able have enough power to be lit for at least one hour.

(6) Automatic fire alarm equipment

Through the receiver, transmitter, detection device and sound alarm, a fire is quickly detected automatically, not only warning the people in the building, but also the precise location of the outbreak is shown in the disaster prevention monitoring room.

(7) Emergency alarm equipment

Should an accident occur or fire breakout, it is possible to communicate with each location by using the warning button, to report the location and what the emergency is.

A regular phone can also be used to communicate.

11) The view and the equipment of inundation measures

It is necessary to install the equipment corresponding to inundation for the purpose of protecting a subway from protection from a flood, the river flood by local severe rain, etc.

There are the following openings in the opening of a subway -- for example, --(1) a station entrance, (2) a ventilation opening and a ventilation tower, and (3) a tunnel part (tunnel pithead) underground connected from the ground. As a plan which prevents a flood, we recommend the following thing.

(1) We install a waterproof-board and a watertight door in a station entrance.
(2) We install an inundation prevention machine in a ventilation opening.Since the opening of a ventilating tower exists in a high position, we install a board in the direction into which rain cannot enter easily.
(3) We install a waterproofing wall or gate in a tunnel pithead.

However, these are unnecessary in the high area of the foundation.

On the other hand, as for operation of a waterproof-board and operation of the inundation prevention machine of a ventilation opening, it is preferable to operate it by directions of the Operation Control Center or judgment of the station. We recommend that the operation method can be made to do the following thing,

(1) Remote control from the Operation Control Center or from the distribution power board of each station,
(2) The automatic closed door by an inundation sensor,
(3) Manual operation in the spot.

12) The Concept of Smooth access and Transferring

The followings are the concept of barrier-free and universal design in Japan, and we recommend to install these facilities in Ho Chi Minh City.

(1) Barrier- free

We, railway industries are required to follow the barrier-free guidelines when building a large-scale facilities regardless of the number of passengers.

The main guidelines are;

(a) All platforms should have at least one pathway to a station.
(b) Screen doors, Half-height platform doors, guide blocks should be installed at platforms to prevent falling and accidental injury or death.
(c) Provide space (140cm x 135cm) for wheelchairs to turn around in the elevators.
(d) Install slopes to eliminate the gap (if there is any) between elevator and floor.
(e) Install stair lifts, automated ticket vending machine and multipurpose toilets which are easy-to-use for wheelchair bound and elderly passengers.
(f) Install guide blocks that provide both warning and guidance on where to go and facilities to provide information for individuals with impaired vision and hearing.
(g) Stairways should be equipped with slopes on both sides.
(h) Provide enough space for wheelchairs to turn around at the hallway.
(i) Provide with a place (facilities) to rest.

Those above guidelines make it possible for elderly and disabled people to travel more safely and convenient. We have once established the system that reflects elderly and disabled people's opinion at the start of a station plan. This maybe works well for Ben Thanh Central Station.

(2) Universal Design

An idea of barrier-free environment is a space that allows free and safe movement, function and access for the elderly and people with disabilities; however, it is practically used by people of all ages and abilities in different situations and under various circumstances. Thus, it is important to make an environment as "accessible" "easy to understand" "user-friendly" . The environment means buildings, stations, roads, parks and other places, service, products of daily use, etc.

Universal Design, on the other hand, is targeting all people both without and with disabilities. In recent years, there are many stations and station facilities are built using universal design features. However, "design for all people" could mean high cost. Thus, the important point that will help to achieve high leveled universal design is to find the right balance between user's need and cost-effective and increase options.

13) Tasks and Countermeasures for Subway Station Plan at Ben Thanh Central Station

The followings are the tasks and countermeasures for subway station plan at Ben Thanh Central Station.

(1) Construct a subway station that provides easy access and convenience to passengers

(a) Task

It is necessary to ensure passengers convenience and easy access when designing a station structure as four lines (Line 1, Line 2, Line 3a and Line 4) will operate at Ben Thanh Central Station.

(b) Countermeasure

Reviewed the following points;

- Rationalize the system for easy and smooth transferring considering passengers' flow line including walking distance.
- Making a flow line plan which is barrier-free and easy to use for all passengers , especially the elderly and disabled.
- Convenient location of the subway station entrance for passengers

(c) Result

Regarding transferring and barrier-free flow plan, ensure to keep a barrier-free route from ground–level station entrances to the platform by elevator and escalator considering passengers' flow line.

As to the location of subway station, it is necessary to consider the surroundings and the path which does not intersect from an entrance to a ticket gate.

(2) The station plan in consideration of safety and relief

(a) Task

It is essential to ensure passengers' safety in the event of an emergency such as the fire.

The task will be to secure an evacuation route for passengers to evacuate to the ground and passenger flow line in case of an emergency. Also, flood prevention measures will be needed for basement floor.

(b) Countermeasure

Reviewed the following points;

- Anticipated passengers' flow line at the time of disaster
- Secure evacuation route in case of an emergency
- Prevent water from flooding

(c) Result

In consideration of emergency evacuation route, an anticipated passengers' flow at the time of disaster should be reviewed. Also, it is recommended to take into consideration the location of exits and entrances, ventilating hole and ventilation tower when reviewing flood prevention measures.

(3) Station Plan without disrupting the town's environment

(a) Task

The ventilation facilities subway station would require a ventilation tower which you can see

above ground. It is important to be careful not to disrupt the town's environment when allocating a ventilation tower.

(b) Countermeasure

Reviewed the following points;

- shape of the ventilation tower
- size of the ventilation tower
- quantities

(c) Result

Although detailed design work should be carried out for the shape, the size and numbers of the ventilation tower, at this point we propose the shape, the size and numbers that would not disrupt the town's environment.

4.3.3 Underground Pedestrian Network Planning

The underground pedestrian network will feature integrated placement of underground pedestrian passageways that connect to subway stations as well as bus terminals and other public transport facilities and the basement floors of adjacent private sector buildings, in order to increase both the convenience and comfort of pedestrians traveling underground. This network will encourage pedestrians to stroll around and will enhance coordination between individual facilities, and it will serve as the foundation for mutual growth. In this way, the underground pedestrian network will form a center for local cooperation in central Ho Chi Minh City and will be an infrastructure facility that contributes to regional development.

The planning of this underground pedestrian network will be conducted from the following perspectives.

- Establishment of the basic axis for pedestrian passageways and an intuitive pedestrian passageway layout
- Liaison between public transport facilities and private sector buildings in the surrounding area
- Placement of underground plazas at strategic locations to form centers and provide richness to the underground environment

The following sections will cover each of these perspectives in detail. Figure 4.21 shows an overview of the overall network.

1) Establishment of Basic Axis for Pedestrian Passageways and Intuitive Pedestrian Passageway Layout

Underground environments have no buildings or sun or other landmarks as in the case of above-ground areas, and it is difficult for pedestrians to recognize directions or even to know in which direction they are heading. For this reason, if underground pedestrian passageways are given a complicated layout, they will become mazes, and it will be difficult for pedestrians to travel to their desired location. To prevent this from happening, a main passageway is established to serve as the basic axis for the pedestrian passageways, and then other pedestrian passageways are placed at right angles to this main passageway in order to create an intuitive pedestrian passageway layout.

For this project, the main pedestrian corridor will be the axis leading from Opera House Station along Le Loi and then passing through the underground plaza in front of the Ben Thanh Market and on to the bus terminal at Twenty-Three September Park. The subway stations and bus terminals and other public transport facilities will be placed along this basic axis, and many private sector buildings in the surrounding area will also be placed adjacent to this basic axis to make it the main route for pedestrian travel. As the basic axis will have a great volume of pedestrian traffic in the underground area around Ben Thanh Station and will

be adjacent to subway stations and shops, it should be planned as a single wide pedestrian passageway. However, out of consideration for the fact that the volume of pedestrians will be reduced in the area beneath Le Loi, and to ensure connectivity with the private sector buildings on both sides of Le Loi and to encourage pedestrians to stroll around, it will be planned as two pedestrian passageways.

Supplementary pedestrian passageways are placed at right angles to the main pedestrian passageway that serves as the basic axis. These will be passageways that connect to the BRT Terminal beneath Ham Nghi (street) and other public transport facilities and private sector buildings.

In this way, the layout of the main passageway that will serve as the basic axis and the pedestrian passageways that intersect this main passageway at right angles will form a layout plan that will be easily understandable to pedestrians.

2) Linkage to Public Transport Facilities and Private Sector Buildings in Surrounding Area

Linkages will be established along the underground pedestrian passageway with various public transport facilities and private sector buildings in the area. The pedestrian passageways for linkage to these establishments will be the main passageway and the supporting passageways that intersect the main passageway at right angles. It is particularly important for these supporting passageways to have the most effective layout possible to ensure connectivity. This is because, for connection to public transport, highly convenient pedestrian passageways are needed to accommodate the flow of passengers transferring to other means of transport, and it is important to enable passengers to move without wasting time and effort.

To ensure connectivity to public transport facilities in this project, passageway layout planning will consider the following connections.

- Joint Ben Thanh Station ← → Bus terminal (beneath Twenty-Three September Park)
- Joint Ben Thanh Station ← → BRT terminal (beneath Ham Nghi street)
- Joint Ben Thanh Station ← → Ground level transport

The passageway planning will also take into consideration future connectivity with private sector buildings in the area. Connection to these private sector buildings will expand the pedestrian network, as there are corridors in the interior of these buildings, and it will increase access to more distant areas for pedestrians passing through the corridors inside the building. In this way, connectivity will be expanded throughout the surrounding area.

3) Placement of Underground Plazas at Strategic Locations to form Centers and provide Richness to Underground Environment

The passageways making up the pedestrian network will extend connectivity in the area. However, it is important for the network to not consist solely of passageways, but rather for it to have underground plazas as well. These underground plazas will serve as landmarks in the underground environment, providing pedestrians with a means of identifying their current location. There will also be resting places for pedestrians while walking or waiting for people, providing richness to the passageway network. For this reason, the underground plazas will be planned with atrium spaces that lead to ground level and so on to ensure that they help to create an attractive urban environment.

In this project, two underground plazas with large atriums will be placed adjacent to the joint Ben Thanh Station, one on the northeast side and one on the southwest side. In coordination with ground level planning, the underground plaza on the northeast side will be placed in front of the Ben Thanh Market to provide underground access to the Ben Thanh Market from the underground passageways. The underground plaza on the southwest side will connect to the bus terminal beneath Twenty-Three September Park as well as providing access to the park itself. Moreover, these underground plazas will secure a gathering place for people next to the entrance gates to the station, as well as providing a place for them to rest or when waiting for others.

In addition, in the area under Le Loi, underground plazas will be placed at the intersections with Nam Ky Khoi Nghia and Pasteur in accordance with the locations of ground level blocks, in order to help pedestrians traveling underground recognize these locations.

In this way, the underground pedestrian network will be accented with underground plazas to create a more intuitive underground environment and provide pedestrians with a more convenient and comfortable underground pedestrian space.

Underground Network Diagram

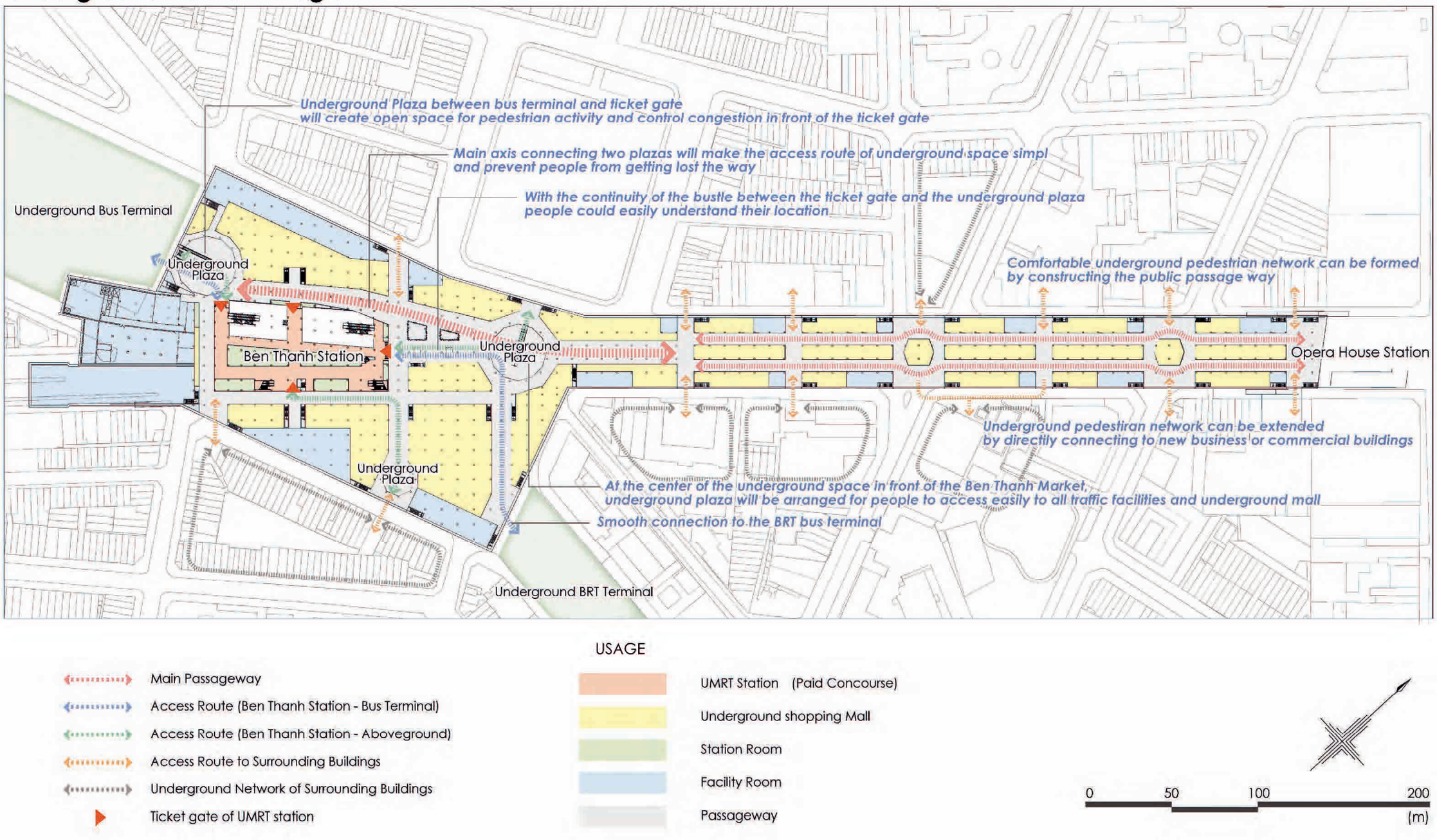


Figure4.21 Pedestrian Network in Underground Development

4.3.4 Underground Shopping Mall Planning

1) Layout Planning

(1) Planning for Underground Shopping Mall around Ben Thanh Station

- Underground plazas will be placed centering on the Ben Thanh subway station, beneath Le Loi on the northeast side and next to the bus terminal on the southwest side, to serve as the starting points for the underground pedestrian network. The layout of underground pedestrian passageways will give consideration to providing underground connectivity with the surrounding area.
- Underground pedestrian passageways will be placed around the Ben Thanh subway station to accommodate the flow of pedestrians and encourage pedestrians to stroll around. Shops will be provided facing the station to provide vitality and avoid creating a maze-like environment.
- The underground pedestrian passageways that connect the two underground plazas will admit natural lighting through the atriums of the subway station platforms and the skylights placed at ground level, incorporating the ground level scenery and forming an integrated environment between the underground and ground level spaces.
- To the greatest degree possible, shops and emergency evacuation stairs will be located in the sections that face the underground pedestrian passageways and underground plazas, while out of consideration for access from surrounding buildings the main equipment rooms and sorting spaces will be concentrated on the side next to the surrounding neighborhood.
- The locations of the emergency evacuation stairs, elevators and escalators will be determined through coordination with ground level planning.

(2) Planning for Underground Shopping Mall around Le Loi

- Two underground pedestrian passageways will be provided to connect the Ben Thanh and Opera House subway stations. Underground plazas (which are effective in disaster prevention) and emergency evacuation stairs will be placed at the end and middle of the section that connects to Opera House Station. This will ensure safety and encourage pedestrians to stroll around, as well as creating an underground environment that is rich in variation.
- Safety zones (which are effective in disaster prevention) and emergency evacuation stairs will be placed between the underground plazas. Like the underground plazas, these will provide underground connectivity with the surrounding area.
- To the greatest degree possible, the sections facing the underground pedestrian passageways and underground plazas will be provided with shops and show windows and the like to create the vitality appropriate for a shopping mall.
- The equipment rooms, toilets, etc. will be placed facing the underground plaza and safety zone so they do not break up the shop area.
- The locations of emergency evacuation stairs will be determined in coordination with ground level planning.
- The locations of elevators and escalators will be determined based on coordination with ground level planning as well as the planning conducted to ensure connectivity with neighboring buildings.

2) Disaster and Evacuation Planning

(1) Basic Policy

- Due to their public character, closed nature and other attributes, underground shopping malls must have a higher level of fire protection and safety measures than ordinary buildings. Planning must naturally give priority to preventing the outbreak of fire as well as, in the event of fire, preventing the spread of fire and ensuring safe evacuation.
- Planning must be based on connectivity with underground subway stations, neighboring buildings and redevelopment planning in the surrounding area. In the connecting sections as well, planning must give priority to preventing the spread of fire and ensuring safe evacuation.
- In case of the flood due to the heavy rainfall or the high tide, the planning must prevent the water coming into the underground space and ensure the safe for underground pedestrian.

(2) Disaster Planning

(a) Fire Prevention

- Fire zones are established for areas with a total area of 3,000 m^2 or less or 500 m^2 or less in the case of a shop zone, under the assumption that the structures are of fire-resistant construction and are equipped with automatic fire extinguishing equipment.
- The Ben Thanh subway station and the underground pedestrian passageways will be established as fire zones. Safety zones, as double fire zones, will also be established for the underground pedestrian passageways that intersect subway station evacuation routes.
- In the underground shopping mall beneath Le Loi, the plazas (which are effective in disaster prevention) and safety zones will be established as a fire zone with a total area of 3,000 m^2 or less that includes shops and underground pedestrian passageways.
- With regard to the underground connectivity between the Opera House subway station, the bus terminal and the neighboring buildings will be connected via the plazas (which are effective in disaster prevention) and the safety zones, and the connecting zones will be connected by means of either a double fire zone or a sunken garden.
- All of the fire zones in the underground shopping plazas will be planned as fire or smoke control zones. The shutters along the evacuation routes will be 2-stage drop-down shutters.
- The smoke control zones will be 300 m^2 or less in the case of the underground pedestrian passageways, and 500 m^2 or less in areas other than underground pedestrian passageways.
- Shops and underground pedestrian passageways will be equipped with mechanical smoke control mechanisms. Plazas (which are effective in disaster prevention) and safety zones will be equipped with automatic smoke control mechanisms.

(b) Flood Prevention

- In order to prevent the water coming into the underground space in case of the flood due to the heavy rainfall or the high tide, the planning makes the same flood prevention level as the planning of UMRT Line 1.
- As for the on-ground structure like the entrance, the atrium, and the ventilation tower, the concrete parapet wall should be constructed around that structure in principle, and the height

of the wall must be more than the flood prevention level.

- The flood prevention sheet must be installed at the entrance. The sheet automatically stands up in case of the flood and protects the underground space from the flood.

(3) Evacuation Planning

- The walking distance to the emergency evacuation stairs will be planned as 40 meters from each shop and underground pedestrian passageway, based on the assumption that the structures will be of fire-resistant structures with nonflammable interior furnishings.
- For evacuation to the emergency evacuation stairs inside the plazas (which are effective in disaster prevention) and safety zones, in order to prevent the fire from spreading and ensure the safe evacuation of the general public, the area in which the fire occurred and the zone on the opposite side will instantly be closed through a fire alarm interlock, and the fire shutters in the underground pedestrian passageway on the side of the area in which the fire occurred will form a shutter sequence in which the fire shutters descend in two stages to secure the evacuation width. In addition, the system will guide evacuees in the opposite direction from the location in which the fire occurred.
- The fire shutters in the plazas (which are effective in disaster prevention) and the underground pedestrian passageways in the safety zone will be combined with evacuation doors from the standpoint of ensuring that people are able to escape from the area of the fire and evacuate in two directions following the closure of the shutters.
- The emergency evacuation stairs will be 1.5 meters or more in width. The exact width will be determined based on the evacuation calculations and the volume of traffic in the stairs and passageways.
- For evacuation in the sections connecting to the subways stations, bus terminal and neighboring buildings, independent evacuation plans will be established for each section, for use following the closure of the connecting area zones in the event of a fire.

3) Above-ground Planning

In planning underground shopping malls and above-ground facilities, it is essential to secure the functions of the underground shopping malls, and to coordinate efforts with the urban planning of surrounding districts and the landscaping plans for above-ground areas. Coordination is needed for the location and design of stairs and elevators in underground shopping malls as well as atriums, skylights, air intake and exhaust towers, cooling towers and so on. In addition, the idea of providing flood barriers and flood panels for use in the event of water inundation should be studied.

(1) Stairs

- Stairs that are used exclusively for evacuation will be 1.5 meters or more in width. Other stairs will be determined by the amount of traffic and the service level of the stairs and passageways.
- Stairs that are used on a daily basis will be provided with roofs to ensure safety, and to make it unnecessary to use umbrellas on rainy days.

- The placement of stairs and ventilation towers together will be avoided. Stairs will be isolated and will have a simple design.
- Handrails and roofs will be made of glass to provide transparency and blend in with the surrounding environment.

(2) Atrium and Skylights

- The atrium will bring in natural lighting and visually integrate the underground shopping mall with the ground level. Its design will make it a landmark of both below-ground and ground level structures.
- The skylights will have a design that functions both to bring in natural lighting and exercise natural smoke control.

(3) Ventilation Towers

- An ventilation tower for air intake and exhaust will be placed in each block of the ventilation system in the underground shopping mall, in coordination with the ground level planning.
- Air intake towers will have a height of three meters or more in order to take in fresh air. The towers will be made of glass in order to minimize their presence.
- Exhaust towers will also provide smoke control functions. As they will emit foul odors, they will have a height of three meters or more. They will have a design that distinguishes them from air intake towers in order to hide the polluted matter.
- For ventilation towers that require a large area, and those that cannot be placed on top of roads due to above-ground planning considerations, the idea of using sites in the surrounding area will be studied.
- As cooling towers require a large area, the idea of using sites in the surrounding area will be studied.

4) Electrical Services

(1) Receiving and Transformer Facilities

- It is envisaged that the method of receiving electricity will be the 3-phase, 3-wire 22kV single circuit method that is most common in Vietnam. For improvement of reliability, it is desirable to have two circuits receive electricity, if possible.
- Distribution of electricity to all parts of the underground mall will be via auxiliary electrical rooms. The number of locations and the positions of installation of the auxiliary electrical rooms will be determined taking into consideration the low voltage distribution distance and the load capacity. The distance from the auxiliary electrical rooms to each part of the underground mall will be set to be about 150 to 200m or less straight line distance.
- The transformer for the heat source will be provided adjacent to the heat source machine room.
- Measures against water seepage will be taken for the electrical rooms, piping for other uses will not pass through the electrical rooms, and other comprehensive measures against water damage will be taken.
- Dry type electricity receiving and transformer equipment will be adopted from the viewpoint

of fire prevention.

- High efficiency power receiving and transforming equipment will be adopted, to achieve energy efficiency by reducing transformer losses.

(2) Electrical Generators

- Electrical generator power sources will be supplied for the following loads, in order to ensure safety of the underground mall.
    1) Power for disaster prevention
    2) Power for water drainage
    3) Safety lighting for passageways
    4) The main communication equipment, important communication and information related equipment, various monitoring devices, etc.
    5) Elevators
- The generators will be ordinary air-cooled diesel generators, and will be installed at two locations, taking into consideration the shape of the facility and the layout of the electrical rooms. Chimney and ventilation tower to cool the radiators will be provided.
- It is necessary to locate the ventilation shafts in a position close to the generator rooms, so it is necessary to examine the locations of the generator rooms and the associated locations of the ventilation shafts above ground.
- Fuel tanks will be located buried in the ground nearby. However, if it is not possible to locate the fuel tanks in the nearby ground because of circumstances such as buried objects, etc., space will be provided as an indoor storage facility within the underground mall.

(3) Trunk Line Facilities

- Low voltage trunk lines will be distributed by cable rack. (3-phase, 4-wire 380/220V)
- Tenant trunk lines will be provided after determining the rental conditions. In particular, electrical power supply for restaurants/cafes kitchens has a major effect on the total power demand of the underground mall, so this will have to be examined sufficiently.

  Reference rental criteria: Retail 200VA/m^2
  Restaurant/cafes: 750VA/m^2 (assuming electrical kitchen equipment)
- Installing tenants' distribution boards in the electrical pipe space of the common area will provide tenant power supply.
- Electricity meters will be centrally located within the tenants' distribution boards for ease of management.

(4) Lighting Equipment

- The lighting scheme will harmonize with the interior design of the underground plazas, underground walkways, and stairs. Light sources will be mainly high efficiency, long life LEDs that light instantly.
- The lighting intensity for each part will depend on the underground mall development policy. The light from the shops will affect the design lighting intensity of the common areas, so it is considered that 500Lx to 1000Lx is sufficient.
- Taking into consideration that this is an underground space, the underground plazas and the

underground walkways will be capable of being supplied with electrical power from the generators, so that sufficient lighting can be ensured during power cuts. (About 100 to 200Lx provided when lighting is powered by the generators.)

(5) Telephone and Information Communication Equipment

- A main distribution board room will be provided adjacent to the location where telephone is brought in, to simplify the incoming route. To improve the reliability, bringing in telephone from several locations will be examined.
- Distribution ducts will be laid to the shops for the cabling for telephone and various pieces of information communication equipment, and a sufficient number will be laid in advance. (Number of ducts 5 to 6.)
- If necessary, a telephone exchange for management use will be provided. Also, intercom will be installed at the specific essential locations for communication at entrances and exits at nighttime, etc.
- Cable routes and equipment installation space will be provided as measures to eliminate mobile phone dead zones.

(6) Broadcasting Equipment

- There will be announcement broadcasting and BGM broadcasting, combined with emergency broadcasting.
- The broadcasting system will be divided into blocks according to use, such as shops, passageways, etc., and according to zone, and will be capable of broadcasting to each block.

(7) Television Reception Equipment

- A reception antenna will be installed on the ground in a suitable location, from which TV signals will be distributed to each tenant.
- This is not necessary for all shops, so cabling and equipment will be installed to the electrical pipe space of each block, and will be provided to shops that wish to receive it.

(8) Emergency Warning Equipment

- In locations where it is considered that communication is necessary in an emergency, such as toilets, etc., emergency call buttons will be installed, which will communicate with the disaster prevention center in an emergency.

(9) Crime Prevention Equipment

- Monitoring cameras will be installed at the necessary locations in the underground mall, such as the underground plazas, underground walkways, stairs, elevators, etc., and monitoring will be carried out from the disaster prevention center.
- Also, the monitored images will be recorded using a disk recorder.
- For important rooms and backyard entrances and exits, etc., entry/exit control devices will be installed to control entry and exit. Control of entry and exit will be by electrical lock control, and the locks can be opened by coupling with fire detection equipment.

(10) Disaster Prevention Equipment

(a) Fire detection equipment

- Fire detection equipment will be installed in accordance with the criteria in the fire prevention plan.
- The system will be designed to have the following function.
    1) Detectors will be an analog detectors and an alarm will be displayed for each detector
    2) Early detection of a fire using pre-alarms
    3) An automatic inspection function will be provided
- Shutters or other automatic closing devices will be installed for compartmentalizing fire prevention zones.
- The following combined control for the shutter control method will be carried out in accordance with the concepts for forming fire prevention zones.
    1) Coupling control for forming initial zones using fire detection sensor alarms
    2) Individual control to prevent spread of smoke to adjoining areas using special sensors
- Also, the equipment will enable manual operation from a fire prevention panel, so that closure can be carried out at the operator's discretion by determining the situation using monitoring cameras, etc.

(b) Emergency Broadcast Equipment

- Emergency broadcast equipment will be installed in accordance with the criteria of disaster prevention plan. The equipment will be also used for normal business use.
- A broadcast amp will be installed in the disaster prevention center, coupled with a fire alarm receiver, so that when a fire alarm is raised, a fire warning can be automatically broadcast.
- Emergency broadcast areas will be divided in accordance with the fire prevention and smoke prevention zone settings, so that it will be possible to broadcast in each block, in accordance with the state of fire occurrence and state of zone formation.

(c) Emergency Lighting and Guide Lighting

- Emergency lighting and guide lighting will be provided in accordance with the criteria of the disaster prevention plan.
- Emergency power supplies will be provided within the fittings.
- Emergency lighting will provide illumination of passageways of about 101Lx, and will have direct current power source individually fitted.
- The guide lighting will have on/off control or off control in order to more clearly indicate the evacuation direction, in accordance with the closure of shutters for forming fire prevention zones.

(d) Disaster Prevention Panel

- A disaster prevention panel will be installed to enable central monitoring and operation of all disaster prevention equipment.
- A disaster prevention center whose safety is ensured will be provided, and the disaster prevention panel will be installed in the center.

(e) Central monitoring equipment

- A central monitoring panel will be installed in a central control room, where central monitoring and control of equipment such as power supply equipment, air conditioning and ventilation equipment, water supply wastewater, and plumbing equipment, lighting equipment, transport equipment, etc.
- Data on the various measurement values necessary for management and operation will be collected.
- Central metering of electrical power and water supply will be carried out for the quantities used by each tenant at each location, etc., and it will be possible to read and record all the quantities used in the central control room.
- The quantity of electrical power used will be measured, and data collection and analysis will be carried out using a Building Energy Management System (BEMS) to support energy efficient operation.

5) Air Conditioning Equipment

(1) Heat Source Machine Room

- A high efficiency centrifugal chiller will be installed in the basement 1st floor heat source machine room. The chiller will be divided into three or four units to cope with transporting in and out, inspection, and breakdown.
- The heat source method will be determined taking into consideration energy efficiency and environmental considerations, etc.
- A cooling tower for the chiller will be installed on the ground near to the heat source machine room.

(2) Air Conditioning Equipment

- An external air handling air conditioner that is combined with ventilation equipment, and single duct air conditioner will be installed in basement 1st floor machine room. Machine rooms will be provided at the rate of one location per 3,000m^2, approximately.
- The air conditioners and ducts will be divided into a shop system (external air handling air conditioner), a public underground walkway system (single duct air conditioner), and a public underground plaza system (single duct air conditioner), as independent systems respectively.
- Fan coil units (FCU) for individual load processing will be installed dispersed in the shops and public underground plaza.
- Chilled water piping will be provided to shops to deal with loads that exceed the rental criteria, and additional FCUs will be installed as required as separate work by tenants.
- A dedicated air heat source heat pump air conditioner will be installed in the disaster prevention center.

(3) Ventilation Equipment

- Dedicated ventilation equipment will be installed in food and beverage establishments, kitchens, and toilets.
- Ventilation machine room will be combined with smoke extraction room, and provided at the rate of one per 3,000m^2.

- Dedicated ventilation equipment will be provided in the disaster prevention center.
- The ventilation equipment will be divided into systems for electrical rooms, generator rooms, heat source machine rooms, other machine rooms, and store rooms, etc., and dedicated ventilation equipment will be provided for each.

6) Plumbing Equipment

(1) Water supply Equipment

- The standard water supply system will include a water tank room on the basement 1st floor in which a water tank and a pressurized water supply pump unit is installed, to supply water to all necessary locations.
- The miscellaneous water system will include a concrete water tank below the floor of the basement 1st floor, from which water will be supplied by a pressurized water supply pump, and used for flushing toilets.
- A concrete water tank will be provided below the floor of the basement 1st floor for the cooling tower replenishment water system, from which water will be supplied to the cooling tower using a pressurized water supply pump.

(2) Hot Water Equipment

- Electrical hot water heaters will be provided dispersed to each location where they are required.

(3) Plumbing Equipment

- Water saving equipment will be adopted.

(4) Wastewater and Aeration Equipment

- Separate foul water and miscellaneous wastewater systems will be used to collect the water in wastewater tanks, and the water will be pumped up and discharged into the main sewerage pipes.
- Wastewater from the kitchens of food and beverage establishments will be collected into a kitchen wastewater tank as an independent wastewater system, and the water will be pumped up and discharged into the main sewerage pipes. If necessary, kitchen wastewater treatment equipment will be provided.

(5) Fire Extinguishing Equipment

- A pump for fire extinguishing water will be provided in the basement 1st floor, and sprinkler devices and indoor fire extinguishing hydrants will be provided.
- Connected water delivery pipes will be installed. Water outlets will be installed at locations where fire trucks can easily approach, and water outlets and hose will be provided in all parts of the underground floors at an average spacing of 50m.
- Hood type fire extinguishing equipment will be provided in kitchens for food and beverage establishments. (Separate tenant construction.)

4.3.5 Ground Level Plan

The plan of site area is going to be regulated by the urban planning law that will come into effect, based on "the study on the formulation of urban construction detailed planning on scale of 1/2000 and urban architectural management regulation at level 2 for the existing center of Ho Chi Minh City"(referred as "The Legal Plan"), conducted by DPA. The Legal Plan is drawing up the zoning plan at 1:2,000, the architecture and landscape plan at 1:500, and the building design guidelines. In November 2011, the Assessment Committee (AC) was summoned by the City and discussed about the plan. As of December 2011, the Legal Plan is being finalized corresponding to opinions at the AC and ready for approvals by the Peoples' Committee (PC), which is scheduled to be held in February 2012.

Considering this progress of the urban planning of Ho Chi Minh City, in this survey not only the ground level plan under current traffic arrangement is studied, but also the ground level plan based on the urban planning is studied and proposed. However, the proposed ground level plan shows the planning policy for the underground development which is main theme in this survey. The landscape design and the shape and design of on-ground structure like atrium should be studied and determined through the consultation with the relevant parties in the next detail design stage.

Therefore, as for the structures above grade such as the atrium, stairs, and ventilation towers which are necessary for the underground development, the location of these structures is studied and the ground level plan is proposed as the planning policy. However, for the easy comprehension the perspective views of some design options of the structure above grade are shown for reference. As shown in these views, many options for the height and the shape of the structures above grade can be studied and designed. The ground level design should be discussed and determined through the consultation with the relevant parties in the next detail design stage.

1) Ground Level Plan under Current Traffic Arrangement

(a) Ben Thanh Station Area

The center of the existing roundabout in front of Ben Thanh Market is called Quach Thi Trang Plaza. This plaza is located at almost same point as the underground plaza. Therefore the atrium planned in the center of the underground plaza is located in Quach Thi Trang Plaza. The diameter of this atrium is approximately 20m. In this plan the location of the bust of Quach Thi Trang and the statue of General Tran Nguyen Han is same as current point. The height of the atrium is bellower than 3.5m not to interrupt the view toward Ben Thanh Market. In addition, it needs to consider the detail design of elevated podium wall not to have rain water run into the underground.

In September 23rd Park two atria are planned. One is in the center of the underground plaza and the other is located above the Line 1 platform. These atria connect the ground level and the underground level, so the underground space can be impressive with natural sunlight.

On the other hand, currently there is a bus terminal on the south side of the Ben Thanh Market, however this bus terminal is determined to be relocated to the west side of September 23rd Park for the construction of UMRT Line 1. In this area the pedestrian space is planned with the bus stops of several bus routes. The atrium above the underground plaza is located in this area, so the underground station will be connected with the bus stops on ground.

The ground level plan under current traffic arrangement is shown as following.

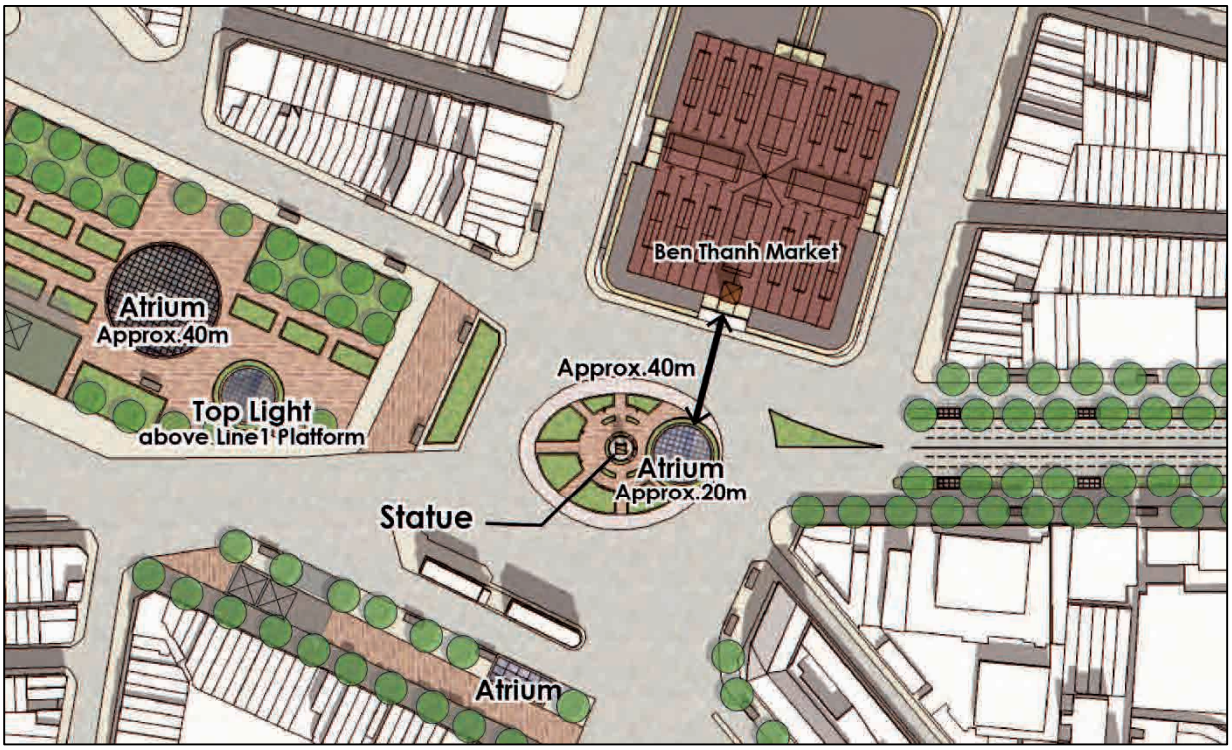


Figure 4.22 Ground Level Plan in Ben Thanh Station Area
(under Current Traffic Arrangement)

The perspective views of some design options in Ben Thanh Station area are shown in Figure4.23 and Figure4.24 for reference. In addition, for reference of the next detail design stage, Table 4.24 indicates both advantage and disadvantage regarding the atrium design such as its shape and height. In this table, the following issues are compared. The impact on the city landscape, mainly for Ben Thanh Market, the connection of accessibility and natural light between underground space and ground level, and location of statues.

In this survey, option 3 or option 3a are recommended, from the view point of the accessibility and the effects by a natural light.

(a) No Atrium

(b) Atrium（H=1.0m）

(c) Atrium（H=3.5m）

(d) Atrium（H=3.5m、Arch Shape）

Figure 4.23 Overall Perspective View in Ben Thanh Station Area
(under Current Traffic Arrangement)

(a) No Atrium

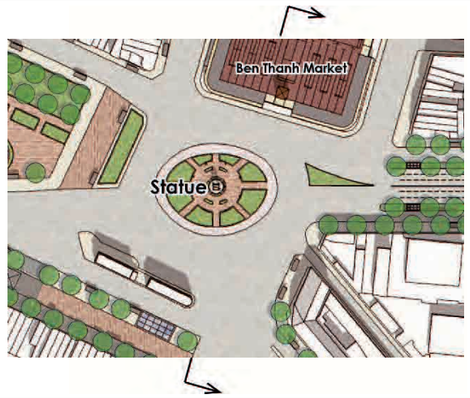
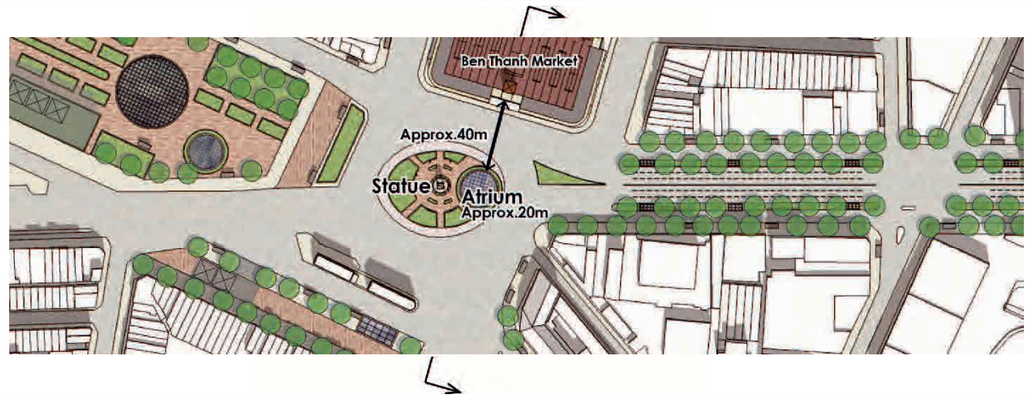
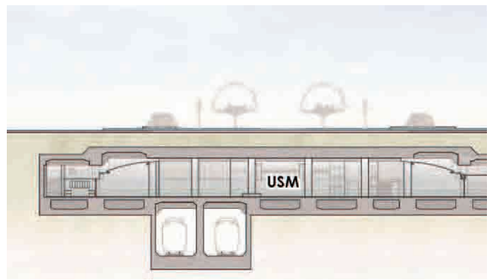
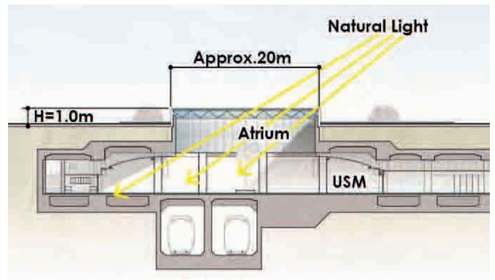
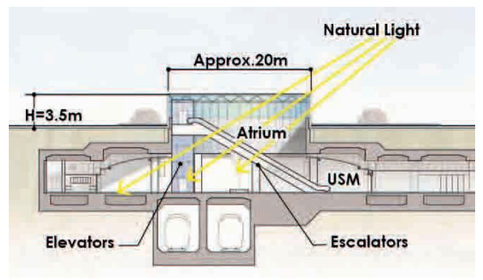
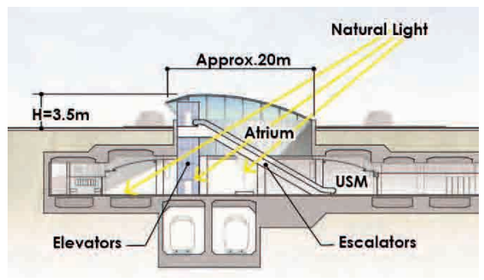
(b) Atrium（H=1.0m）

(c) Atrium（H=3.5m）

(d) Atrium（H=3.5m、Arch Shape）

Figure 4.24 Eye-Level View in Ben Thanh Station Area
(under Current Traffic Arrangement)

Table4.24 Comparative Study for Ground Level Plan under Current Traffic Arrangement (For Reference)

	Option 1 No Atrium	Option 2 Atrium (H=1.0m)	Option 3 Atrium (H=3.5m)	Option 3a Atrium with Arch Shape (H=3.5m)
Plan				
Section				
Perspective View				
Impact on Scenery	・ There is no change for the scenery in front of Ben Thanh Market.	・ There is small change for the scenery in front of Ben Thanh Market.	・ There is some change for the scenery in front of Ben Thanh Market. ・ The high rise atrium will create new landscape.	・ There is some change for the scenery in front of Ben Thanh Market. ・ The arch shaped atrium will create new landscape.
Statue	・ Statues are able to be kept at the same location as current.	・ Same as Option 1	・ Same as Option 1	・ Same as Option 1
Entrance	・ There is no entrance to underground plaza.	・ Same as Option 1	・ The entrance with elevators and escalators to underground plaza can be designed.	・ Same as Option 3
Natural Light	・ There is no natural light poured into underground space.	・ Natural light can be poured into the underground space through glazed atrium.	・ Same as Option 2	・ Same as Option 2
Connection between Underground and Ground level	・ There is no accessibility between underground and ground level. ・ The attractive underground urban space can not be created.	・ The attractive urban space can be created because of the underground space connected with ground level through the atrium. ・ However People cannot move from underground plaza to ground level pedestrian space.	・ The attractive urban space can be created because of the underground space connected with ground level through the atrium. ・ People can easily move from underground plaza to ground level pedestrian space.	・ Same as Option 3
Recommendation	**C** **Not recommendable**	**B**	**A** **Recommendable**	**A** **Recommendable**

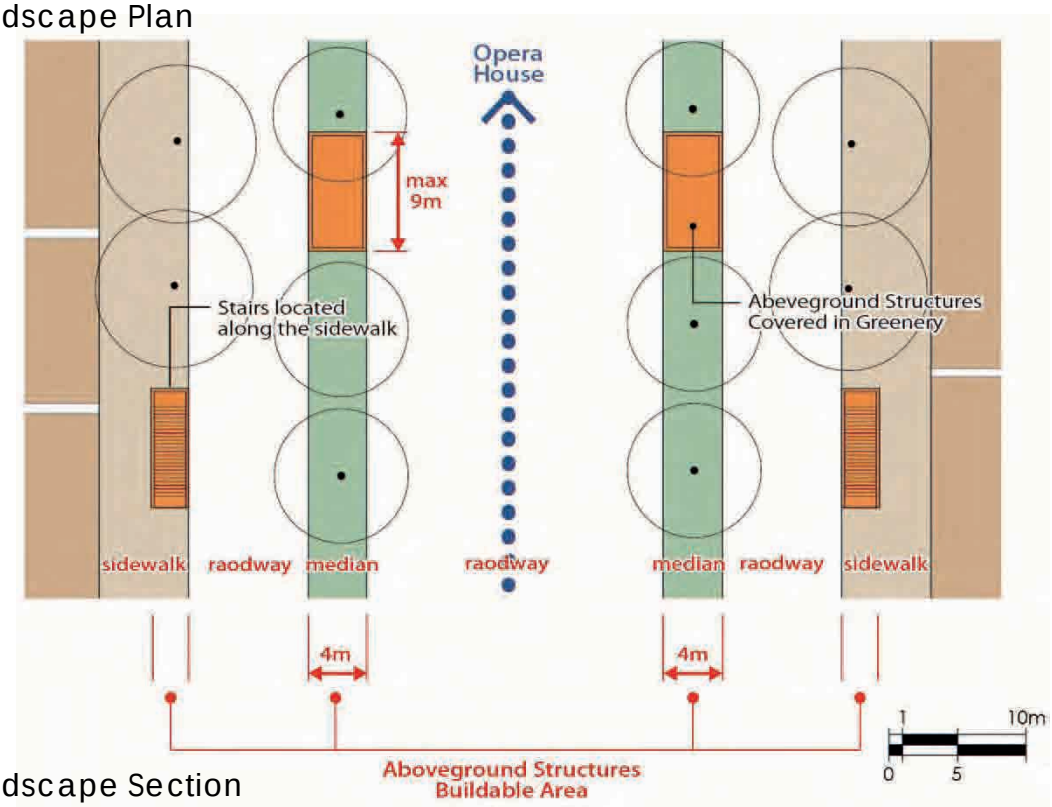
(b) Le Loi Street Plan

Le Loi Street has automobile lanes in the middle and the motorbike lane on the both sides. The median is located between the automobile and motorbike lanes, and sidewalks are on the both edge of the Street. Along Le Loi Street there will be structures from underground, such as staircases, and ventilation towers. The planning policies for the structures excluding the structures of UMRT are set as follows:

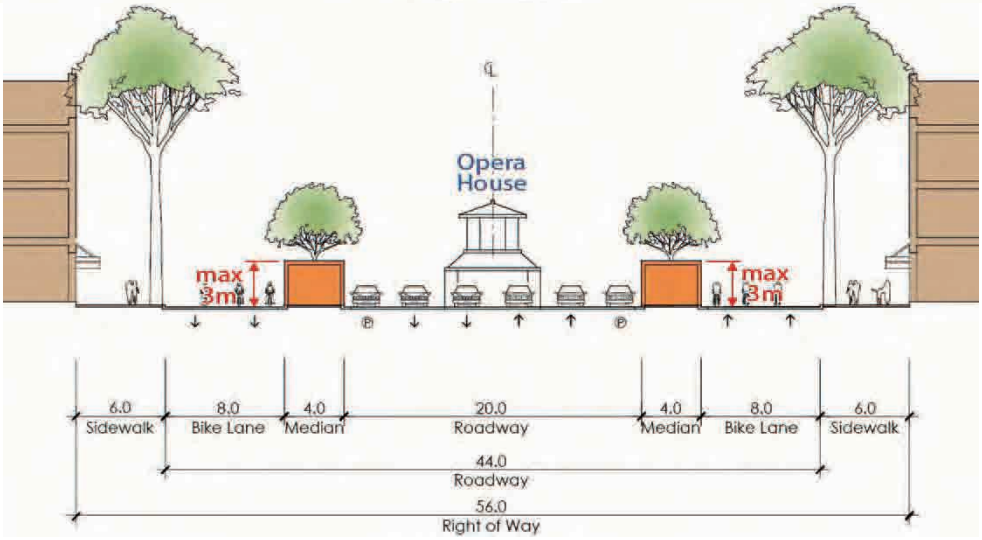
- It is preferred that PC requires the developers of future redevelopment projects along the Street, to accommodate some of the structures in their site or inside the building, if possible.
- The ventilation towers are installed in the median. The staircases are located in the sidewalk.
- In order to mitigate the massiveness of structure, the size of structure shall be approximately less than 9m at length, less than 3m at height.
- Structures shall use glassy transparent material to mitigate the massiveness, or green wall to contribute to the environment and Le Loi landscape.

Figure 4.25 Incidents for Structures above Grade

Landscape Plan



Landscape Section



Landscape Image

Figure 4.26 Basic Plan, Section, and Perspective View of Le Loi Street (under Current Street Condition)

2) Ground Level Plan based on Urban Planning of Ho Chi Minh City

(1) Concept

The ground level plan based on the urban planning of Ho Chi Minh City, which will be soon approved by the Peoples' Committee, is studied and proposed in this section. The site area is under the jurisdiction of the architecture and landscape plan by the Legal Plan. It sets the goals in the site area as follows:

- Le Loi Street will be a great pedestrian oriented transit mall. It will also provide a vista toward Opera and the landscape harmonizing with the historic buildings.
- The existing roundabout in front of Ben Thanh Market will change to be a new pedestrian station plaza, surrounded with the historic buildings as a heart of the city.

The Ground Level Plan is required to apply these goals above, by considering the size and location of the machines and structures from the underground levels, such as staircases, elevators, atriums, and ventilations, and coordinating with the plan for Le Loi Street transit mall and Ben Thanh Plaza, by the Legal Plan.

However, the proposed ground level plan shows the planning policy for the underground development which is main theme in this survey. The landscape design and the shape and design of on-ground structure like atrium should be studied and determined through the consultation with the relevant parties in the next detail design stage.

In addition, the Legal Plan is assuming that it will take about 25years to complete their goals. There is much possibility that Line 1 is developed sooner than Le Loi Street and Ben Thanh Plaza redevelopment. In this case, the phasing is assumed as follows:

- In phase one, to restore to its original condition at the time when Line 1 is built.
- In phase two when Ben Thanh underground development will be completed, to build Le Loi Street and Ben Thanh Plaza according to the Legal Plan.

(a) Ben Thanh Plaza Plan

The ground level plan based on urban planning of Ho Chi Minh City is shown in Figure4.27. As shown in this figure, There are three underground plazas. Each plaza is covered with atrium connecting the ground level and the underground level, so the underground plaza can be an impressive space with natural sunlight, casting from the atrium.

The underground plaza locates in front of September 23rd Park and in front of Ben Thanh Market. Setting the diameter of the atrium above about 40m and making it large to some extent, an attractive underground plaza space is created. The large plazas also helps solve disorientation problem that any underground developments likely to have, because it has the clear difference from other underground spaces by size.

The atriums above grade are assumed that they are round-shape, transparent and low thermal emissive structure. The height of each atrium is bellower than five meter to not to interrupt the view toward Ben Thanh Market. In addition, it needs to consider the detail design of elevated podium wall not to have rain water run into the underground.

(i) Ben Thanh Plaza and the Atrium

- Each plaza has a symbolic atrium which diameter is from 20m to 40m.
- Locating the atrium along the center line of the vista from both Le Loi Street and September 23rd Park, it works as a focal point.

- To not to interrupt the view toward Ben Thanh Market, the height of atrium shall be moderate and the distance from other atriums shall be more than 30m.
- The height of the Atrium elevated podium wall for rain water protection shall be higher than flood level. Drainage gradient is set outward from the atrium.
- In order to ease air condition load, Low-e glass and perforated panel are installed in the top of atrium. In addition, it allows the atrium to be illuminated with light from the underground.
- The historic façade of Ben Thanh Market and other buildings around the plaza, and the massive greenery trees in September 23rd Park that can be seen from Ben Thanh Plaza, should be main scenic resources to attract people to the plaza. Thus, the design of atriums shall not be vivid and fancy one to not to interrupt these resources.

(ii) The Statues in the Roundabout in front of Ben Thanh Market

The center of the existing roundabout in front of Ben Thanh Market is called Quach Thi Trang Plaza. There are the portrait bust of Quach Thi Trang who is the origin of the name of the plaza, and the bronze statue of General Tran Nguyen Han. The Legal Plan is planning to relocate these statues to the other side of Ben Thanh Plaza. The location of new Ben Thanh Plaza atrium in the Ground Level Plan is right next to the original location of statues. Therefore, it is capable of keeping the original location of statues by modifying the shape of the atrium, if it is necessary.

The perspective views of some design options in Ben Thanh Station area are shown in Figure4.28 and Figure4.29 for reference. In addition, for reference of the next detail design stage, Table 4.25 indicates both advantage and disadvantage regarding the atrium design such as its shape and height. In this table, the following issues are compared. The impact on the city landscape, mainly for Ben Thanh Market, the connection of accessibility and natural light between underground space and ground level, and location of statues. In this survey, option 3 or option 3a are recommended, from the view point of the accessibility and the effects by a natural light.

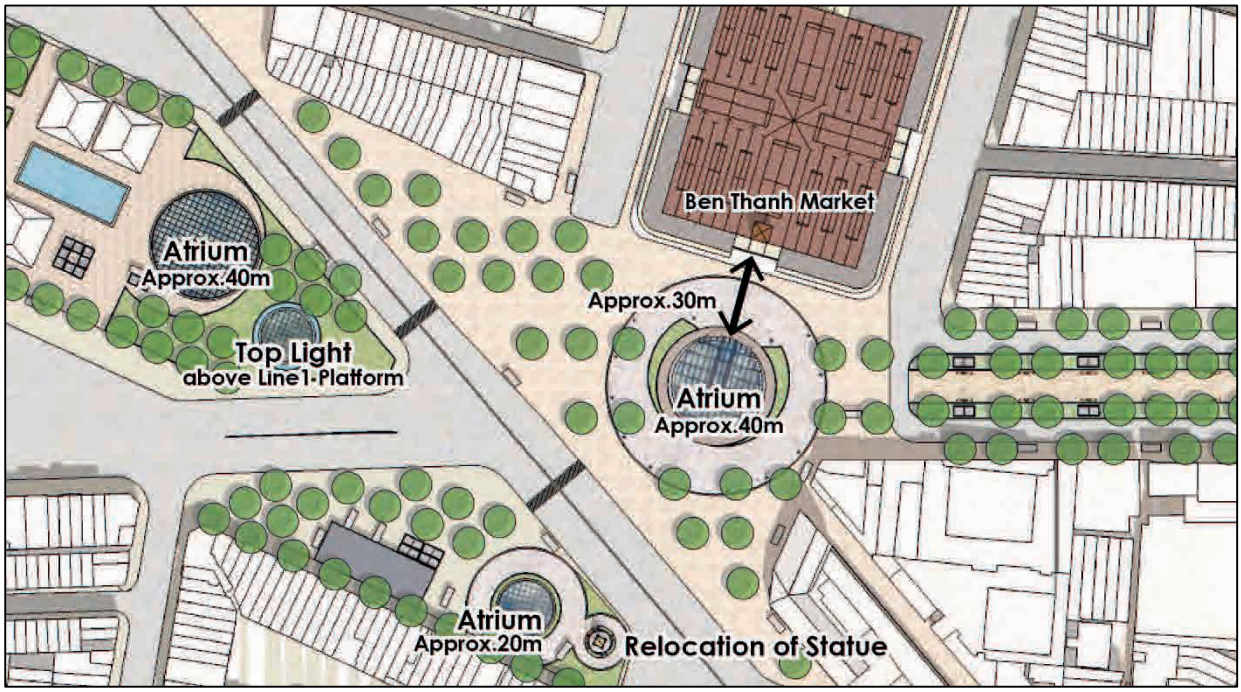
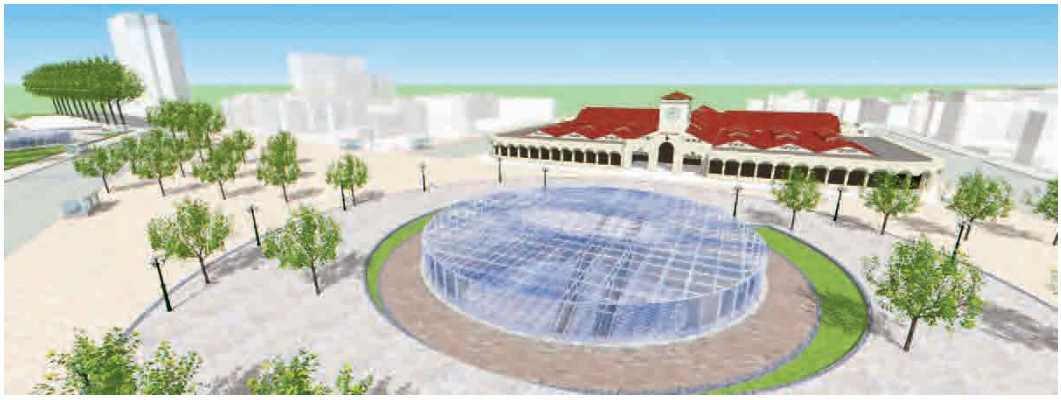


Figure4.27 Ground Level Plan in Ben Thanh Station Area
(based on Urban Planning of Ho Chi Minh City)

(a) No Atrium

(b) Atrium（H=1.0m）



(c) Atrium（H=3.5m）

(d) Atrium（H=3.5m、Arch Shape）

Figure 4.28 Overall Perspective View in Ben Thanh Station Area
(based on Urban Planning of Ho Chi Minh City)

(a) No Atirum

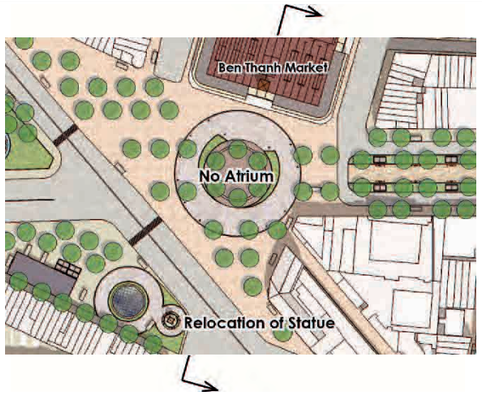
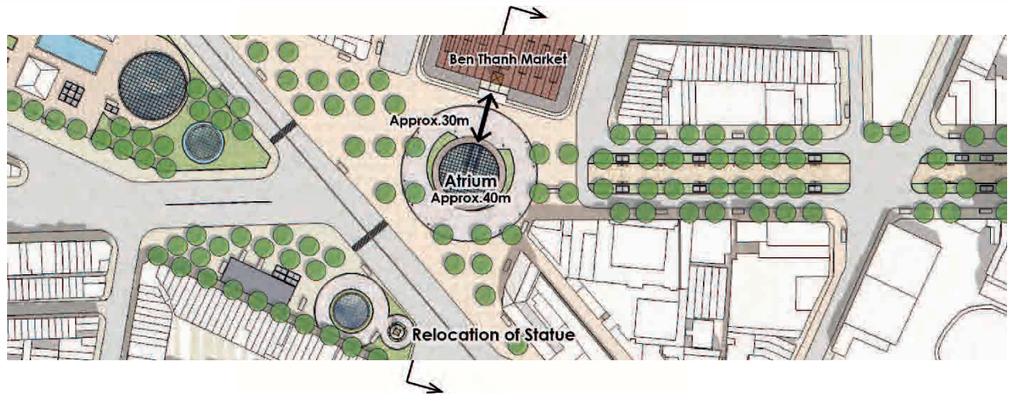
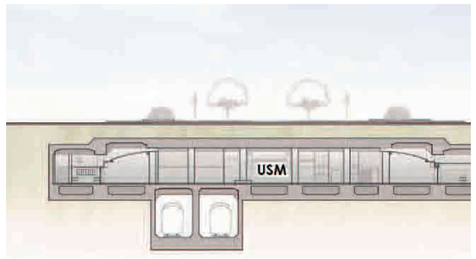
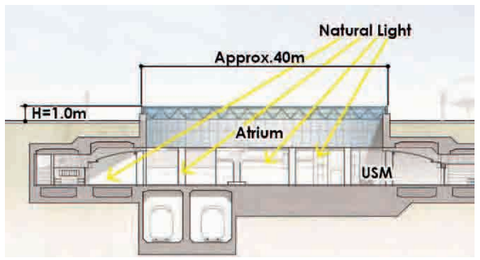
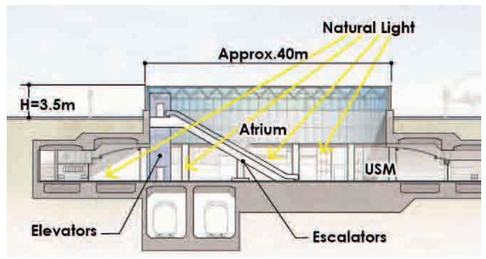
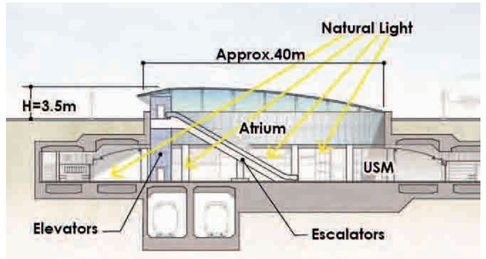
(b) Atrium（H=1.0m）

(c) Atrium（H=3.5m）

(d) Atrium（H=3.5m、Arch Shape）

Figure 4.29 Eye-Level View in Ben Thanh Station Area
(based on Urban Planning of Ho Chi Minh City)

Table 4.25 Comparative Study for Ground Level Plan based on Urban Planning of Ho Chi Minh City (For Reference)

	Option 1 No Atrium	Option 2 Atrium (H=1.0m)	Option 3 Atrium (H=3.5m)	Option 3a Atrium with Arch Shape (H=3.5m)
Plan				
Section				
Perspective View				
Impact on Scenery	・ The landscape in front of Ben Thanh Market will be renovated according to the new urban planning.	・ The landscape in front of Ben Thanh Market will be renovated according to the new urban planning. ・ The new landscape with low rise atrium will be created.	・ The landscape in front of Ben Thanh Market will be renovated according to the new urban planning. ・ The new landscape with high atrium will be created.	・ The landscape in front of Ben Thanh Market will be renovated according to the new urban planning. ・ The new landscape with arch shaped atrium will be created.
Statue	・ Basically statues will be relocated in accordance with urban planning of HCMC.	・ Same as Option 1	・ Same as Option 1	・ Same as Option 1
Entrance	・ There is no entrance to underground plaza.	・ Same as Option 1	・ The entrance with elevators and escalators to underground plaza can be designed.	・ Same as Option 3
Natural Light	・ There is no natural light poured into underground space.	・ Natural light can be poured into the underground space through glazed atrium.	・ Same as Option 2	・ Same as Option 2
Connection between Underground and Ground level	・ There is no accessibility between underground and ground level. ・ The attractive underground urban space can not be created.	・ The attractive urban space can be created because of the underground space connected with ground level through the atrium. ・ However people cannot move from underground plaza to ground level pedestrian space.	・ The attractive urban space can be created because of the underground space connected with ground level through the atrium. ・ People can easily move from underground plaza to ground level pedestrian space.	・ Same as Option 3
Recommendation	**C** **Not recommendable**	**B**	**A** **Recommendable**	**A** **Recommendable**

(b) Le Loi Street Plan

The ground level plan for Le Loi street based on urban planning of Ho Chi Minh City is shown in Figure4.30. According to this planning, Le Loi street is designed to form a pedestrian priority zone and serve as a transit mall while keeping the traffic flow of Nam Ky Khoi Nghia street and Pasteur street. Along Le Loi Street where the underground shopping mall will be developed, there will be structures from underground, such as staircases, ventilation towers, and cooling towers. The planning and design policies for the structures are set as follows:

- It is preferred that PC requires the developers of future redevelopment projects along the Street, to accommodate some of the structures in their site or inside the building, if possible.
- The most of structures are installed not in the sidewalk, but in the new median of Le Loi Street.
- In order to provide a vista toward the Opera, and to mitigate the massiveness of structure, the structure shall locate within five-meter-zone from the edge of the median. In addition, the size of structure shall be less than 8m at length, less than 3m at height.
- Structures shall use glassy transparent material to mitigate the massiveness, or green wall to contribute to the environment and Le Loi landscape.

The design image of the structures above grade like stairs, ventilation towers, and cooling towers is the same as Figure 4.25 shown in the Le Loi Street plan under the current street condition. In the next page the basic plan, section, and perspective view of Le Loi Street are shown as the planning policy of Le Loi street based on the urban planning of Ho Chi Minh City. The landscape design should be studied and determined through the consultation with the relevant parties in the next detail design stage.

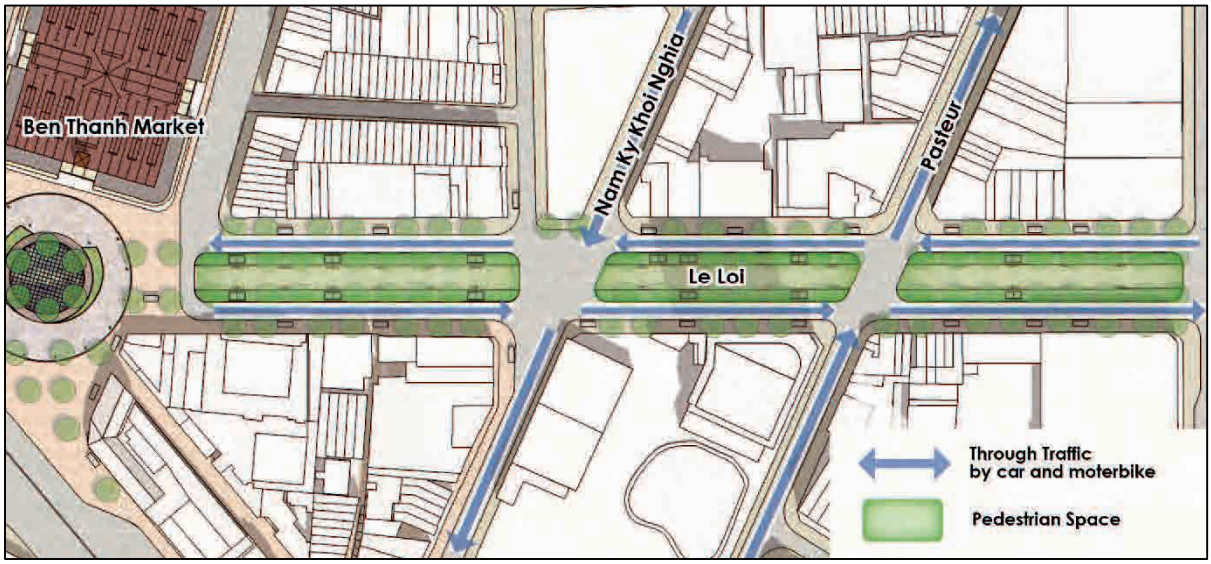
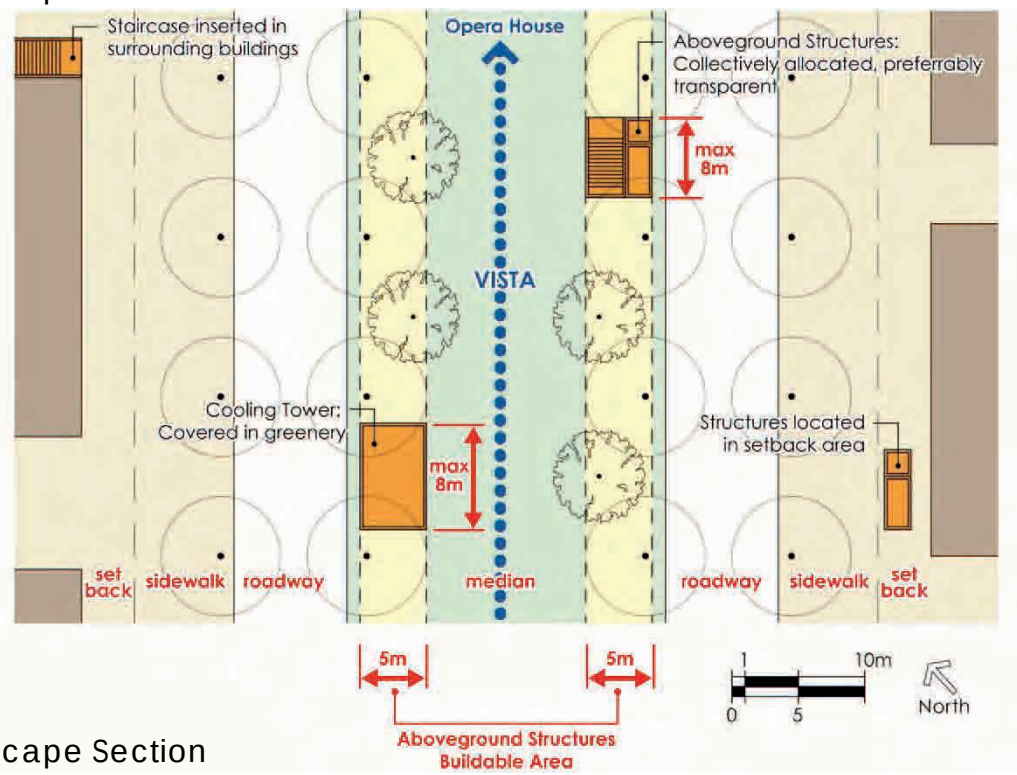
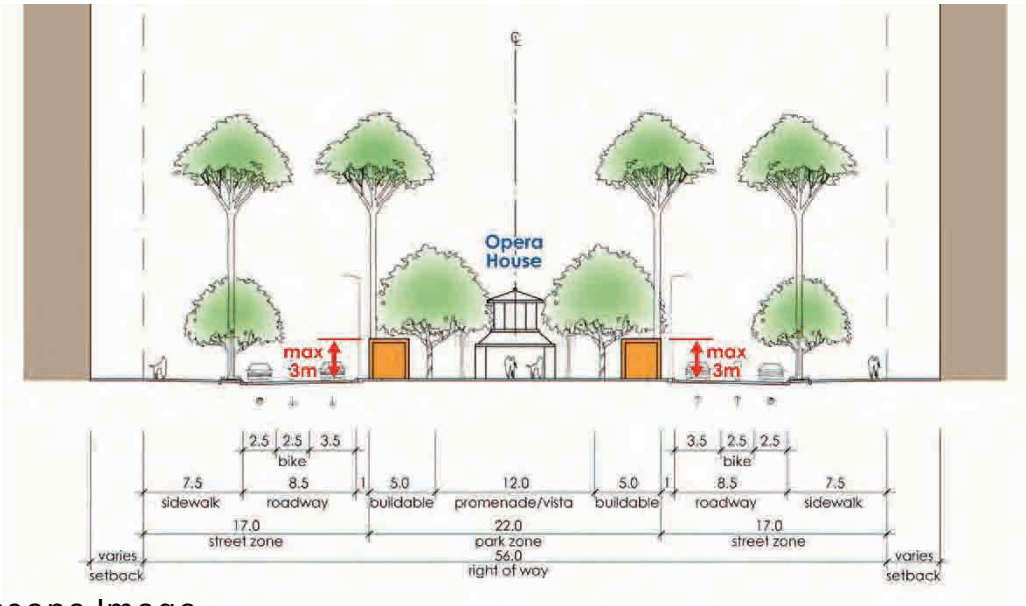


Figure4.30 Ground Level Plan of Le Loi Street
(based on Urban Planning of Ho Chi Minh City)

Landscape Plan



Landscape Section



Landscape Image

Figure 4.31 Basic Plan, Section, and Perspective View of Le Loi Street (based on Urban Planning of Ho Chi Minh City)

(2) Structures above Grade

The landscape design and the shape and design of on-ground structure like atrium should be studied and determined through the consultation with the relevant parties in the next detail design stage. However the design of the structure above grade, which is suitable for the urban planning of Ho Chi Minh City, is proposed for reference in this section.

(a) Atrium

- Structure : Fireproof-painted steel
- Outer wall : Tempered glass (Dot Point Glazing)
- Elevated podium wall: Stone tile on asphalt waterproofing concrete (H : above flood level)
- Roof : Tempered-laminated glass, Low-e glass, perforated steel panel below
- Natural smoke control system:Glass window
- Ground level entrance: Glass automatic door, airlock, Vertical damp proof barrier

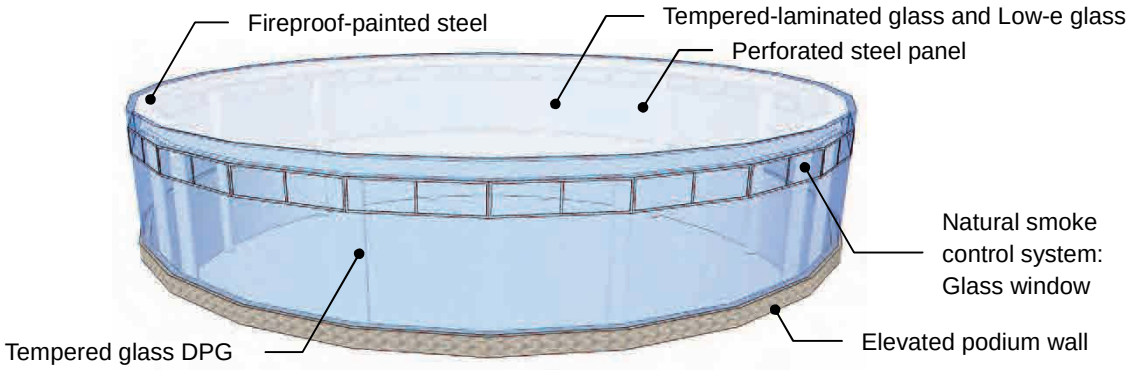


Figure 4.32 Atrium Image

(b) Staircase

- Structure : Stainless steel pipe frame
- Floor : Rough surface ceramic tile (Stair-nosing and Landing: anti-slip tile)
- Roof : Bake coating aluminum honeycomb panel (H=3,000)
- Wall : Ceramic tile
- Underground entrance: Roller shutter
- Ground level entrance: Vertical damp proof barrier

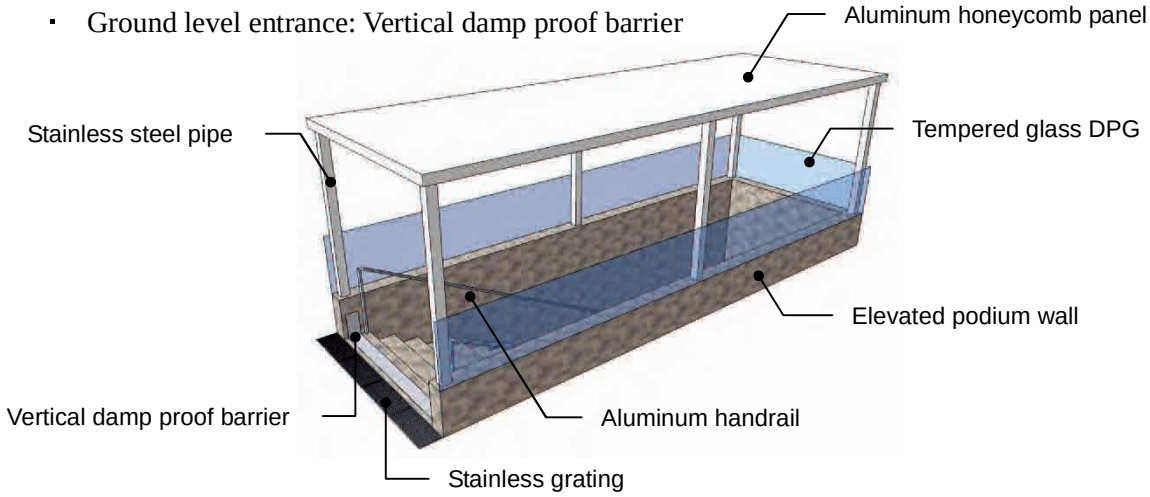


Figure 4.33 Staircase Image

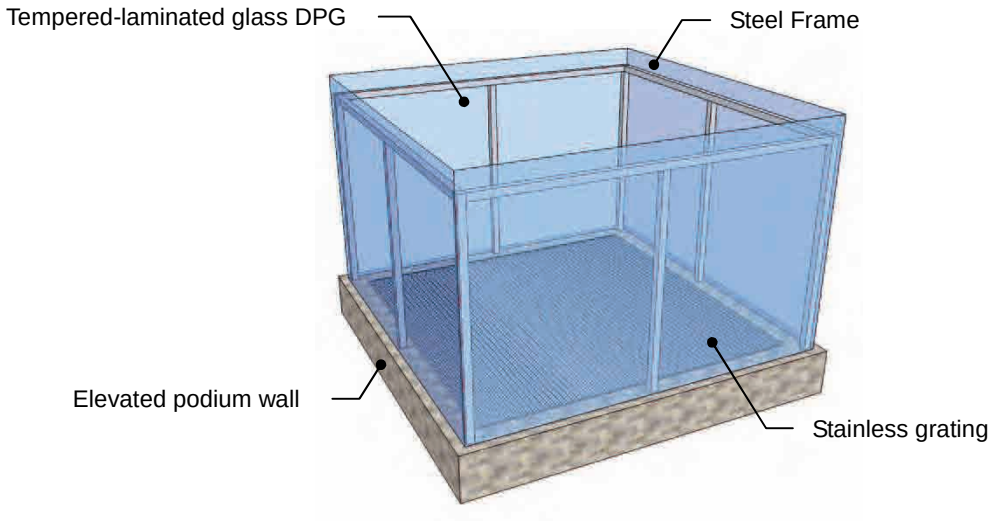
(c) Ventilation Tower

(i) Tempered Glass Type

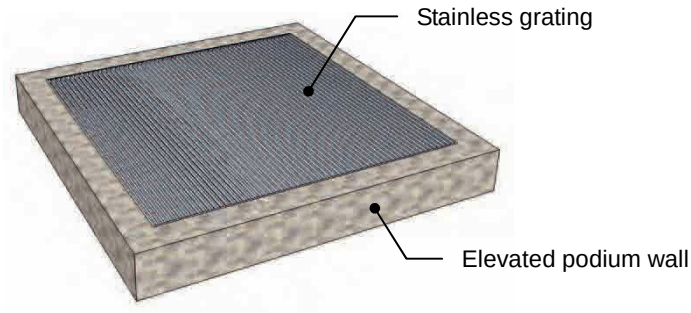
- Wall : Steel frame, tempered-laminated glass DPG (H:3,000)
- Elevated podium wall: Stone tile on asphalt waterproofing concrete (H: above flood level)
- Aperture : Stainless steel grating (aperture ratio: 75%)

(ii) Low-rise Type

- Elevated podium wall: Stone tile on asphalt waterproofing concrete (H: above flood level)
- Aperture : Stainless steel grating (aperture ratio: 75%)



(a) Tempered Glass Type Image



(b) Low-rise Type Image

Figure 4.34 Ventilation Tower (Low-rise Type) Image

(d) Cooling Tower

- Hiding Wall : Steel frame, precast concrete panel (H:5,000)
  To keep distance from the cooling tower at least 3m.
  Façade: green wall

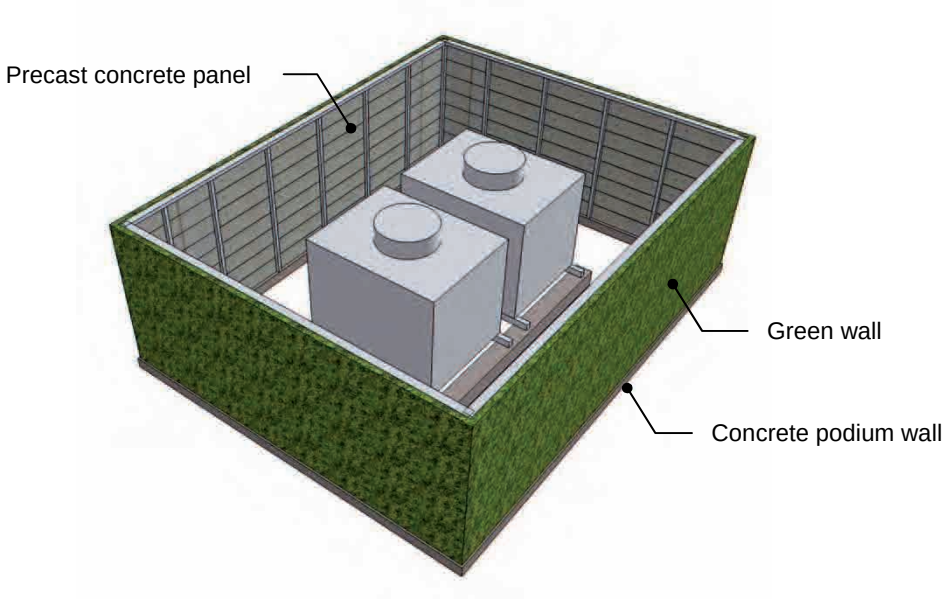


Figure 4.35 Cooling Tower Image